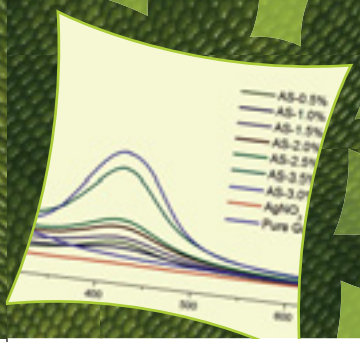
ANNUAL REPORT
वार्षिक प्रतिवेदन
2015-16



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

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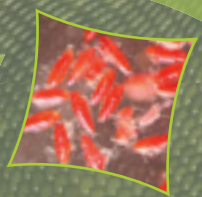

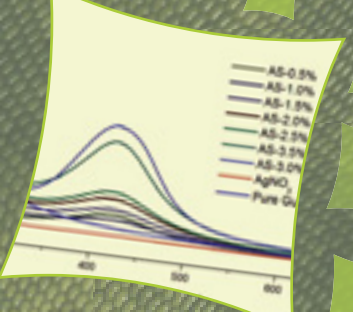

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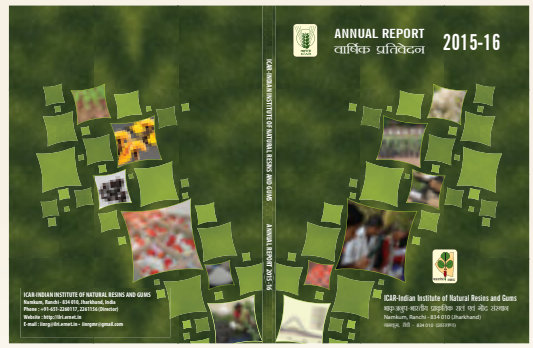

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- PGPR treated *F. macrophylla* seedlings
- Air layering in *palas*
- Students observing lac-insect-stages
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Preface

India is a major global player in production and export of natural resins and gums (NRGs). The NRGs are low volume – high value commodities and play an important role in livelihood of the farmers. Of the 150 disadvantaged districts identified by the Planning Commission, NRGs are important source of income to farmers in around seventy districts.

The Institute is mandated to undertake research on the complete commodity chain-from production to end products for the consumers. Therefore, it has to respond to technological requirement for production, processing as well as application/product development of NRGs. The NRG sector is likely to confront challenges from several fronts. In the production front, the climate change is throwing newer threats affecting biodiversity, productivity and sustainability. The processing sector requires greater homogeneity and stringent quality criteria of NRGs in view of their use in applications related to human consumption. Processing and value addition of NRGs is need of the hour for enhanced returns and to carve new areas of consumption.

Accordingly, the programmes have been conceived to open up new frontiers in production, processing and applications. Researches on lac production have been linked to the climate change which is adversely affecting the production of lac. Intensive lac cultivation on bushy host plants, establishment of lac host plantations on a larger scale, improvement in lac production system management and integration of lac cultivation with agro-forestry have also been intensified on priority basis. Having realized that the summer *rangeeni* lac crop is often lost due to parasitization, research efforts on pest management with emphasis on bio-rational approaches are on. *In-situ* conservation of the lac insect biodiversity in the light of prevalent threat to their habitat through network approach has started yielding results with a futuristic goal of location specific lac production strategies exploiting local lac insect populations.

Most of the NRGs are still exported as raw material or in semi-refined form. Efforts are being made to develop new technologies with emphasis on export of refined / value added products and especially to reduce processing losses, development of protocol etc. Lac / NRG processing industry is still labour oriented. Keeping in view the impending demand for stringent quality standards and for reducing drudgery, integration of mechanization processes have resulted in development of Integrated Small Scale Lac Processing Unit to bring automation in the industry. Additional pilot plant on de-waxed de-colourized lac is being developed for training, demonstration and process refinement. The available facilities will also serve as Technology Incubation Units for the prospective entrepreneurs.

The technology delivery system has been complemented with expert advisory support using IT tools through structured and IT-complemented dissemination and delivery systems; web-based information and SMS services. This will lead to awareness and capacity building of farmers, industry (supply and consuming) and the developmental machinery.

Dedicated scientific input is likely to result in identification of newer potential hosts, conservation of lac insects and hosts through characterization and registration, new Lac Integrated Farming System models, development of new applications and products from NRGs, design & development of processing machines/plants and standard quality parameters of test procedure.

May, 2016
Namkum, Ranchi

(KK Sharma)
Director

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.

Introduction

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. Export of NRG showed an increasing trend in quantity, but decreased in value in 2014-15 in comparsion to 2013-14. Based on the final data available till November 2015, a sharp decline in export is noted. Consequently, the total value of NRG export particularly for *guar* gum was less than previous two year 2012-13 and 2013-14.

Indian Institute of Natural Resins and Gums (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 1064 mm, of which about 75 per cent (795 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, 24 administrative and 52 supporting posts with a total of 148 staff are in position as on December 31, 2015.

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 148 staff in scientific, technical, administrative and supporting categories. The Institute has a number of prestigious labs, like High Voltage Laboratory, Biotechnology, Bio-control Laboratory, Instrumentation Laboratory, Quality Evaluation Laboratory etc. The Institute shoulders the responsibility of collection and maintenance of germplasm of lac insect lines as well as lac host trees. More than 1800 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 of the NATLIGEC. Similarly, the Lac Host Plant Field Gene Bank of the Institute has ninety collections of 12 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. More than 1800 cultures of 72 lac insect lines are being conserved lives on potted plants of *bhalia* (*F. macrophylla*) under protected conditions in the Field Gene Bank of National Lac Insect Germplasm Centre (NATLIGEC).

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

- Lac insect was observed on rain tree in a survey conducted in northern districts of Tamil Nadu *viz*., Vellore, Tirivannamalai, Kanchipuram and Tiruvalluar. Lac insect stocks collected from NEH region (Assam, Manipur, Meghalaya and Nagaland) were evaluated during *baisakhi* (summer) crop 2014-15.
- Three new *palas* (*Butea monosperma*) variants for flower colours have been identified from Giridih district of Jharkhand.
- 1825 cultures of 73 lac insect lines are being conserved on potted plants of *Flemingia macrophylla* in Lac Insect Field Gene Bank and 90 collections of 55 species of lac host are being conserved in the National Lac Insect Germplasm Centre (NATLIGEC), at ICAR-IINRG, Ranchi**.**
- Evaluation studies carried out in the summer crop (2014-15) revealed that *Calliandra calothyrsus* is a potential host for both *Kerria lacca* and *Kerria chinensis* and for *K. lacca* (*rangeeni* and *kusmi*) only during winter and rainy crop (2014-15).
- Potential of twenty seven germ plasm of pigeon pea were assessed for summer *rangeeni* (*baisakhi*) crop. Birsa Arhar 1, Bahar, RCMP 2, IPA 9-1 and ICP 8863 were identified as promising for *baisakhi* crop.

Lac production system management

- Based on four year's screening for winter *kusmi* lac production potential, 23 fruit varieties of *ber*, *Maharawali* performed best with average output ratio of 8.8 followed by *Banarasi Pebandi*, Thornless and *Seb x Gola* (F1).
- Harvesting-cum-pruning of fruit *ber* varieties initiated during rainy season (*katki*) crop of *rangeeni* and winter season (*aghani*) crop of *kusmi*, revealed that growth rate in February pruning was much better than October pruning. *Bagwadi*, *Tikadi*, *Banarasi Karka* and ZG3 had good response during both pruning periods.
- Forty trees of *swadi palas* were pruned in five consecutive months from December to April at farmers' field to know the pruning response and suitability of new branches for winter *kusmi* lac inoculation. Relatively better length of new shoots (102 cm) recorded in late January pruning and in early February pruning (94 cm). The trees pruned in other months had poor response and did not gain adequate length for lac inoculation.
- Growth of three years old plantation of *swadi palas* raised in IRF during 2012 was found satisfactory; rate of increase in collar girth and height were 37 % and 30 %, respectively.
- Application of 25 % N through lac mud, 25 % N through vermicompost and 50 % N through inorganic source resulted in significantly higher fruit yield, fruit weight and number of fruits per plant of tomato and brinjal.
- Total carbon stock under *ber, palas* and *kusum* plantations, as estimated from the standard allometric equations, was revealed as 17552 kg/ha, 18816.93 kg/ha and 36573.55 kg/ha, respectively.
- Air layering in *kusum*, taking the best treatment combinations from the results achieved in 2014 conducted during the pre-monsoon season showed poor (30 %) rooting as compared to the previous year (66 %). 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 26 per cent and 30 per cent, respectively.
- *Rhizobium* group of bacterial isolates from root nodule of *F. macrophylla* and *F. semialata* are better choice for development of bio-fertilizer. Use of this bacterial inoculums along with other PGPR, accelerate the growth of this lac host plant at nursery condition to generate healthy, vigorous and early maturing host plant.

Pest and disease management

- Parasitoid and predator populations varied on different lac host plants viz*., ber, semialata, kusum, palas* and red gram. Among the parasitoids, *A. purpureus* was the most prevalent followed by *Tachardiaephagus tachardiae* and *Parechthrodrynus clavicornis* in all crops. Number of parasitoids trapped in *in-situ* method of

caging was more as compared to lab caging in all the hosts.

- The population of *Eublemma amabilis* and *Pseudohypatpa pulverea* reduced significantly (81-100 %) due to dipping treatment of novaleuran during 5 - 15 min dipping. 23-81 % suppression in the population of *T. tachardiae* was observed during 5 - 15 min dipping.
- Three sprays of Cantaf and Kavach at 60, 90 and 120 days after lac inoculation significantly reduced sooty mold and recorded the highest lac yield ratio on *semialata* and *ber*.
- Semio-chemcials present in lac insect ecosystem were studied using GC-MS. Volatile compounds *viz*., Tetratricontane, Hexacosane, Tetradecanoic acid, Palmitoleic acid and Octocosanol were more commonly recorded from lac associated products *viz*., wax, resin, lac insect whole body, lac dye and lac crawlers.
- Partial gene of farnesyl pyrophosphate synthase, one of the key genes involved in sesquiterpene synthesis was cloned from the Indian lac insect, *K. lacca* using transcriptome data following PCR based techniques. The expression profile study revealed that this gene expression got up regulated in settled larvae and adult female lac insects in comparison to crawlers.
- For identification of molecular markers associated with drought tolerance in selected lines of *F. semialata,* forty RAPD primers (Operon Technologies) were selected randomly and optimized in order to ensure the reproducibility and the discriminatory power of this technique between drought tolerant and susceptible lines of *F. semialata*.

Tapping, processing and characterization of NRGs

- Tree management by manuring and watering coupled with gum inducer application, substantially increased gum yield in *A. senegal* in semi-rocky areas of Bhopalgarh (ICAR-CAZRI, Jodhpur).
- As compared to arc method, the drilling method for application of ethephon for gum production was found superior in Karaya (*Sterculia urens*).
- Standardization of gum tapping from *B. monosperma* revealed that 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.
- *Guggul* (*Commiphora wightii*) plants were treated by CAZRI gum inducer (CGI) and *guggul* oleo-gum-resin inducer (GGI). It was observed that in the month of January (14.5 ^{0}C; average day temperature) oleo-gum-resin production was maximum for CGI followed by GGI. The results also indicated that with increase in temperature, the production of oleo-gum-resin decreased sharply.
- Physico-chemical properties of gum ghatti and Jhingan (Grades I, II and III) samples were determined as per BIS standards. Alditol acetate and uronic acid derivatives of both the gums were synthesized and characterized.
- Hydroxypropyl derivative of guar gum was characterized by thermal analysis using DSC and TGA/DTA. Cationic derivative of guar gum was also prepared and characterized by FT-IR and DSC.
- Integrated small scale lac processing unit, designed with CAD software, based on unit operations *i.e.* feeding, material conveying, crushing, grading, presoaking, washing and washing barrel tilting units was fabricated and evaluated successfully.
- Study on solvent extraction system, process of operations, use of different solvent carried out for determining type and suitability for pilot scale DDL preparation.
- Engineering properties (bulk density, true density, compressibility index, solubility, water holding capacity, oil holding capacity, angle of repose and static coefficient of friction) of 14 natural gums were studied and documented.

Application and product development

- Synthesis of borax cross-linked guar gum hydrogels was done with varying percentage of borax cross-linker. Cross-linking with borax improved the flocculation efficiency of hydrogels as compared to raw guar gum. Maximum flocculation was obtained at 1.5 ppm dose of the hydrogel.

- Green synthesis of silver nano-particles (AgNPs) using *A. senegal* and *A. nilotica* gums was carried out by autoclaving the reactants at 121 ^{0}C and 15 psi. The synthesis of silver nanoparticles was confirmed by UV-VIS spectroscopy, where a band at 425/427 nm corresponding to the typical surface plasmon resonance (SPR) band was observed.
- Lac based coating formulations were developed for paper packaging. Strength of the paper increased after coating the papers. Films of the formulation showed flexibility, good water and acid resistance.
- Work on development of nuggets from freshwater catfish, *Basa* (*Pangasius pangasius*) was concluded, in which guar gum and gum *acacia* gave the best performance, as regards binding, sensory and textural attributes of the nuggets.
- 0.4 % of gum blend (guar and *arabic* gum) improved the mouth feel and consistency of chocolate flavored milk; Incorporation of 0.2% of blend of gum (guar and *arabic* gum) in yoghurt improved the texture of yoghurt without wheying – off.

Capacity building and training

- Nine Farmers' Training Programmes on 'Scientific lac cultivation, processing and utilization' were organized for 207 farmers from four States *viz*., Assam, Jharkhand, Maharashtra and Odisha.
- 23 Master Trainers' Training Programmes on 'Scientific lac production, processing and uses' were organized for 778 stakeholders from Assam, Chhattisgarh, Jharkhand, Madhya Pradesh, Nagaland, Odisha and West Bengal States.
- Educational programme on 'Production, processing and uses of natural resin and gums' was conducted for 50 M.Sc. students of three institutions namely *Sam Higginbottom* Institute of Agriculture Science & Technology, Allahabad; Institute of Agriculture Science, Banaras Hindu University, Varanasi (U.P.) and Guru Ghasidas University, Bilaspur (Chhattisgarh).
- Two HRD programme on 'Lac promotion and development for executives of NEH region' (27 participants) and 'Integrated pest management in lac cultivation' were organized. A three day National workshop on 'Current trends in lac production on *F. semialata* and sustainable lac production technologies (37 beneficiaries from Chhattisgarh and Gujarat); and JASCOLAMPF sponsored vocational training for skill development on lac processing (25 beneficiaries) were conducted.
- 26 on-farm training programmes were organized for 2751 stakeholders of two States *viz*., Chhattisgarh and Jharkhand. 244 participants from three districts of Jharkhand *viz*., Gumla, Khunti and Ranchi benefitted from on-farm motivational / supplementary training programme.
- 82 in-campus one day orientation programmes on 'Natural resins and gums' were organized; 6482 farmers, school / college students and executives visited the institute. Eight short term lac based product demonstration training programmes were organized on aleuritic acid and dewaxed bleached lac products.

Field demonstration and extension activities

- Lac Integrated Farming System-II, models were evaluated at two locations in Hurum kocha village, two locations in Mangobandh and one each in Jawghai and Pater villages, besides two newly adopted farmers of Gosaintoli of Deoghar village.
- An ICT enabled One to One Programme (OTOP) benefited farmers, processors, industrialists, lac businessmen, lac handicraft entrepreneurs and others through interaction with the experts of Institute on the technical aspects of NRG.
- Experts of the Institute participated in six Exhibition / *Kisan Melas* wherein around 7100 visitors were acquainted with the different activities of Institute; participated in 19 *Kisan gosthi* organized in different districts of Jharkhand & Odisha States that benefitted about 3000 participants. A sum of Rs. 24,76,700 /- (Rs. Twenty Four Lakh Seventy Six Thousand Seven Hundred) only was generated through training charges, consultancy project and sale of literature during the period.
- Total production of NRG increased from 1160314 tons in 2013-14 to 1196308 tons in 2014-15. However, due to high market price fluctuation a decline in guar gum production was observed during 2015-16. Production of lac also decreased by 19.18 % than the previous year.

Research Accomplishments

Lac Production

1. Productivity and Quality Improvement

1.1. Collection, conservation, characterization and documentation of lac insect and host plant biodiversity

Survey of Jharkhand for lac insect and lac host plants

Dumri and Majhidih village of Giridih district (Jharkhand) were visited on March 20-21, 2015 and identified three new *palas* (*Butea monosperma*) variants for flower colour. The flower colour variants from Dumri were orange (Fig. 1a) and saffron (Fig. 1b) and from Majhidih was saffron (Fig. 1c) as compared to scarlet (Fig. 1d) which was naturally available.

Survey of Himachal Pradesh for lac insect and lac host plants

Solan, Chail, Kufri, Kandaghat, Dharampur and surrounding hills were surveyed for exploring lac insect and host plants. Lac host plants such as *palas, khair, pipal, Ficus glomerata, Ficus palmata, Mallotus phillipensis* were observed in and around Solan, but no lac insect was observed.

Survey of Tamil Nadu for lac insect and lac host plants

Four northern districts of Tamil Nadu *viz.* Vellore, Tirivannamalai, Kanchipuram and Tiruvalluar were surveyed. The regions of Eastern Ghats *viz.* Jawadhu hills, Kavalur forest area, Alangayam, Yelagiri forest hills and Thiruthani hills were covered during the survey. Lac insect was observed on rain tree (*Albizia saman*) at Vellore (Fig. 2a), in the peripheral areas of Jawadhu hills *viz*. Venkatesapuram (Fig. 2b) and Gandhi Nagar (Fig. 2c) in Katpadi, Rathnagiri (Kanikapuram) and Tiruvalluar (Fig. 2d). Lac insect was also observed on *pipal* (*Ficus religiosa*) at Vellore (Fig. 2e) and on rain tree observed at Tuni railway station, East Godavari (Andhra Pradesh) (Fig. 2f). Lac host plants such as *A. saman*, *A. lebbeck, B. monosperma*, *M. phillipensis, Peltophorum ferrugenium, Schleichera oleosa, Ficus spp, Zizipus spp, Acacia spp* and *Ziziphus mauritiana* were observed during the survey.

Fig. 1. Flower colour variants of *palas* (*B. monosperma)* **(a-d)**

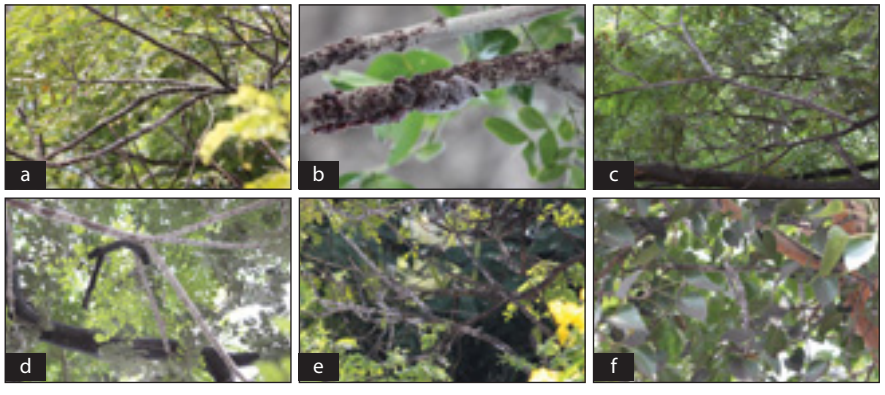


Fig. 2. Natural lac insect population on rain tree (*A. saman*) at Vellore (a) Venkatesapuram (b) and Gandhi Nagar (c) in Katpadi, Tiruvalluar (d) Tuni (e) East Godavari (Andhra Pradesh) and on *pipal* (*Ficus religiosa*) at Vellore (f)

Documentation of Lac Hosts

Characterization of flower/pod of *Dalbergia assamica* tree species

Flower is typical papilionaceous, calyx is campanulate (bell shaped), 5-toothed, lowest tooth longer than tube. Corolla is white with purple stripes inside, standard reflexed (turn back abruptly), orbicular (flat, with a circular, or almost circular outline), emarginated (having slight notch at the tip). Wings broadly ovate. Keel half-moon-shaped, enclosed by wing petals. Pod is a legume, broadly ligulate (strap-shaped) or oblong to. Both flowering and fruiting occur in April to May (Fig. 3a & b).

Fig.3. Flowers (a) and pods (b) of *Dalbergia assamica* tree species

Characterizationof flower/pod of *Shorea talura* tree

Talura lac tree is a resin-bearing deciduous tree with simple alternate leaves. Leaves are elliptic-oblong, thin, slender and rather prominent beneath. Panicles are 8-10 cm long, white, axillary, branchlets up to 4 cm long with three flowers. Flowers are two cm long, lanceolate, white, five petals and twisted (Fig. 4a) with one stigma and 15 stamens. Calyx 5 mm long cup-shaped, light green in colour with winged accrescent. Fruit is a capsule (Fig. 4b). All panicle, flowers, calyx are glabrous in nature. Flowering period from February to March and fruiting from April to May.

Fig.4. Flowers (a) and pod (b) of *Shorea talura*

Characterization of flowers/pods of Sandan (*Dalbergia oojeinensis*)

Flowers are white or pink (Fig. 5a), some what fragrant, borne in short-fascicled racemes arising from the nodes of old branches. Pedicels 1.2-2 cm long, filiform. Calyx pubescent, teeth short, triangular, red wine in colour. Fruits (pods) linear-oblong, flat (Fig. 5b).

Fig.5. Flowers (a) and pods (b) of *Sandan* (*Dalbergia oojeinensis*)

Evaluation of lac insect stocks

Lac insect stocks collected from NEH region (Assam, Manipur, Meghalaya and Nagaland) were evaluated during *baisakhi* (summer) crop 2014-15. Average density of settlement was the highest (87 per sq. cm) in Assam stock with 16 per cent mortality. Male sex ratio ranged from 66-88 per cent in Assam, Meghalaya and Nagaland stock whereas Manipur stock recorded 100 per cent male emergence. Average fecundity was more (332) in Assam stock whereas no difference was observed in cell weight and resin weight from other three stocks (Fig. 6). Evaluation of lac insect stocks collected from NEH region was continued during *katki* (rainy) crop 2015. Average density of settlement varied between 96-109 per sq. cm and initial mortality was 3-12 per cent in three stocks. Male sex ratio was more than optimum and ranged between 44-64 per cent on all the stocks. There was no difference in average fecundity, cell weight and resin weight in all the stocks (Fig. 7).

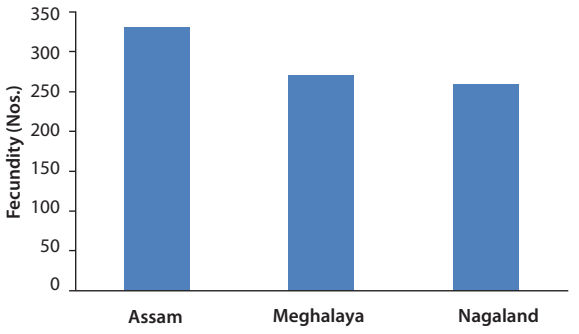


Fig. 6. Average fecundity during summer (*baisakhi*) crop 2014-15

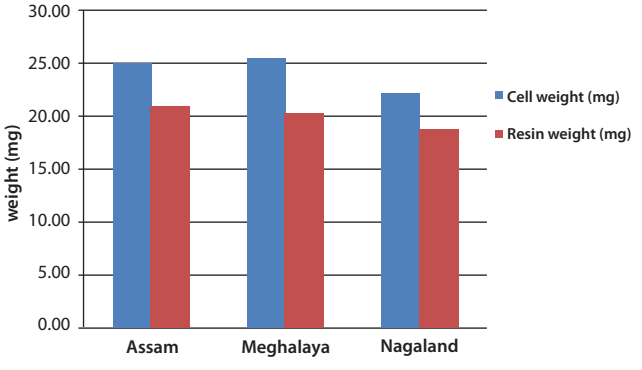


Fig. 7. Cell and resin weight during rainy (*katki*) crop 2015

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

Evaluation of *K. chinensis* and *K. lacca* (*kusmi* and *rangeeni*) was carried out during both crop cycles of 2015. Broodlac was inoculated and biological attributes, *viz.* pre-harvest and post-harvest parameters were recorded on *C. calothyrsus, C. surinamensis, D. assamica* and *M. penduliflorus*.

Evaluation of *K. chinensis* and *K. lacca* (*kusmi* and *rangeeni*) during summer 2014-15

Initial settlement density of *K. chinensis* was the highest in *M. penduliflorus* (134 per sq. cm) followed by *D. assamica, C. calothyrsus* and *C. surinamensis.* Initial mortality and sex ratio of *K. chinensis* were lesser in *C. calothyrsus* 19 and 15 per cent, respectively than the other hosts. No significant differences were recorded in average fecundity, cell and resin weight on *C. calothyrsus* and *M. penduliflorus* (Fig. 8). Yield attributes *viz.* broodlac and broodlac ratio obtained were more on *M. penduliflorus* (175 g and 2.39 per plant) (Fig. 9) than *C. calothyrsus* (120 g and 2.0 g per plant).

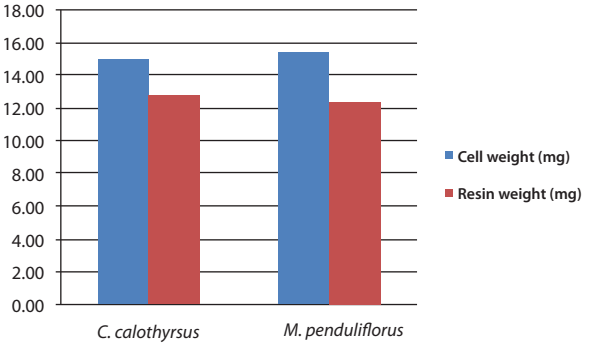


Fig. 8. Cell and resin weight of *K. chinensis* on different hosts during summer, 2014-15

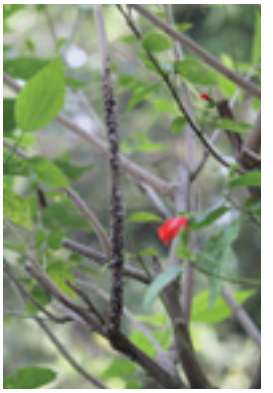


Fig. 9. *K. chinensis* on *M. pendulifloru* during summer 2014-15

Evaluation of *K. lacca* (*rangeeni*) during summer (*baisakhi*) crop 2014-15

Settlement density was more in *M. penduliflorus* followed by *C. calothyrsus, D. assamica* and *C. surinamensis.* Initial mortality ranged between 6-15 per cent in all the host plants. Average fecundity (424 Nos.), cell and resin weight (20 and 16 mg) was more on *C. calothyrsus* than other hosts (Fig. 10). Yield attributes *viz.* broodlac (1.08 kg), scraped lac (112 g) and broodlac ratio (4.32) was obtained on *C. calothyrsus* (Fig. 11).

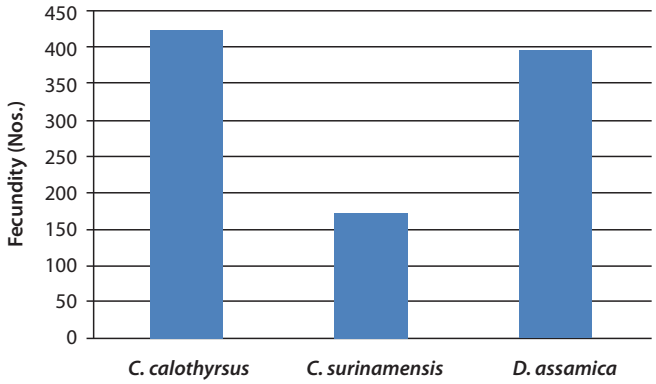


Fig. 10. Fecundity of *K. lacca* (*rangeeni*) on different hosts during summer (*baisakhi*) crop 2014-15

Fig. 11. *K. lacca* (*rangeeni*) on *C. calothyrsus* during summer 2014-15

Evaluation of *K. lacca* (*kusmi*) during summer (*jethwi*) crop 2015

Initial settlement density of *K. lacca* (*kusmi*) was higher with low mortality on *C. calothyrsus* and *D. assamica* than the other hosts. Sex ratio was more than 50 per cent on *D. assamica* and *M. penduliflorus.* Average fecundity was more on *D. assamica* (307) whereas cell and resin weight were more on *C. calothyrsus* (19 and 15 mg) than other hosts (Fig. 12). Yield attributes *viz.* broodlac, rejected lac, scraped lac and broodlac ratio obtained were on *C. calothyrsus* (701 g, 0.0 g, 178 g and 4.21 per plant), *C. surinamensis* (845 g, 53 g, 87 g and 3.38 per plant) (Fig. 13) and *D. assamica* (137 g, 0.0 g, 30 g and 2.05 per plant).

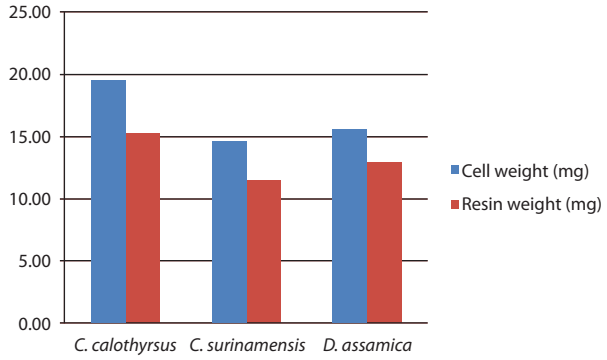


Fig. 12. Cell and resin weight of *K. lacca* (*kusmi*) during (*jethwi*) 2015

Fig. 13. *K. lacca* (*kusmi*) on *C. surinamensis* during summer 2014-15

Evaluation of *K. lacca* (*kusmi*) during winter (*aghani*) crop (2014-15)

Settlement density of *K. lacca* (*kusmi*) was more (142 per sq. cm) on *C. calothyrsus* followed by *M. penduliflorus, D. assamica* and *C. surinamensis.* Initial mortality was lesser (16 % and 29 %) on *C. calothyrsus* and *D. assamica,* respectively. Optimum sex ratio was recorded on all the hosts except *M. penduliflorus.* Average fecundity was more on *C. calothyrsus* than *D. assamica* (Fig. 14). However, cell and resin weight

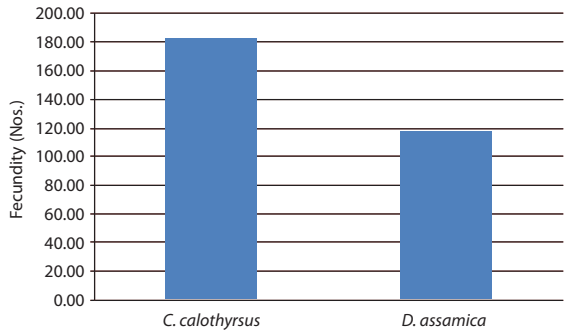


Fig. 14. Fecundity of *K. lacca* during winter (*aghani*) crop 2014-15

(30 and 26 mg) were more on *C. calothyrsus* than *D. assamica*. Yield attributes, *viz.* broodlac, scraped lac and broodlac ratio obtained were on *C. calothyrsus* (0.77 kg, 530 g and 3.7 per plant) and *D. assamica* (0.09 kg, 90 g and 0.47 per plant).

Evaluation of *K. chinensis* during rainy season (2015)

Settlement density of *K. chinensis* was more with lesser mortality on *M. penduliflorus* (116 per sq. cm and 38 per cent) followed by *C. calothyrsus* and *D. assamica*. Sex ratio was more than 60 per cent on *C. calothyrsus* and *M. penduliflorus*. Post harvest parameters could not be recorded due to lac insect mortality during rainy crop 2015.

Evaluation of *K. lacca* (*rangeeni*) during rainy (*katki*) crop (2015)

Settlement density of *K. lacca* (*rangeeni*) varied between 61-76 per sq. cm on *C. calothyrsus, C. surinamensis* and *D. assamica,* whereas mortality was lesser on *C. calothyrsus* (30 %) followed by *D. assamica* and *C. surinamensis*. Fecundity (312), cell and resin weight (18 and 13) was more in *C. calothyrsus* (Fig. 15) than other hosts. Yield attributes, *viz.* broodlac, rejected lac, scraped lac and broodlac ratio obtained were 4.68 kg, 738 kg, 553 g and 4 per plant on *C. calothyrsus*. However, only rejected lac (573 and 283 g/plant), scraped lac (288 and 92 g/plant) were obtained from *C. surinamensis and D. assamica,* respectively.

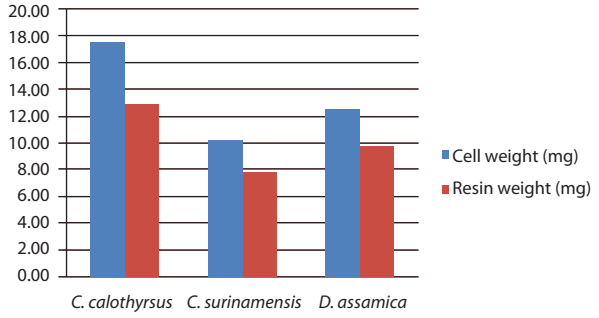


Fig. 15. Cell and resin weight of *K. lacca* during rainy (*katki*) crop 2015

Comparison between *K. chinensis* with *K. lacca* (*kusmi* and *rangeeni*) during summer, winter and rainy crop, 2014-15

C. calothyrsus proved to be good host for both *K. lacca* and *K. chinensis* during the summer crop 2014-15. Comparison was made between *K. chinensis* with *K. lacca* on *C. calothyrsus* which revealed that, higher density of settlement and lower initial mortality of *K. chinensis* than *K. lacca* (*rangeeni* and *kusmi*). However, *K. lacca* (*rangeeni* and *kusmi*) recorded higher fecundity, cell and resin weight, brood lac weight and broodlac ratio than *K. chinensis. C. calothyrsus* proved to be good hosts for only *K. lacca* (*rangeeni* and *kusmi*) during the winter and rainy crop 2014-15. Comparison between *K. lacca* (*rangeeni* and *kusmi*) revealed that higher density of settlement with lesser initial mortality and more cell and resin weight of *K. lacca* (*kusmi*) than *K. lacca* (*rangeeni*). However, fecundity, broodlac weight and broodlac ratio were more on *K. lacca* (*rangeeni*) than *K. lacca* (*kusmi*) during winter and rainy crop, 2014-15.

Collection and Conservation of Lac Insects/Host Plants

Conservation of *palas* variants through vegetative propagation

Air layering of *palas* (*B. monosperma*) variants for flower colour

Three trees with yellow coloured *palas* flowers from Khakikala and Dumri villages of Giridih (Jharkhand) were selected for air layering. Two treatments of plant hormones *viz.* T_1 (IBA 2000 ppm: NAA 1000 ppm: Kinetin 100 ppm) and T_2 (IBA 1000 ppm: NAA 500 ppm: Kinetin 50 ppm) with one soil media (1 vermicompost: 1 soil: 0.5 spagnum moss: 2 sand) were used for air layering. The air layering was carried in the month of May 2015. Ten air layers of each treatment were carried out in each plant. Total 60 air layers were done, out of which 31 air layers were successfully rooted. The treatment T_2 gave high rooting performance over T_1 (Fig. 16). T_2 had given 19 (61%) successful air layers whereas T_1 12 (38%) successful air layers.

Fig.16. Air layering in yellow coloured flower *palas*: T_1 (b & c) and T_2 (a)

National Lac Insect Germplasm Centre (NATLIGEC)

- 1825 cultures of 73 lac insect lines are being conserved on potted plants of *F. macrophylla* in Lac Insect Field Gene Bank.
- Ninety collections of 55 species are being conserved in the Lac Host Field Gene Bank.
- *Swadi palas* plantations consisting of 72 plants are being conserved in a separate plot.
- A perennial local red gram variety collected from Damara was planted in the field.
- Seedlings of *swadi palas*, *palas* variants for flower colour (chrome yellow, yellow, mustard yellow and orange colour) and *F. stricta* were in the nursery.

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

One of the main components of lac resin is sesquiterpenes. The biosynthesis of sesquiterpenes is through the mevalonate pathway and the precursor for all sesquitepenes is farnesyl pyrophosphate (FPP). The enzyme involved in the formation of FPP is farnesyl pyrophosphate synthase (FPPS). Since it is one of the key steps in sesquiterpenoid biosynthesis, the cloning of FPPS gene was attempted. The primers were designed from the transcriptome data and partial gene was initially cloned. Then the 3' RACE was conducted to clone the 3' end of the gene. After the sequencing and assembly of the partial FPPS fragment and 3' RACE product, it resulted in 769 bp sequence of *K. lacca* FPPS encoding gene (Fig. 17). The final product revealed a great homology with the mitochondrial isoprenyl diphosphate synthase gene reported in bird cherry-oat aphid (*Rhopalosiphum padi*). The expression profile study revealed that this gene expression got up regulated in settled larvae and adult female lac insects in comparison to crawlers.

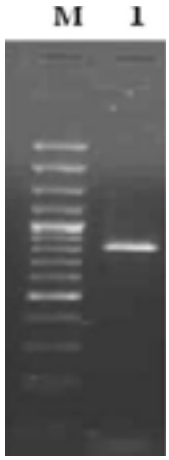


Fig. 17. Cloning of partial FPPS gene from *Kerria lacca*

1.3 Development and evaluation of lac production technologies

Ber : Winter *kusmi* (2014-15)

Twenty three *ber* varieties were assessed for winter *kusmi* lac productivity by inoculating quantity of broodlac @ 200 gram per plant in July 2014. A*ghani* crop was harvested in February 2015 for the fourth consecutive years. Varieties responded significantly different for *kusmi* lac production. Initial settlement density ranged from 129 to 179 nymph/sq. cm. Average settlement length of crawlers on tender shoots was maximum (95 cm) in *Katha* and minimum (51 cm) in *Jogia*. Sex ratio varied from 13 % (*Kaithali*) to 26 % (*Aligarh*). *Maharawali* (3158 g/plant) and *Banarasi Pebandi* (2970g / plant) performed significantly better than the check *ber* variety (CAZRI *Gola,* 2257 g / plant) so far as per plant lac yield was concerned. Maximum broodlac output ratio of 15.7 was recorded in *Maharawali* followed by 14.9 in *Banarasi Pebandi* (Fig. 18). *Maharawali* had also significantly higher scraped lac yield per plant (1711 g) followed by *Banarasi Pebandi*.

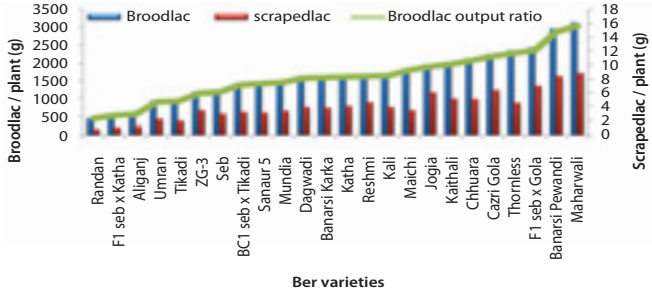


Fig. 18. Winter *kusmi* lac production on *ber* varieties

Based on screening of four years, *ber* varieties for winter *kusmi* lac production potential, *Maharawali* performed the best for winter (*aghani*) crop with average output ratio of 8.8 amongst twenty three fruit varieties followed by *Banarasi Pebandi*, Thornless, *Seb* x *Gola* (F_1).

Pruning response of fruit *ber* varieties

All the 23 varieties of *ber* grouped into two coupe were pruned in the month of October 2014 and February 2015 for comparison of pruning response (Table 1). Final diameter of shoots was recorded in the month of July in both the coupe.

Table 1. Pruning dimension of new shoots in *ber* varieties after harvest of *katki* and *aghani* crop

	Maximum shoot diameter per 10 mm branch diameter	Number of shoot per 10 mm branch diameter	Average shoot diameter	Number of shoot	
Varieties of *ber*	During pruning time	During pruning time	During pruning time	February	October
Dandan	3.74	2.98	2.85	3.92	2.04
Aligarh	5.35	2.83	3.49	3.67	2.00
Seb × *Katha* (F_1)	4.64	1.70	3.53	2.02	1.38
Bagwadi	5.37	1.92	4.26	2.65	1.18
Illaichi	4.71	1.32	3.10	1.74	0.89
Thornless	4.27	1.87	3.06	2.29	1.44
Maharawali	4.56	1.64	3.52	1.70	1.59
Kali	5.56	1.64	3.66	2.52	0.77
CAZRI Gola	5.69	1.58	3.36	2.22	0.94
Reshmi	5.25	1.64	3.99	1.38	1.90
Katha	4.83	1.62	3.73	2.10	1.14
Seb × *Gola* (F_1)	4.89	1.79	3.53	2.23	1.35
Seb × *Tikadi* (BC_1)	4.61	1.59	3.75	2.31	0.87
Chhuara	5.17	1.17	3.83	1.38	0.96
Umran	6.38	1.49	4.95	1.44	1.54
Tikadi	7.75	2.77	4.41	4.16	1.37
Jogia	5.02	1.48	3.90	1.77	1.20
Banarsi Karka	6.09	1.91	5.05	2.10	1.71
ZG-3	6.09	1.91	5.05	1.74	1.05
Seb	5.19	1.40	4.34	1.59	1.21
Sanaur 5	5.73	1.91	4.31	1.62	2.20
Kaithali	4.60	1.58	3.44	1.79	1.38
Banarsi Pebandi	4.07	1.67	2.97	1.75	1.59
	*	*	*	*	
CD=	1.22	0.71	0.83	1.01	
	3.74	2.98	2.85		
Pruning time					
February pruning	5.17	2.18	3.35		
October pruning	5.10	1.38	4.22		
	NS	*	*		
CD=	0.36	0.21	0.25		

Data pertaining to maximum shoot diameter, number of shoots and average shoot diameter per 10 mm branch diameter (computed values) were compared separately for comparison in general. Data in Table 1 revealed that *Bagwadi*, *Kali, CAZRI Gola, Umran, Tikadi, Banarasi Karaka* and ZG-3 were better performers so far as maximum shoot generation capacity is concerned. Similarly, *Dandan, Aligarh, Bagwadi, Tikadi, Banarasi Karka* and ZG-3 performed better for number of shoot and *Bagwadi, Umran, Tikadi, Banarasi karaka*, ZG-3 and *Seb* for average diameter of shoots. So far as pruning time is concerned, February and October were not markedly different in maximum shoot diameter generation. However, February pruning gave rise to significant increase in number of shoots (58%). Similarly, October pruning registered high

value for average shoot diameter per 10 mm branch diameter (4.22 mm). Here, it is worth while to mention that it took nine months to obtain the value (4.22 mm) in October pruning and five months for February pruning (3.35 mm). Therefore, growth rate in February pruning was much better than pruning in October. As far as growth trend is concerned, initial growth of new shoots was very slow in February but got accelerated in March 2015 and onward. New shoots achieved average diameter of 8.2 mm and length of 92 cm in July at the time of broodlac inoculation for *katki* crop (Fig.19).

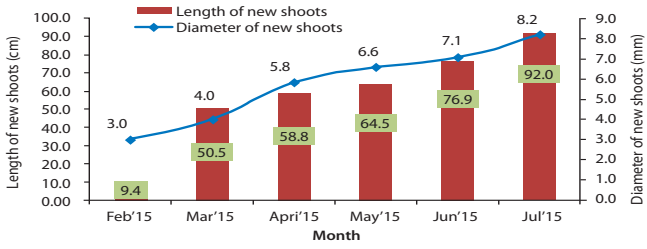


Fig. 19. Diameter and length of new shoots over *ber* varieties in October pruning

Identification of molecular markers associated with drought tolerance in selected lines of *F. semialata.*

Leaf samples of twelve random plants of *F. semialata,* six each of drought tolerant and drought susceptible were collected, frozen in liquid nitrogen and stored at -80 ^{0}C for DNA extraction. Genomic DNA was isolated by CTAB method. The extracted genomic DNA was estimated on 0.8 % agarose gel in 1XTBE buffer, stained with ethidium bromide and visualized under Gel Documentation System. The quantity of extracted DNA was estimated by NANO Drop Spectrophotometer (Thermo, USA) and diluted to 100 ng/µl with 1xTE buffer and stored at - 20 ^{o}C. Forty RAPD primers (Operon Technologies, Almeda, CA) were selected randomly. Optimizations of the RAPD reactions were done in order to ensure the reproducibility and the discriminatory power of the technique between drought tolerant and susceptible lines of *F. semialata.* The standardization of some parameters such as $MgCl_2$ and *Taq* DNA polymerase enzyme concentrations, the annealing temperature and the thermal cycling profile were done to get reproducible and polymorphic amplification. At present, the optimization of PCR conditions for RAPD primers is still continuing.

Potential of pigeon pea germplasm for summer *rangeeni* crop

Potential of twenty seven germplasm of pigeon pea was assessed for summer *rangeeni* (*baisakhi*) crop. Survival of lac insect was satisfactory up to sex differentiation stage, however mortality of plant was observed due to biotic factors. Although performance was not very good but few lines like Birsa Arhar 1, Bahar, RCMP 2, IPA 9-1 and ICP 8863 were identified as promising for *baisakhi* crop.

Pruning response in *swadi palas* at farmers' field

Forty trees of *swadi palas* were pruned for five consecutive months during December 2014 to April 2015 on farmers' field at Putadag, Angarha, Ranchi to know the pruning response and suitability of new branches for winter *kusmi* lac inoculation. Data on growth parameters like length and diameter of new branches were recorded at lac inoculation stage in early August 2015. There was significant difference in length of new branches. The highest length of new shoots (102 cm) was recorded in late January pruning followed by 94 cm in early February pruning. The trees pruned in December 2014 or in March and April 2015 had poor response in growth and did not gain adequate length. Although, difference in diameter of new branches was non-significant, however the highest diameter was recorded in December pruning and the lowest in April pruning (Fig. 20).

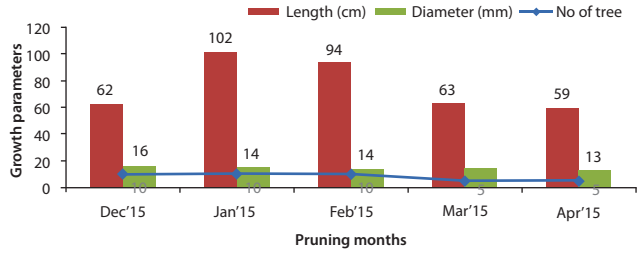


Fig. 20. Pruning response of *swadi palas*

Growth in new plantation of *swadi palas* at IRF

New plantation of *swadi palas* was raised with seventy two trees in IRF in 2012. Growth of three years old plantation of *swadi palas* was found satisfactory. Average height of trees increased from 36 cm to 47 cm whereas collar girth increased from 12 mm to 16 mm. Rate of increase in collar girth and height among 70 live trees were 37 % and 30 %, respectively (Fig. 21).

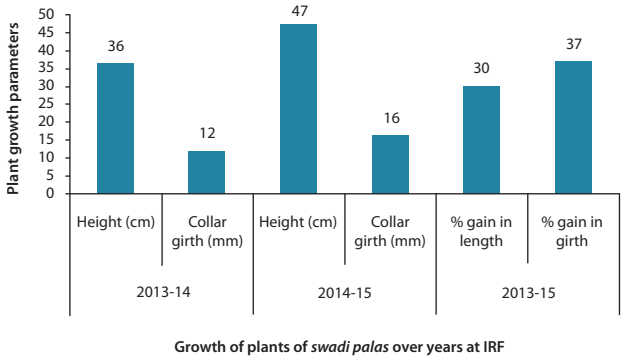


Fig. 21. Growth parameters of *swadi palas* at IRF

1.4 Isolation and characterization of root nodule bacteria from *Flemingia spp*

Isolation of root nodule bacteria from *F. macrophylla* and *F. semialata* was carried out by using YEM agar as media. Total 49 and 28 bacterial isolates were recorded from *F. macrophylla* and *F. semialata* respectively. The isolated bacterial strains were identified based on 16S rDNA sequence analysis and found that they mainly represented the genera *Bacillus*, *Rhizobium*, *Pseudomonas*, *Lycobactor* and *Ensifer*. The isolated bacterial strains were also tested *in-vitro* for plant growth promoting properties including indole acetic acid (IAA) production, potassium (K) solubilization, zinc (Zn) solubilization, siderophore production and urea utilization. On the basis of biochemical tests performed *in-vitro,* twelve efficient bacterial strains were selected as consortia for *in-vivo* treatment. The consortia of the selected efficient strains along with *Rhizobium* consortia, *Pseudomonas* consortia and *Bacillus* consortia were inoculated into the soil to validate the effect of bacterial isolates on growth and root nodule formation ability in *F. macrophylla*. It was found that *Rhizobium* inoculated plants showed two fold increase in biomass as compared to control. The study shows that *Rhizobium* bacterial isolates are efficient bio-fertilizer for the production of healthy and quick growing seedlings at nursery stage (Fig. 22).

2. Crop Production System Management

2.1 Lac Integrated Farming System (LIFS)

LIFS models at farmers' fields were evaluated for winter crops at different locations. At the field of Mahaveer Munda of Hurum Kocha village (area of 60 decimel land) LIFS comprising of paired *semialata* rows (1300 plants) in alternation with vegetables (tomato) was taken up. Paired row distance was 2 m and 12 kg tomato was harvested. Nepal Singh Munda of Hurum kocha village, who has adopted LIFS in an area of 30 decimel land, harvested 50 kg tomato, 55 kg brinjal, 25 kg peas and 6 kg mustard. Madi Munda of Mangobandh, who was given 32 kg of broodlac for adopting the lac cultivation on *semialata* in combination with brinjal and tomato, harvested 60 kg broodlac. Illizar Rhunda of Jawghai, who had already adopted LIFS (*semialata* + chilli + brinjal + tomato) on 2280 m^2 area two years back, harvested 99 kg scraped lac, 600 kg brinjal and tomato 500 kg. Jagan Nath Munda of Pater, who had adopted LIFS two years

Fig. 22. Two month old *F. macrophylla* seedlings inoculated with bacteria isolated from *F. macrophylla* root nodules

(The treatment from left 1st & 2nd rows are efficient consortia in non-sterile soil; 3rd & 4th rows are non-sterile soil control; 5th & 6th rows are efficient consortia in sterile soil; 7th, 8th, 9th & 10th rows are sterile soil control; 11th & 12th rows are *Bacillus* consortia; 13th & 14th rows are *Pseudomonas* consortia; 15th & 16th rows are *Rhizobium* consortia).

back on an area of 985 m^2, with 700 *semialata* plants in paired row pattern, harvested 40 kg broodlac and 30 kg brinjal. Prakash Sangha of Mangobandh, who had adopted LIFS (*semialata* + papaya + vegetables) on area of 1728 m^2, harvested 250 kg broodlac, 90 kg scraped lac, 20 kg ari lac, 150 kg papaya.

During the summer season, most of the farmers could not grow vegetables due to less rainfall during monsoon. Mahaveer Munda of Hurum Kocha harvested 100 kg scraped ari lac; Nepal Singh Munda harvested 30 kg scraped ari lac; Maleshwar Das harvested 300 kg turnip, 5 kg *bukhla*; Illiyar Rhunda harvested 220 kg scraped ari lac and 10 kg chilli and Prakash Sangha harvested 740 kg broodlac, 55 kg scraped lac and 210 kg papaya.

Two new farmers Maleshwar Das and Madan Das of Gosaitoli Deoghar in Ranchi were identified for LIFS evaluation. Under LIFS field demonstration, 1200 and 800 seedlings of *Flemingia* were planted in their fields, respectively. Development of new LIFS models was initiated in the IRF in which 1200 seedlings of *Flemingia* were planted with interspacing of 4 m so that the cultural operations could be done through tractor. Mustard, peas and brinjal were sown/planted following standard packages and practices under three replications for each.

2.2 Development of spraying schedule of fungicides for management of sooty mold in winter *kusmi* lac crop

The lac insect *K. lacca* secretes lac from its body and make a cell, leaving three pores- two anterior brachial pores (through which respiration occurs) and one posterior anal tubular pore. Under favourable conditions species of *Capnodium* grow profusely making a dense fungal mat that also covers the lac encrustation. Probably, they block and choke the brachial pores leading suffocation to the lac insects and finally resulting in its death or complete or partial failure of the lac crop. During rainy season relative humidity is quite high throughout the cropping season of the winter *kusmi* lac providing favourable climate to the sooty mold fungi and causes significant loss to the lac crop, if not protected.

For optimizing fungicide, experiments were carried out to standardize suitable spraying schedule of Cantaf (hexaconazole) and Kavach (chlorothalonil) on *kusum*, *ber* and *F. semialata* on winter *kusmi* lac crop. In earlier experiments a dose of 0.5 ml Cantaf / liter water was found equally effective to its higher doses in managing sooty mold and, therefore, in the present experiment 0.5 ml/ liter dose was used. Similarly, for Kavach, the optimum dose was standardised as 1 g / liter water in earlier experiment. Three experiments on three hosts each for Cantaf and Kavach were laid out and *Kusmi* broodlac was inoculated accordingly. Eight treatments and 4 replications were undertaken in each experiment. Thirty two *ber* and 32 *kusum* trees each for Cantaf and Kavach were taken. In *F. semialata* 10 bushes were taken in one plot and thus 320 bushes for Cantaf and 320 bushes for Kavach were taken for the experiment. Recommended two insecticide sprays were given (Thiodan at 21st day and Dhawagold at 50th day after inoculation). Cantaf and Kavach were sprayed as per treatments.

Results indicated that in *semialata* Cantaf reduced sooty mold when two or more sprays were given whereas Kavach reduced the mold in all the spraying treatments. The highest yield ratio was recorded with three sprays of both the fungicides at 60, 90 and 120 days after lac inoculation (Table 2).

Table 2. Standardization of spraying schedule of Cantaf and Kavach to manage sooty mold infestation and prevent loss of lac yield due to sooty mold in *kusmi* winter crop on *semialata*

S. No.	Treatments	Cantaf			Kavach		
		Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)	Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)
1	1 spray at 60 DALI*	27.9	5.08	24.5	30.4	5.66	28.6
2	1 spray at 90 DALI	24.1	4.57	12.0	18.4	4.98	13.2
3	2 sprays at 90 and 120 DALI	23.7	5.85	43.4	20.4	4.50	2.2
4	2 sprays at 90 and 105 DALI	20.8	4.57	12.0	17.5	5.45	23.9
5	3 sprays at 60, 90 and 120 DALI	20.4	6.00	47.1	18.7	6.49	47.5

S. No.	Treatments	Cantaf			Kavach		
		Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)	Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)
6	3 sprays at 90, 105 and 120 DALI	17.9	6.03	47.8	20.9	5.87	33.4
7	2 sprays at 70 and 105 DALI	21.2	5.04	23.5	25.4	5.02	14.1
8	No fungicidal spray	36.6	4.08		43.7	4.40	
Cd 5%		13.3	0.95		12.7	1.50	

*DALI, days after lac inoculation

In case of *ber* also three sprays of both the fungicides reduced the sooty mold and gave maximum increase in yield ratio though in case of Kavach all the spraying schedules increased the lac yield (Table 3). In *kusum* both the fungicides reduced the mold significantly but in general yield ratio was very less and, therefore, definite conclusion on effect of fungicides on yield ratio could not be obtained (Table 4).

Table 3. Standardization of spraying schedule of Cantaf and Kavach to manage sooty mold infestation and prevent loss of lac yield due to sooty mold in *kusmi* winter crop on *ber*

S. No.	Treatments	Cantaf			Kavach		
		Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)	Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)
1	1 spray at 60 DALI*	18.4	7.56	55.9	19.5	6.74	103.0
2	1 spray at 90 DALI	23.8	6.21	28.0	13.7	5.57	67.8
3	2 sprays at 90 and 120 DALI	22.0	6.55	35.1	22.5	7.00	110.8
4	2 sprays at 90 and 105 DALI	22.9	6.83	40.8	14.0	6.70	101.8
5	3 sprays at 60, 90 and 120 DALI	13.3	7.50	54.6	12.5	8.11	144.3
6	3 sprays at 90,105 and 120 DALI	22.1	7.07	45.8	16.5	7.73	132.8
7	2 sprays at 70 and 105 DALI	24.2	6.88	41.9	14.6	6.88	107.2
8	No fungicidal spray	30.3	4.85		27.1	3.32	
Cd 5%		14.8	2.18		9.4	2.10	

*DALI, days after lac inoculation

Table 4. Standardization of spraying schedule of Cantaf and Kavach to manage sooty mold infestation and prevent loss of lac yield due to sooty mold in *kusmi* winter crop on *kusum*

S. No.	Treatments	Cantaf			Kavach		
		Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)	Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)
1	1 sprays at 60 DALI*	19.4	0.42	133.3	25.2	0.79	690.0
2	1 spray at 90 DALI	10.2	0.24	33.3	13.0	1.26	1160.0
3	2 sprays at 90 and 120 DALI	17.1	0.35	94.4	12.7	1.30	1200.0
4	2 sprays at 90 and 105 DALI	11.9	1.14	533.3	9.8	0.78	680.0
5	3 sprays at 60, 90 and 120 DALI	6.6	0.92	411.1	8.2	0.75	650.0
6	3 sprays at 90,105 and 120 DALI	9.4	1.49	727.8	19.2	0.63	530.0
7	2 sprays at 70. and 105 DALI	22.5	0.53	194.4	10.5	0.56	460.0

S. No.	Treatments	Cantaf			Kavach		
		Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)	Sooty mold (%)	Yield (output:input ratio)	Increase in yield (%)
8	No fungicidal spray	28.3	0.18		39.1	0.10	
Cd 5%		11.1	0.37		12.0	1.00	

*DALI, days after lac inoculation

The treatment of three sprays at 60, 90 and 120 days after inoculation of Cantaf, Kavach and Bavistin, the best three fungicides found in our experiments, were tested on *ber* at farmers' field in Jharkhand and W. Bengal. In Jharkhand, it was tested at three villages on 30 trees of 5 farmers. Yield ratio of 4.45 to 8.6 was achieved and Bavistin was found to be the best. In W. Bengal it was tested on 43 trees of 9 farmers in the village Putidih. Yield ratio of 7.9 to 8.5 was achieved with highest in Kavach. Our recommended practice could provide yield ratio of 7.0 whereas treatment without any management practices could yield only 0.9 yield ratio (Table 5 & 6).

Table 5. Effect of fungicidal spray schedule at farmers' field at Putidih (W. Bengal)

	Cantaf	Kavach	Carbendazim	Recommended	Without pesticide
No. of farmers	2	2	3	1	1
No. of trees	18	11	11	2	1
Broodlac used (kg)	40	25	25	8	2
Broodlac harvested (kg)	316.5	211.5	199	56	1.8
Scraped lac from rejected brood (kg)	37.0	21.0	14.0	3.0	1.0
Broodlac ratio (output:input)	7.9	8.5	7.9	7.0	0.9

Table 6. Effect of fungicidal spray schedule at farmers' field of Jharkhand

	Cantaf	Kavach	Carbendazim
No. of farmers	2	1	2
No. of trees	15	4	11
Broodlac used (kg)	40	20	40
Broodlac harvested (kg)	273.5	89	346
Scraped lac from rejected brood (kg)	15.9	5.0	17.0
Ratio (output : input)	6.8	4.45	8.6

2.3 Integrated nutrient management for quick establishment of *kusum* (*S. oleosa*) plantation

Germination per cent as affected by inoculation by different PGPRs and liming

VAM and azotobacter inoculation reduced seed germination by 71 per cent and 13 per cent, respectively. Liming proved to increase germination significantly (Fig. 23). Application of lime and phosphobacterin together improved germination remarkably. *Kusum* seeds sown in poly tubes and covered with plastic bags increased seed germination by 5 per cent (Fig. 24). Comparing germination percent and seed attributes of two years, a verifiable indicator has been developed for judging seed quality.

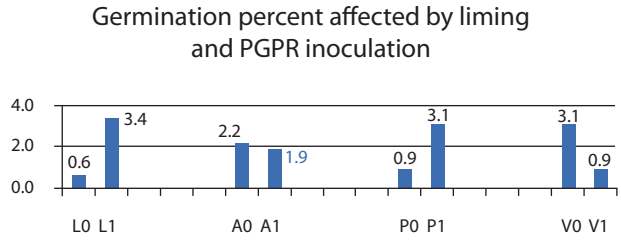


Fig. 23. Germination per cent affected by liming and different PGPR inoculation

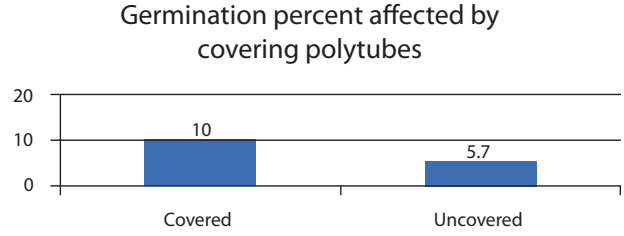


Fig. 24. Increased germination per cent by covering of nursery polytubes

Effect of fertilizer application and seed inoculation of azotobacter, phosphobacterin and VAM on growth of *kusum* seedlings

At the early stage of growth (September), application of chemical fertilizers did not produce any remarkable result in most of the growth attributes. So far as PGPR inoculation is concerned, all the factors *e.g.* azotobacter, phosphobacterin and vasicular arbuscular mycorrhizae inoculation (seed) reduced most of the plant growth attributes significantly. As a result plant vigour suffered remarkably.

However, at later stages of growth, fertilizer application proved its superiority on two growth parameters *i.e.* tap root length and shoot dry weight out of 10 parameters studied. Seventy eight and 22 per cent increase was observed respectively due to fertilizer application.

Inoculation of azotobacter did not show any influence on plant growth. Phosphobacterin inoculation, however, reduced plant growth significantly. Amongst different growth parameters, shoot diameter, shoot weight and root weight registered a decrease of 21, 22 and 44 per cent respectively, over control (Fig. 25, Table 7).

Table 7. Growth parameters as affected by fertilizer application and PGPR inoculation

	Shoot dia (cm)	Shoot length (cm)	Root length (cm)	Shoot wt (g)	Root wt (g)	Leaf wt (g)	Tap root length (cm)	Shoot dry wt (g)	Leaf dry wt (g)	Root dry wt (g)
F0	5.0	14.9	22.5	2.7	3.2	3.7	8.2	0.9	1.5	1.3
F1	5.2	15.4	23.1	2.9	4.1	3.5	14.6	1.1	1.3	1.1
							*	*		
A0	5.2	15.6	23.3	2.9	3.8	4.1	10.6	1.1	1.5	1.2
A1	5.0	14.8	22.3	2.7	3.5	3.1	12.2	0.9	1.2	1.1
P0	5.7	16.3	24.3	3.2	4.7	4.7	12.5	1.1	1.8	1.5
P1	4.5	14.1	21.3	2.5	2.6	2.5	10.3	0.9	0.9	0.9
	*	*		*	*	*		*	*	*
V0	5.4	15.8	25.0	3.0	3.6	4.0	11.4	1.1	1.6	1.3
V1	4.8	14.5	20.6	2.6	3.7	3.1	11.4	0.9	1.1	1.0
	*							*	*	
CD	0.4	1.5	4.2	0.5	1.5	1.0	3.9	0.2	0.4	0.5

F, Fertilizer; A, Azotobacter; P, Phosphobacterin; V, VAM

Out of 11 interactions of different orders, 10 showed its influence in some form or the other. Fertilizer x phosphobacterin and fertilizer x VAM application interactions showed their influence on 4 and 6 parameters out of 10, respectively. Fertilizers, azotobacter, phosphobacterin and VAM could influence on 16, 7, 13 and 14 occasions out of 100, respectively. Values indicated relative importance of factors on growth study.

Interaction study in majority of cases showed that interaction of factors in its lowest level of application (control) performed the best followed by the highest levels. Thus, a combination of no fertilizer application and no phosphobacterin inoculation performed as good as a combination of fertilizer application and phosphobacterin inoculation.

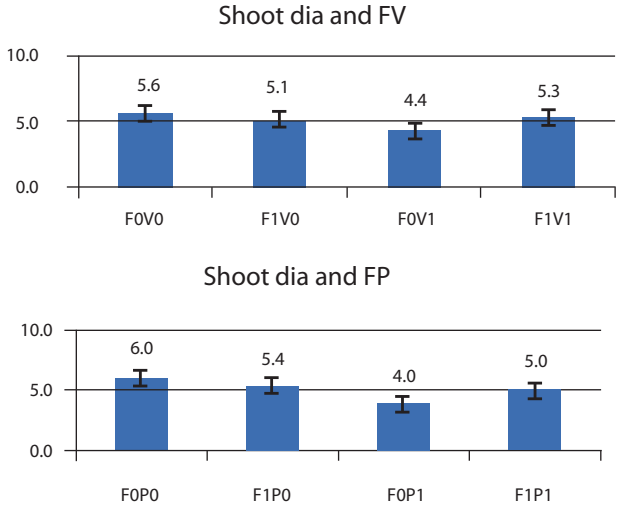


Fig. 25. Interaction effect of different PGPRs on plant growth attributes

Variation in seed attributes due to location and year

Observations revealed that there were wide variations in germination per cent of *kusum* seeds of 2014 and 2015 (Table 8). Study involved mainly two seeds-sources *i.e.* seeds from Purulia and Institute Research Farm. It was visualized that test weight (100 seed weight) did not vary significantly due to variations in sources. However, test weight of 2014 was 36 per cent higher than that of 2015. So far as damaged seed per cent (based on visual observation) is concerned seeds procured from Purulia had 18 per cent lesser damaged seeds. Values of same for 2014 and 2015 were 40 and 87 per cent respectively. Thus seeds procured from Purulia in 2014 were satisfactory in all aspects. Study on germination per cent also confirmed the same findings (Fig. 26 a & b).

Single seeds of small (0.4-0.7 g) and bold seeds (0.8-1.1 g) were examined to differentiate in single seed weight over the sources. Study indicated that average single seed weight and average single seed weight for smaller seeds were comparable for two locations. But it varied significantly for bigger or bold seeds. Values for Purulia seeds were 0.87 g as against 0.72 g for IRF seeds. Results indicated that bolder seed is beneficial for better germination and average weight of damaged kernel is 0.24g as against 0.45g for healthy kernels.

Table 8. Test weight and damaged seed per cent over location and year

	Test wt (g)	Damage seed per cent
Purulia	52.9	54.5
IRF	52.9	72.8
CD	1.5	6.4*
Year 2014	61.0	40.1
Year 2015	44.8	87.2
CD	1.5*	6.4*

Fig. 26 a. Inferior quality seeds

Fig. 26 b. Good quality plump and bold seeds

2.4 Vegetative propagation of *kusum* (*S. oleosa* (Lour.) Oken)

Air layering in *kusum*, taking the best treatment combinations from the results achieved in 2014, was conducted during pre-monsoon season, but poor rooting (30%) was observed as compared to the previous year (66 %).

25 cleft graftings and 25 side graftings in *kusum* were also carried out during April and June. Overall success in cleft grafting and side grafting was 26 per cent and 30 per cent, respectively.

2.5 Carbon sequestration under different lac host based land use systems

Above ground, biomass (as estimated from the standard allometric equations), for *ber, palas* and *kusum* was 7969.88 kg/ha, 2078.46 kg/ha and 35926 kg/ha, whereas, below ground it was 13899.67 kg/ha, 17777.70 kg/ha and 18610.41 kg/ha, respectively. Further, total carbon stock under *ber, palas* and *kusum* was 17552 kg/ha, 18816.93 kg/ha and 36573.55 kg/ha, respectively.

2.6 Tritrophic interaction in lac ecosystem

Tritrophic interaction in lac ecosystem : A semio-chemical approach

Semio-chemcials present in lac insect ecosystem were studied using GC-MS. Volatiles were collected from lac insect associated products *viz.* wax, resin, lac insect whole body, honey dew, lac dye and lac crawlers using hexane. The following volatiles recorded from (i) lac wax (Tetratricontane, Hexacosane, Docosenamide and Pentatricontane), (ii) lac resin (Tetradecanoic acid, Palmitoleic acid, Hexadeconaic acid, Tetratricontane, Hexacosane, Octocosanol), (iii) lac insect whole body (Palmitoleic acid, Tetratricontane, Hexacosane and Octocosanol), (iv) lac dye (Tetradecanoic acid, Palmitoleic acid, Hexadeconaic acid, Octadeconaic acid, Tetratricontane, Hexacosane and Octocosanol)

and (v) lac insect crawlers (Tetradecanoic acid, Palmitoleic acid, Hexadeconaic acid, Octadeconaic acid, Tetratricontane, Hexacosane, Nonacosane, Tritetracosane and Octocosanol). Volatile compounds *viz.* Tetratricontane, Hexacosane, Tetradecanoic acid, Palmitoleic acid and Octocosanol were more commonly recorded from lac associated products.

To have the differential presence of volatiles at various life stages of lac insect *viz.* adult and crawler and among two sexes *i.e.* male and female were carried out. Comparative profiling of semio-chemicals in male and female of lac insect was carried out by GC-MS. Volatile compounds detected specific to male lac insect were octadecanal, octadecane and heptacosanol. Volatile compounds detected specific to female insects were hexadecane, pentatriacontane, tetratetracontane, hentriacontane, tetratriacontane, octacosane, hexacosane, tetracosane, triacontyl acetate, hexatriacontane and tetrapentacotane. The most abundant volatile compound in both male (66.5%) and female lac insect (47.2%) was octadecyl acetate. Tetracontane and pentacosane constituted about 35% of the total volatile compounds present in the female lac insect. Heptacosanol constituted about 21.5% of the total volatiles present in case of male lac insect. The gas chromatogramme of both male and female lac insect is given in Fig. 27.

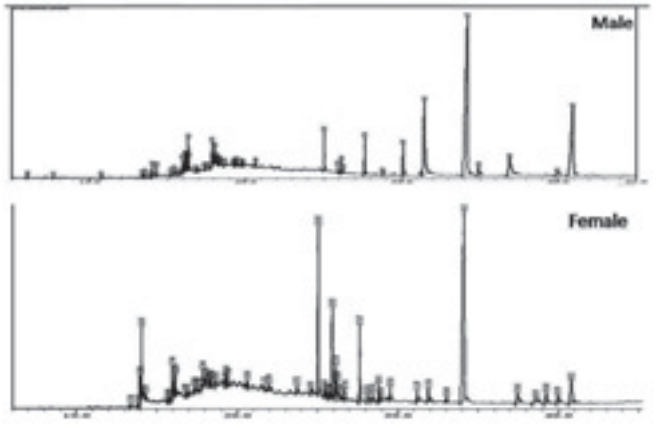


Fig. 27. Comparative gas chromatogramme profile of both male and female lac insects

Comparative profiling of semio-chemicals in adult female and crawler revealed compounds *viz.* 2-Methyl hexacosane, tricontyl acetate, hexadecane 2,6,10,14, tetramethyl, hentriacontane and 9-octadecenamide specific to adult female and compounds *viz.* hexadecane 1-iodo, octadecanoic acid, tetratetracontane, tetratriacontane, hexacosane, heneicosane and heptadecyl acetate specific to crawlers. The most abundant volatile compound in adult female was octadecyl acetate while most abundant compound in crawler was tetradecanoic acid and octadecyl acetate. Octadecylacetate and tetraconatne constituted 96.4 % of volatile compounds in adult female while tetradecanoic acid, octacosyl acetate, tetracontane and pentacosane constituted about 83.7 % of the total volatile compounds present in lac insect crawler. The gas chromatogramme of both adult female and lac insect crawler is given in Fig. 28.

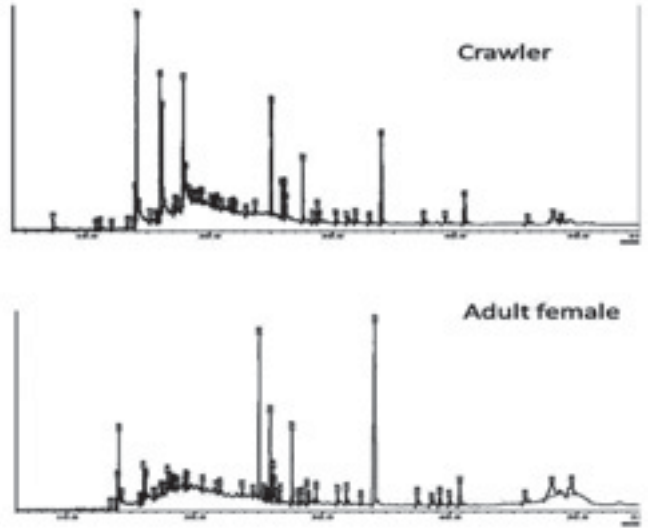


Fig. 28. Comparative gas chromatogramme profile of both adult female and lac insect crawler

2.7 Variation of lac associated fauna in relation to different host plants

Data pertaining to associated fauna of lac from different host plants were recorded by caging of lac insect samples (one meter length) from *ber, semialata, kusum* and *ber, palas* and red gram at fortnightly intervals from IRF during *kusmi* (*aghani* 2014-15) and *rangeeni* (*baisakhi* 2014-15), respectively.

In *aghani* crop 2014-15, *A. purpureus* (19), *T. tachardiae* (9) and *E. amabilis* (4) population was more on *ber* followed by *kusum* and *semialata* whereas *P. pulverea* and *Bracon greeni* emerged in meager numbers during the crop season. Amongst all the parasitoids, *A. purpureus* was higher on *palas* (68) followed by red gram and *ber* but *T. tachardiae* was more on red gram (24) than *ber* and *palas* whereas predators population *E. amabilis* was recorded more on *ber* (23) followed by *palas* and red gram. Amongst the hyper-parasitoids,

B. greeni was recorded in meager number in *palas* only during *baisakhi* crop 2014-15. It was observed that parasitoid and predator populations varied on different lac host plants *viz. ber, semialata, kusum, palas* and red gram. Amongst the parasitoids, *A. purpureus* was the most prevalent parasitoids followed by *T. tachardiae* and *P. clavicornis* in all crops.

In addition, emergence profile of lac associated fauna was compared between different caging methods *viz. in-situ* caging and lab caging during both the seasons. Higher parasitoids population was recorded in *in-situ* method of caging compared to lab caging in all the hosts. However, predator, *E. amabilis* population was more in lab caging as compared to *in-situ* caging during *aghani* 2014-15 (Fig. 29 a) and *baisakhi* 2014-15 (Fig. 29 b).

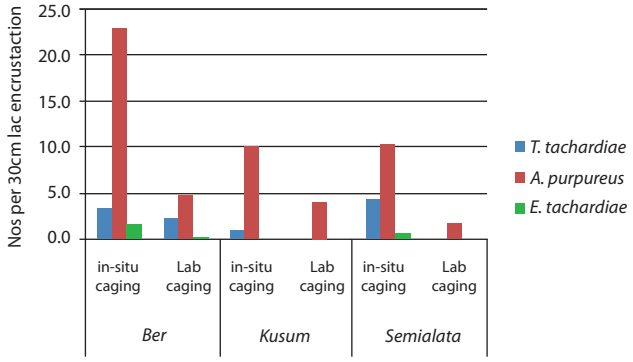


Fig. 29 a. Emergence profile of parasitoids from different caging methods during *aghani* 2014-15

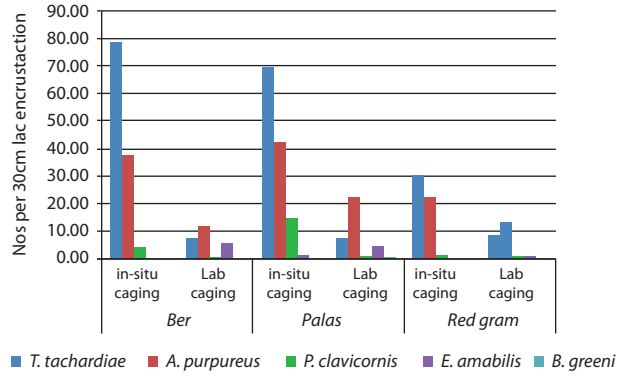


Fig. 29 b. Emergence profile of lac associated fauna from different caging methods during *baisakhi* 2014-15

2.8 Effect of abiotic factors on lac associated fauna in *rangeeni* crops

Relative abundance of lac associated fauna during *rangeeni* crops

Relative abundance and emergence profile of parasitoids and predators associated with lac insect were recorded at Institute Research Farm, Ranchi (Jharkhand) during *baisakhi* (2014-15) and *katki* (2015) crops. The information generated revealed that, only three parasitoids (*A. purpureus*, *T. tachardiae* and *P. clavicornis*) and one predator (*E. amabilis*) were abundant. Per cent composition of lac associated fauna analysis showed that the parasitoids alone constituted (91 and 93 per cent) populations among lac associated fauna followed by predators (9 and 7 per cent) on *ber* and *palas*, respectively during *baisakhi* (2014-15). Among them, *A. purpureus* was more abundant which constituted 87 and 61 per cent population, followed by *T. tachardiae* (12 and 37 per cent), respectively on *ber* and *palas* during *baisakhi* (2014-15). *In katki* (2015), the parasitoids alone constituted (87 per cent) population among lac associated fauna followed by predators (13 per cent) on *ber*. Among them, *T. tachardiae* and *A. purpureus* were more abundant and constituted 65 and 22 per cent populations.

Emergence profile of lac associated fauna during *baisakhi* and *katki* crops

Study on weekly emergence profile of lac associated fauna showed maximum population of *A. purpureus* in those samples which were collected 35 weeks after inoculation (WAI) (38) on *ber* and 18 on *palas* when caged during *baisakhi* 2014-15 (Fig. 30 a & b), whereas, in *katki* 2015, the maximum emergence of *T. tachardiae* (12) and *A. purpureus* (4) was recorded 17 WAI when raised on *ber* (Fig. 31a).

In addition, emergence profile of lac associated fauna was compared between different caging methods *viz. in-situ* caging and lab caging during *katki*, 2015. Higher number of parasitoids were recorded in *in-situ* method of caging compared to lab caging. During this crop season relative abundance of lac associated fauna were also compared under two different conditions *viz.* spray with (Fipronil + Chlorothalonil) and with Chlorothalonil alone. *A. purpureus*, *P. clavicornis* and *E. amabilis* were more in number except *T. tachardiae* when sprayed with Chlorothalonil only in both methods of caging (Fig. 31b).

Assessment of level of parasitization and sex ratio of *A. purpureus*

Lac insect cells (733 Nos.) were collected at fortnightly intervals from field during summer season *rangeeni*

(*baisakhi*) crop 2014-15 and examined under microscope by pricking the cells to assess the level of parasitization. There were 5 and 9 per cent mortality in lac culture due to parasitization on *ber* and *palas*, respectively. Out of which *A. purpureus* alone caused 94 and 83 per cent mortality which clearly showed the predominance of *A. purpureus* in *baisakhi* (2014-15). Similarly, 17 per cent mortality was recorded during *katki* (2015) crop due to parasitization when raised on *ber* trees, wherein *A. purpureus* only caused 48 per cent mortality. The highest level of parasitization was recorded during sexual maturity period on *ber* (14 per cent) and *palas* (22 %) during *baisakhi* (2014-15) whereas, in *katki* (2015), highest level of parasitization was recorded during crop maturity period on *ber* (57 per cent). Sex ratio (Male: Female) of *A. purpureus* was also recorded during the both crop seasons and it was in the ratio of 51:49 during *baisakhi* (2014-15) and 39:61 during *katki* (2015).

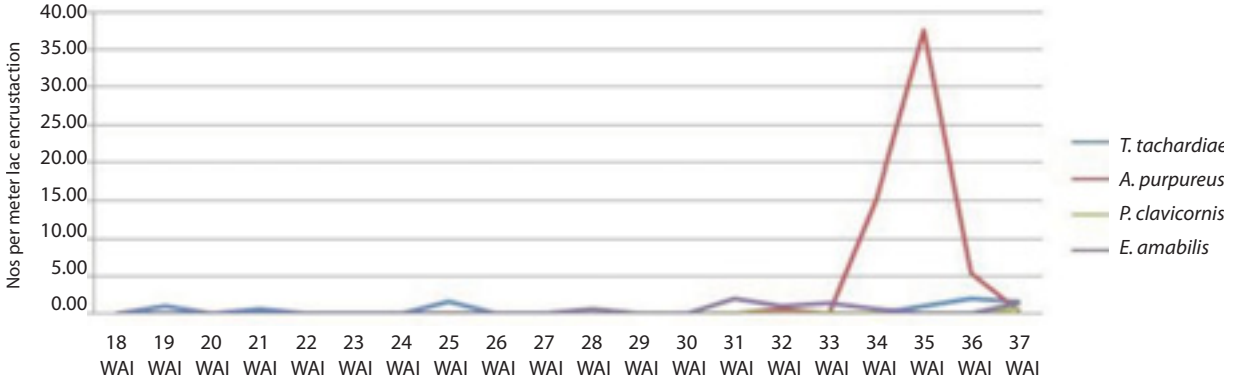


Fig. 30 a. Emergence profile of lac associated fauna on *ber* during *baisakhi* 2014-15

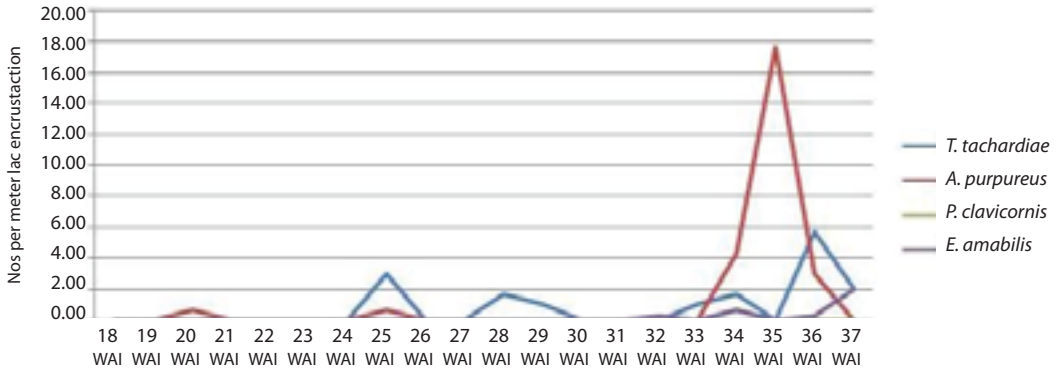


Fig. 30 b. Emergence profile of lac associated fauna on *palas* during *baisakhi* 2014-15

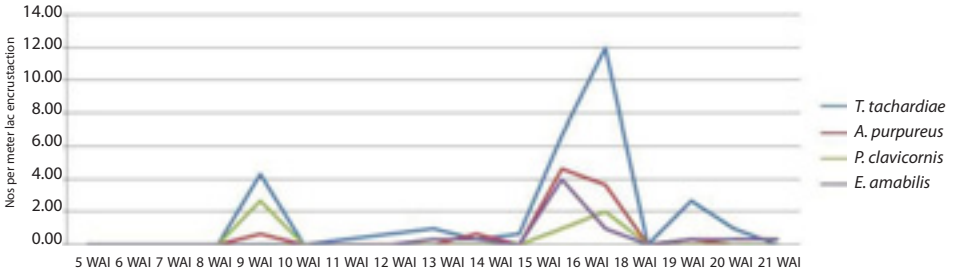


Fig. 31 a. Emergence profile of lac associated fauna on *ber* during *katki* 2014-15

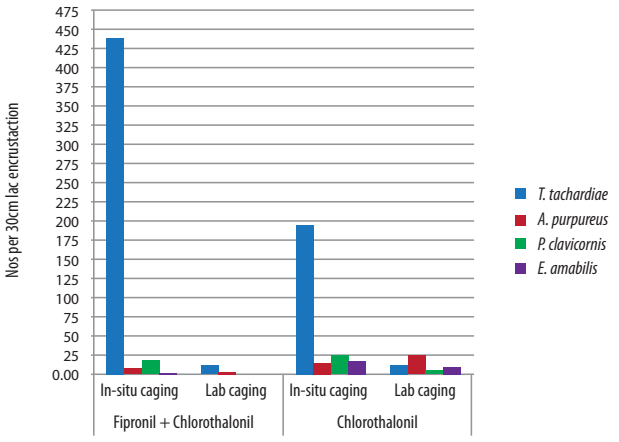


Fig. 31 b. Emergence profile of lac associated fauna from different methods during *katki* 2015

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

Effect of selected insecticides on lac yield

Emamectin benzoate, chlorantraniliprole and novaleuran have been evaluated for *kusmi* lac yield growing on *F. semialata*. The spray was carried out on winter *kusmi* lac crop for one, two and three times at 30, 40 and 60 days respectively. There were 18 treatments and each with three replicates in case of emamectin benzoate and chlorantraniliprole. In case of novaleuran, there were 15 treatments. The crop was harvested around 15 days prior to crop maturity to quantify sticklac yield from each plant. There were three controls, each for one, two and three spray where only water was sprayed on lac crop.

Effect of emamectin benzoate (5 % SG)

Six concentrations (0.00025, 0.0005, 0.001, 0.0015, 0.002, and 0.0025 %) were sprayed on lac culture. There was significant increase in yield over control even with only one spray and lowest concentration tried. The per cent increase in yield over control was 4.57 to 157.14 %, 50 to 322.73 % and 69.56 to 339.12 % with one, two and three sprays respectively.

Effect of Chlorantraniliprole (20 % w/v SC)

Six concentrations (0.001, 0.002, 0.004, 0.006, 0.008, and 0.01 %) were sprayed on lac culture. The yield of sticklac was at par with lower concentrations (0.001 and 0.002 %). Significant increase in yield was recorded with 0.004 % and higher concentrations for two and three spray. The per cent increase in yield over control was 5.56 to 161.33 %, 10.76 to 248.10 % and 22.0 to 333.33 % with one, two and three sprays respectively.

Effect of novaleuran (5 % EC)

Five concentrations (0.000125 to 0.0015% were sprayed. The per cent increase in yield over control was 26.58 to 79.11 %, 26.58 to 153.16 % and 38.67 to 211.33 % with one, two and three sprays respectively.

Effect of novaleuran (5% EC) for safety of lac insect and effect on population of insect- predators and parasitoids

The *rangeeni* broodlac obtained from *B. monosperma* was dipped in novaleuran formulations, 0.000125, 0.00025, 0.0005 and 0.001 % for 5, 10 and 15 min. There were five replications and 50g broodlac in each replicates. The randomly selected samples were dipped in the plastic bucket filled with various formulations. After dipping for a specified period, it was air dried and each 50 g broodlac was kept in 60 mesh net bag separately and inoculated on *B. monosperma* tree treatment wise. 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. The survival per cent of lac insect in different treatments was at par with control, indicating safety of novaleuran on lac insect. The survival per cent varied 84.47 to 90.95 %, 89.58 to 93.42 % and 87.48 to 97.29 % for 5, 10 and 15 min. respectively.

The population of *E. amabilis* reduced significantly due to treatment of novaleuran. The suppression in the population varied 90-100 % over control with 5-15 min. of dipping. Even the lowest concentration of 0.000125% with 5 min. dipping caused 90% reduction (Table 9). The population of *P. pulverea* suppressed to the extent of 85-100, 82-98 and 81-100 per cent for 5, 10 and 15 min dipping respectively (Table 10). In respect of *T. tachardiae*, the suppression in the population varied 23-64, 25-82 and 78- 81 % for 5, 10 and 15 min. dipping respectively (Table 11).

Residual toxicity of emamectin benzoate and chlorantraniliprole on *Eupelmus tachardiae*

Two newer insecticides namely emamectin benzoate and chlorantranilprole have been evaluated. Newly emerged adult of *E. tachardiae* were collected from *phunki* lac kept in laboratory. Known numbers of

specimens were released in pre-coated 15 ml glass vials with different formulations of insecticides in water. In control, only water was used. Observations were taken after 1, 3, 6, 9, 18 and 24 hr. after release.

Six concentrations of emamectin benzoate (0.00025, 0.0005, 0.0010, 0.0020 and 0.0025%) were tried. After 3 hr. of exposure, the mortality of adult insect varied 27.50 to 39.0 %. After 12 hr., it was 46.9 to 95.2 % which were significantly higher than control. In respect of chlorantraniliprole, 0-17.2% mortality recorded within 3 hr. of exposure and 30.2 to 65.3 % mortality was recorded within 24 hr. of exposure, whereas 19.7 % was recorded in control.

Table 9. Effect of novaleuron (5 % EC) on population of *E. amabilis* due to dipping of *kusmi* broodlac

Dipping time	5 minutes		10 minutes		15 minutes	
Conc. (% *a.i.*)	Mean number*	% Reduction	Mean number*	% Reduction	Mean number*	% Reduction
0.000125	4.0 (1.96)^{cdef}	42.86	3.4 (1.93)^{cdef}	51.43	0.4 (0.88)^{abcd}	68.75
0.00025	4.6 (2.21)^{def}	34.29	3.6 (1.90)^{cde}	48.57	2 (1.42)^{abcd}	62.50
0.0005	3 (1.72)^{bc}	57.14	2.6 (1.62)^{abcd}	62.86	2.4 (1.63)^{abcd}	68.75
0.001	1.8 (1.32)^{abc}	74.29	0.6 (0.99)^{ab}	91.43	2 (1.52)^{a}	93.75
Control	7 (2.66)^{ef}		7 (2.73)^{f}		6.4 (2.61)^{ef}	
SEd ±	0.408					
F	3.863					
P	0.0					

*Mean number in 50 g broodlac. Figures in parentheses are transformed values to √n+0.5. Means marked with different letters including 5, 10 and 15 minutes of each dipping time are significantly different (P<0.05)

Table 10. Effect of novaleuron (5 % EC) on population of *P. pulverea* due to dipping of *kusmi* broodlac

Dipping time	5 minutes		10 minutes		15 minutes	
Conc. (% *a.i.*)	Mean number*	% Reduction	Mean number*	% Reduction	Mean number*	% Reduction
0.000125	3.6 (1.86)^{c}	70.49	2 (1.55)^{abc}	79.59	1.4 (1.21)^{abc}	79.41
0.00025	2.6 (1.64)^{bc}	78.69	1.2 (1.22)^{abc}	87.76	1.2 (1.26)^{abc}	82.35
0.0005	2 (1.51)^{abc}	83.61	0.8 (1.04)^{ab}	91.84	0.4 (0.88)^{a}	94.12
0.001	1.2 (1.22)^{abc}	90.16	0.8 (1.09)^{ab}	91.84	0.4 (0.91) ^{a}	94.12
Control	12.2 (3.5)^{e}	0.0	9.8 (3.16)^{de}	0.0	6.8 (2.69)^{d}	0.0
SEd ±	0.351					
F	10.89					
P	0.0					

Mean number in 50 g broodlac. Figures in parentheses are transformed values to √n+0.5 Means marked with different letters including 5, 10 and 15 minutes of each dipping time are significantly different (P<0.05)

Table 11. Effect of novaleuron (5 % EC) on population of *T. tachardae* due to dipping of *kusmi* broodlac

Dipping time	5 minutes		10 minutes		15 minutes	
Conc. (% *a.i.*)	Mean number*	% Reduction	Mean number*	% Reduction	Mean number*	% Reduction
0.000125	3.4 (1.85)^{cd}	22.73	4.20 (1.92)^{d}	25.00	1.20 (1.22)^{abc}	81.25
0.00025	1.6 (1.39)^{abc}	63.64	2.20 (1.49)^{bc}	65.63	1.20 (1.22)^{abc}	78.57
0.0005	1.6 (1.43)^{abc}	63.64	1.00 (1.11)^{abc}	82.14	1.00 (1.16)^{abc}	84.38
0.001	1.6 (1.37)^{abc}	63.64	1.00 (1.09)^{abc}	82.14	1.20 (1.22)^{abc}	81.25
Control	5.60 (2.39)^{d}		6.40 (2.49)^{d}		4.4 (2.12)^{bc}	
SEd ±	0.38					
F	3.73					
P	0.0					

Mean number in 50 g broodlac. Figures in parentheses are transformed values to √n+0.5. Means marked with different letters including 5, 10 and 15 minutes of each dipping time are significantly different (P<0.05)

2.10 Evaluation of lac mud as organic manure

Evaluation of lac mud as manure was carried out in second year as field experimentation on vegetables (spinach, tomato and brinjal) and floriculture (rose and chrysanthemum).

Effect of lac mud on spinach fresh leaf yield

Substitution of 25% N through lac mud, 25 % N through vermicompost and 50 % N through inorganic source recorded highest fresh leaf yield of spinach (378.41 q/ha) which was at par with 50 % N through lac mud + 50 % N through inorganic source, 25 % N through lac mud + 75 % N through inorganic source, 12.5 % N through lac mud + 12.5 % N through vermicompost + 75 % N through inorganic source, but recorded significantly higher fresh leaf yield of spinach compared to other treatments including recommended practice *i.e.* 100 % N through inorganic source (Table 12). Treatment 5 recorded 15.9 % higher fresh leaf yield of spinach over recommended practice (100 % N through inorganic source).

Table 12. Effect of lac mud based different treatment on fresh leaf yield of spinach

Treatments	Ferti-vermi-lac mud manure mixer	Fresh leaf yield (q/ha)
T_1	100 % N through lac mud	275.59^{d}
T_2	75 % N through lac mud + 25 % N through inorganic source	305.72^{cd}
T_3	50 % N through lac mud + 50 % N through inorganic source	365.26^{ab}
T_4	25 % N through lac mud + 75 % N through inorganic source	358.19^{ab}
T_5	25 % N through lac mud + 25 % N through vermicompost + 50 % N through inorganic source	378.41^{a}
T_6	12.5 % N through lac mud + 12.5 % N through vermicompost + 75 % N through inorganic source	362.54^{ab}
T_7	100 % N through inorganic source	326.33^{bc}
T_8	Control (No manure and fertilizers)	108.851^{e}
	SEd	22.79
	CD (P= 0.05)	48.88

Effect of lac mud on growth and yield of tomato and brinjal

Utilization of lac mud as a component of INM along with vermicompost and inorganic fertilizer in tomato and brinjal recorded higher plant height, stem girth, number of primary branches and number of leaves per plant at 25, 50 and 75 days after transplanting as compared to recommended practice (100 % N through inorganic source) or control (no manure and fertilizers). Application of 25 % N through lac mud, 25 % N through vermicompost and 50 % N through inorganic source resulted in significantly higher fruit yield, fruit weight and number of fruits per plant of tomato and brinjal (Table 13 & 14). Fruit yield under treatment 5 over recommended practice (100% N through inorganic source) was increased by 25.6 % and 36.3 % in tomato and brinjal, respectively.

Table 13. Effect of lac mud based different treatment on number of fruits, fruit weight and fruit yield of tomato

Treatments	Ferti-vermi-lac mud manure mixer	No. of fruits/ plant	Fruit weight (g)	Fruit yield (q/ha)
T_1	100 % N through lac mud	21.27^{e}	48.38^{d}	362^{e}
T_2	75 % N through lac mud + 25 % N through inorganic source	23.51^{ade}	54.69^{cd}	421^{de}
T_3	50 % N through lac mud + 50 % N through inorganic source	33.35^{b}	64.16^{ab}	532^{ab}
T_4	25 % N through lac mud + 75 % N through inorganic source	29.83^{bc}	62.54^{ab}	493^{bc}
T_5	25 % N through lac mud + 25 % N through vermi-compost + 50 % N through inorganic source	35.56^{a}	67.88^{a}	584^{a}
T_6	12.5 % N through lac mud + 12.5 % N through vermi-compost + 75 % N through inorganic source	32.42^{ab}	65.25^{ab}	524^{bc}
T_7	100 % N through inorganic source	26.69^{cd}	58.47^{bc}	465^{cd}
T_8	Control (No manure and fertilizers)	10.17^{f}	30.56^{e}	105^{1f}

Treatments	Ferti-vermi-lac mud manure mixer	No. of fruits/ plant	Fruit weight (g)	Fruit yield (q/ha)
	SEd	1.7742	3.4236	27.64
	CD (P= 0.05)	3.8057	7.3436	59.28

Table 14. Effect of lac mud based different treatment on number of fruits, fruit weight and fruit yield of brinjal

Treatments	Ferti-vermi-lac mud manure mixer	No. of fruits/ plant	Fruit weight (g)	Fruit yield (q/ha)
T_1	100 % N through lac mud	6.1^{d}	145.48^{d}	291.22^{c}
T_2	75 % N through lac mud + 25 % N through inorganic source	6.6^{bcd}	155.52^{cd}	311.11^{c}
T_3	50 % N through lac mud + 50 % N through inorganic source	7.3^{ab}	164.92^{bcd}	384.78^{b}
T_4	25 % N through lac mud + 75 % N through inorganic source	7.5^{a}	172.92^{abc}	403.48^{ab}
T_5	25 % N through lac mud + 25 % N through vermi-compost + 50 % N through inorganic source	7.8^{a}	186.77^{a}	435.78^{a}
T_6	12.5 % N through lac mud + 12.5 % N through vermi-compost + 75 % N through inorganic source	7.2^{abc}	180.55^{ab}	421.26^{ab}
T_7	100 % N through inorganic source	6.4^{cd}	159.82^{cd}	319.63^{c}
T_8	Control (No manure and fertilizers)	3.5^{e}	107.65^{e}	107.63^{d}
	SEd	0.4159	9.4238	20.97
	CD (P= 0.05)	0.8922	20.2141	44.99

Effect of lac mud on number and weight of rose and chrysanthemum flowers

The data on number and weight of rose and chrysanthemum flowers presented in Table 15 and 16 revealed that application of lac mud in pot mixture fortified with 0.2 % N + 0.2 % P_2O_5 + 0.2 % K_2O resulted in significantly higher number and weight of rose and chrysanthemum flowers, however it was at par with lac mud fortified with 0.2 % N + 0.2 % K_2O for number and weight of rose flowers.

Table 15. Effect of lac mud based treatments on number and weight of flowers of rose

Treatments	Ferti-vermi-lac mud manure mixer	No. of flowers / plant	Weight of flowers (g/plant)
T_1	Lac mud fortified with 0.2 % N	16.962^{de}	274.44^{de}
T_2	Lac mud fortified with 0.2 % P_2O_5	15.448^{f}	243.46^{f}
T_3	Lac mud fortified with 0.2 % K_2O	16.227^{ef}	260.93^{ef}
T_4	Lac mud fortified with 0.2 % N + 0.2 % P_2O_5	18.631^{c}	314.49^{c}
T_5	Lac mud fortified with 0.2 % N + 0.2 % K_2O	21.854^{ab}	373.27^{ab}
T_6	Lac mud fortified with 0.2 % P_2O_5 + 0.2 % K_2O	21.149^{b}	359.95^{b}
T_7	Lac mud fortified with 0.2 % N + 0.2 % P_2O_5 + 0.2 % K_2O	22.763^{a}	389.70^{a}
T_8	Lac mud without fortification	12.686^{g}	187.49^{g}
T_9	Vermicompost	17.575^{cd}	290.05^{cd}
	SEd	0.6290	12.63
	CD (P= 0.05)	1.3335	26.78

Table 16. Effect of lac mud based treatments on number and weight of flowers of chrysanthemum

Treatments	Ferti-vermi-lac mud manure mixer	No. of flowers / plant	Weight of flowers (g/plant)
T_1	Lac mud fortified with 0.2 % N	33.6^{de}	256.574^{e}
T_2	Lac mud fortified with 0.2 % P_2O_5	31.8^{e}	235.846^{e}
T_3	Lac mud fortified with 0.2 % K_2O	32.5^{e}	247.155^{e}
T_4	Lac mud fortified with 0.2 % N + 0.2 % P_2O_5	38.7^{bc}	307.508^{c}
T_5	Lac mud fortified with 0.2 % N + 0.2 % K_2O	41.4^{b}	345.413^{b}
T_6	Lac mud fortified with 0.2 % P_2O_5 + 0.2 % K_2O	39.2^{b}	324.504^{bc}
T_7	Lac mud fortified with 0.2 % N + 0.2 % P_2O_5 + 0.2 % K_2O	45.3^{a}	396.300^{a}
T_8	Lac mud without fortification	27.4^{f}	186.166^{f}
T_9	Vermicompost	35.9^{cd}	281.607^{d}
	SEd	1.38	10.39
	CD (P= 0.05)	2.93	22.02

Standardization of package of practices for *rangeeni* lac cultivation on *Flemingia semialata*

To study the effect of different time of pruning and agronomic management practices on growth and development of plant, *semialata* plants were pruned at different times and *rangeeni* crops were raised accordingly.

Effect of time of pruning on shoot height and number of bushes

Semialata plants were pruned during April, November and February. In April pruned plants, steady increase in height was observed up to September (Fig. 32a). When plants were pruned during November, increase in height was insignificant up to February, after that steady increase was observed (Fig. 32b). In case of February pruned plants, there was increase in height from initial stage (Fig. 32c). Almost similar trend was also observed in case of number of bushes (Fig. 33a to 33c).

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

Limited irrigation along with mulching with dry grasses recorded more shoot height and higher number of shoots in a bush over different dates of pruning at monthly intervals. It was followed by irrigation and least was recorded under no irrigation.

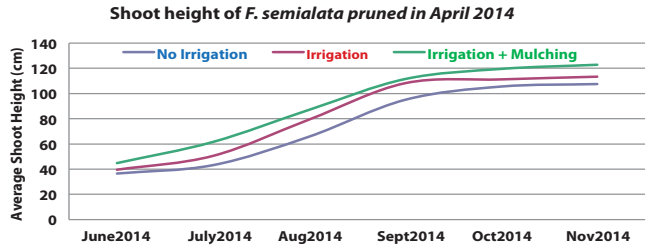


Fig. 32a. Shoot height of *F. semialata* pruned in April 2014

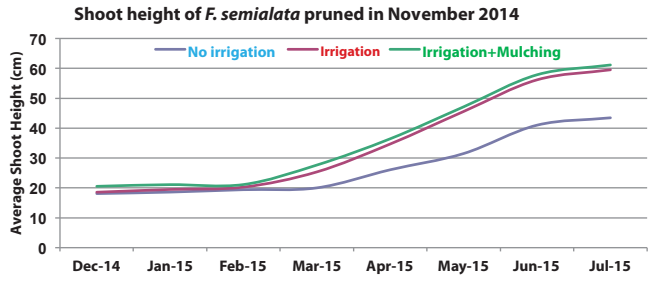


Fig. 32b. Shoot height of *F. semialata* pruned in November 2014

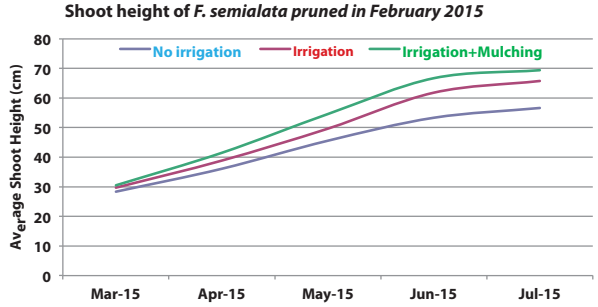


Fig. 32c. Shoot height of *F. semialata* pruned in February 2015

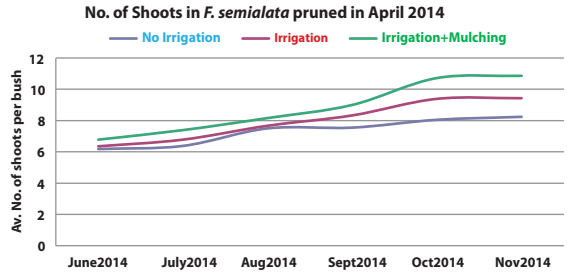


Fig. 33a. No. of shoots in *F. semialata* pruned in April 2014

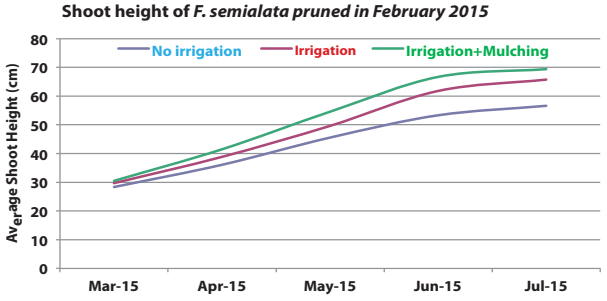


Fig. 33b. No. of shoots in *F. semialata* pruned in November 2014

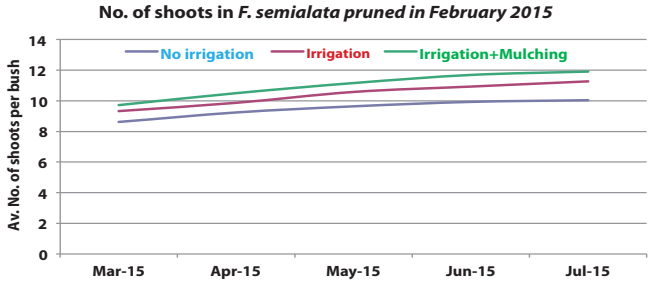


Fig. 33c. No. of shoots in *F. semialata* pruned in February 2015

Performance of *baisakhi ari* crop

Lac stick, scrap and 10-single cell weight of *baisakhi ari* crop on *F. semialata* was higher under irrigation + mulching compared to irrigation and no irrigation, and values were 158.3 g/m of stick, 15.73 g/m and 0.162 g, respectively, under irrigation + mulching treatment (Table 17).

Performance of *baisakhi (Broodlac)* crop

Irrigation along with mulching resulted in higher lac stick, scrap and 10-single cell weight of *baisakhi (*broodlac) crop on *F. semialata* than that of irrigation and no irrigation, however respective values were lower on *semialata* compared to corresponding crop on *ber* (Table 18). Lac stick and 10-single cell weight was higher on *semialata* under irrigation + mulching compared to crop on *palas*.

Table 17. Lac stick, scrap and 10-single cell weight of *baisakhi ari* crop on *F. semialata*

Lac host tree/plant	Treatment	Lac stick yield (g/m of stick)	Fresh scrap weight (g/m)	10 single cell weight (g)
F. semialata	No Irrigation	133.3	9.77	0.111
	Irrigation	150.0	11.62	0.136
	Irrigation + Mulching	158.3	20.30	0.162
Ber		191.7	20.96	0.153
Palas		208.3	15.73	0.206
Date of pruning, April 2014; Date of inoculation, 2nd November 2014; Date of *ari* harvesting, 27th May 2015.				

Table 18. Lac stick, scrap and 10-single cell weight of *baisakhi* broodlac crop on *F. semialata*

Lac host tree/plant	Treatment	Lac stick yield (g/m of stick)	Fresh scrap weight (g/m)	10 single cell weight (g)
F. semialata	No Irrigation	92.22	8.99	0.224
	Irrigation	103.33	11.96	0.246
	Irrigation + Mulching	142.78	15.92	0.276
Ber		216.67	45.17	0.327
Palas		116.67	22.88	0.236
Date of pruning, April 2014; Date of inoculation, 2nd November 2014; Date of broodlac harvesting, 14th July 2015.				

Performance of *katki* crop

Katki crop was inoculated on *semialata* during July on November pruned plants, but mortality of most of lac insect was observed due to heavy enemy insect population. However, observation recorded revealed higher lac stick and scrap weight under irrigation + mulching treatment.

2.11 Collaborative Projects

Development of seri-lac culture model for income augmentation (CSRTI, Mysore)

9 kg *Kusmi* broodlac (summer season) was inoculated on *Flemingia semialata* between mulberry plantation in farmer's field at Thumbla, T.N Pura and Regional Sericulture Research Station, CSRTI, Chamarajanagar, Mysore on February 13, 2015. (Fig. 34 a & b). Lac insect sample was collected for cross infectivity study and only *E. amabillis* was recorded from the sample.

Fig. 34 a. Inoculation of broodlac (summer season) on *F. semialata*

Fig. 34 b. *F. semialata* inoculated with broodlac

2.12 Exploratory Study

Evaluation of different methods for early detection of *Aprostocetus purpureus* in *baisakhi* crop

Baisakhi crop has often witnessed large scale mortality due to parasitization. One of the key parasitoids of lac crop is *A. purpureus*. Detection of *A. purpureus* through incidence (microscopic observation), adult emergence (caging) and molecular technique (PCR based) was conducted during *baisakhi* crop of 2015 on *ber.* Incidence of *A. purpureus* was detected 42 days after inoculation (DAI) through PCR technique, whereas microscopic observation and caging revealed the incidence 112 and 119 DAI respectively. Since the size of the lac insects is small, microscopic observation through pricking is tedious. The caging detects the parasitoid only when it reaches adult stage and emerges out of the lac cover. However, PCR technique is able to detect even immature stages and is comparatively lesser tedious than the microscopic observation (Fig. 35).

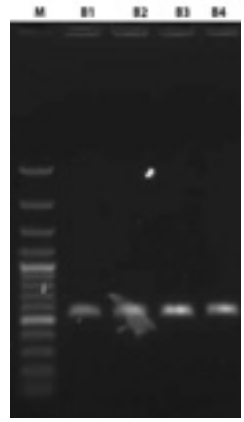


Fig. 35. Detection of *A. purpureus* using PCR. M,molecular marker, B1-B4, *baisakhi* samples collected at weekly intervals 42 DAI

3. Processing, Storage and Quality Management

3.1 Design and development of integrated small scale lac processing unit for conversion of sticklac – seedlac

Design drawing of integrated small scale lac processing unit was prepared in Pro Engineer CAD software alongwith different components/modules of the unit based on unit operations *i.e.* feeding, material conveying, crushing, grading, presoaking, washing and washing barrel tilting units. Assembly of each unit was also done by proper assembling of the fabricated components of different units. Unit operation wise components of the integrated small scale lac processing unit was fabricated as per developed design drawing in CAD software and assembled (Fig. 36). Fabricated units were evaluated with raw material (sticklac) for each unit operation and observed that all the fabricated units and components are functioning as per requirement.

Fig. 36. Integrated small scale lac processing unit

Seedlac was manufactured through integrated small scale lac processing unit and small scale lac processing and their quality parameters [*i.e.* flow (mm), life (min), colour index, impurity (%), acid value and colour parameters (L, a and b)] were determined (Fig. 37).

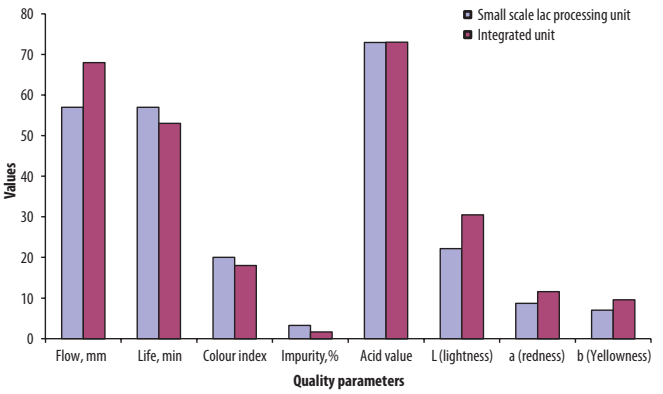
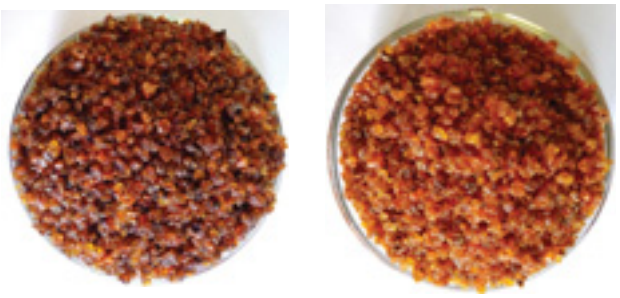


Fig. 37. Comparison of quality parameters of manufactured seedlac through small scale lac processing unit and integrated unit

Impurity content in seedlac manufactured through integrated unit was competitively lower (1.65% than seedlac manufactured through small scale lac processing unit (3.29%). Similarly, seedlac manufactured through integrated unit showed appreciable higher lightness (L), redness (a and yellowness (b) values compared to seedlac manufactured through small scale lac processing unit (Fig. 38 a & b).



(a) Small scale lac processing unit (b) Integrated unit

Fig. 38. Manufactured seedlac

Batch washing experiments were carried out with ratio of crushed sticklac and normal water using laboratory stirrer in plastic and MS container with and without addition of soda in three replications. Average values of colour parameters (L, a and b) of washed seedlac obtained after 5th batch of washing in plastic and MS containers were lighter in colour than seedlac washed without soda (Fig. 39) with the same treatments.

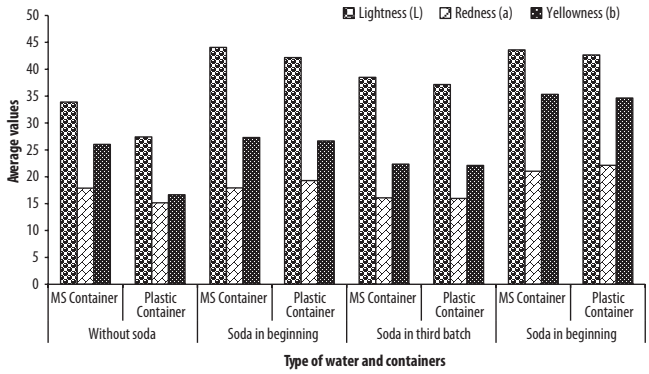


Fig. 39. Effect of soda addition, type of water and container on colour parameters of seedlac

3.2 Characterisation, chemical profiling and evaluation of gum ghatti (*Anogeissus latifolia* Wall.)

Gum ghatti (grade I, II and III) samples (Fig. 40) were analyzed for their physico-chemical properties *viz.* ash %, acid insoluble ash %, cold water soluble %, pH, acidity (as HCl) % by mass and BFOM % by mass, viscosity, iodine value, elemental and heavy metals analysis. DSC and FT-IR was also done. Tannin was isolated from gum ghatti (grade I, II and III) by Soxhlet extraction with triplicates samples of each grade. Tannic acid (TA) equivalent of each extract was determined by UV-VIS Spectroscopy at 725 nm, using tannic acid standard with Follin Ciocalteu reagent. Average value of TA equivalent *i.e.* actual tannin present in the gum ghatti was found to be 0.0078, 0.0254 and 0.3554 mg/g of gum, for grade I, II and III, respectively.

Elemental analysis of gum ghatti (grade I, II & III) obtained from Bilaspur (Chhattisgarh) and samples collected from Maharashtra, Madhya Pradesh and Karnataka was carried out. Based on the nitrogen percentage, protein content was calculated and found to be highest (8.11) in the sample collected from Maharashtra and the lowest (2.044) in the grade I from Bilaspur (Chhattisgarh) (Table 19).

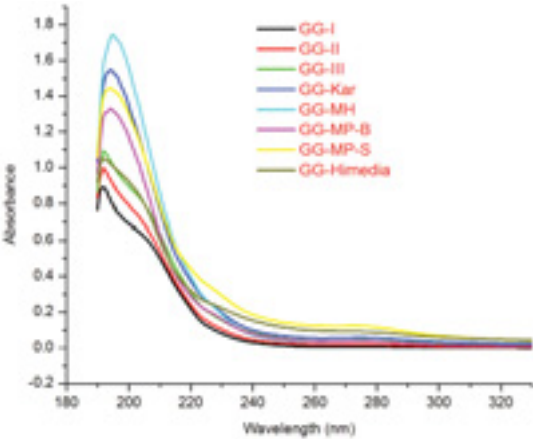
Fig. 40. Grade I, II & III of gum ghatti

Table 19. Physico-chemical parameters of different gum ghatti samples

S. No.	Parameters	Grade I Bilaspur	Grade II Bilaspur	Grade III Bilaspur	GG - Karnataka	GG - Maharashtra	GG-B, MP	GG-S, MP	BIS Limit
1	Ash %	1.97	2.75	3.51	2.37	3.22	2.13	3.16	6
2	Acid insoluble ash%	0.15	0.55	0.70	0.20	0.15	0.17	0.19	0.5
3	Protein content (%)	2.044	3.625	3.844	6.775	8.113	6.363	6.331	-
4	BFOM	0.39	1.09	3.71	1.34	2.76	2.01	3.24	-
5	Cold water solubles	87.75	82.87	82.02	92.24	89.70	85.83	83.35	-
6	Gum content (%)	83.18	79.76	79.26	75.215	70.997	75.217	74.489	-
7	Moisture % (volatile matter)	12.66	13.32	12.64	15.44	17.52	16.12	15.83	14
8	Acidity %	0.196	0.265	0.325	0.46	0.39	0.43	0.55	-

Dilute solutions of different gum ghatti samples collected from Chhattisgarh, Madhya Pradesh, Maharashtra and Karnataka were scanned for UV-VIS spectral absorption by Cecil 7200, UK Spectrophotometer from 190 nm to 700 nm. Interestingly all samples, including sample purchased from Himedia showed characteristic absorption between 190-200 nm (Fig. 41). Little absorption at 279 nm was also observed which is due to the traces of tannin present in the gum samples.

Iodine value of gum ghatti samples of different grades was estimated by modified Wij's-Langmuir method. It was found that iodine value for grade III was highest (27.91), followed by grade II (22.84) and grade I (18.40). As the iodine value represents amount of tannic acid in the gums, thus the trend obtained confirmed that tannin content in gum samples is in order of grade III>II>I. Microbiological criteria in different grades of gum ghatti was determined following standard protocols (IS: 5887:1976, Part I) for *E. coli* and IS: 5887:1999 (Part 3) for *Salmonella*.



GG-I, II & III: Gum ghatti samples from Bilaspur, (Chhattisgarh);

Kar: Karnataka;

MH: Jalgaon, Maharashtra;

MP-B: Betul (Madhya Pradesh);

MP-S: Shivpuri (Madhya Pradesh)

Fig. 41. UV-VIS absorption spectra of the gum ghatti samples

Alditol acetate and uronic acid derivatives of gum ghatti (grade II and III) were synthesized. All synthesized derivatives of gums as well as standards were analyzed by Agilent technology-GCMS (with 5975 C, inert XL EI/CI MS detector) in the Division of Agricultural Chemicals, IARI, New Delhi. The MS method was standardized to get optimum separation and then all samples were analyzed.

3.3 Physico-chemical characterization and monosaccharides profiling of Jhingan gum (*Lannea coromandelica*)

Jhingan gum samples of grade I, II and III of 5 Kg each was procured from Bahubali Udyog, Bilaspur (Chhattisgarh) and tested for ash %, acid insoluble ash %, cold water soluble %, pH, acidity (as HCl) % by mass and BFOM % by mass. The pH of gum samples was found to be neutral ranging from 7.0-7.2. Similarly, ash % was within the range of 2.2 to 2.7 and moisture (volatile matter %) was 12. Acidity % was 0.31 to 0.4 and acid insoluble ash % 2.2 to 2.78. Cold water soluble was found to be 84 to 91%. BFOM was within the range of 1.3 to 4.9 %. Viscosity of solution of jhingan gum (grade I, II and III) was determined by Brookfield Viscometer (LV-2 spindle). For 5 % solution of grade I at 10 rpm, 18 cP value increased to 2.5 times *i.e.* 45 cP at 100 rpm; for 10 % solution, it again increased from 90 cP to 222 cP. Similar trends were observed for grade II and grade III gum samples. From the result it was found that the viscosity gradually increases with increasing spindle rotation speed for each grade confirming that the viscosity is concentration-dependent and is shear-thickening or dilatants in its flow pattern.

The N:C:H was found to be in the ratio of 0.6:36:5 for grade I, 0.5:16.3:2 for grade II and 0.4:36:5 for grade III, respectively. The average value of L, a & b for jhingan gum I, II and III was found to be 73.3: 4.7: 11.1, 64.2:4.1:10.8 and 33.4:6.9:11.8, respectively. Iodine value for Jhingan gum samples was estimated by modified Wij's-Langmuir method and it was highest for grade III (32.35) followed by grade II (28.55) and grade I (24.74). The heavy metals present in gum samples were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The results obtained confirmed that the gum carbohydrates are present in their salts: Ca (5.77, 6.82 and 7.42 mg/g), Cd (0.003, 0.002 and 0.002 mg/g), Cr (BDL, 0.002 and 0.002 mg/g), Fe (0.068, 0.128 and 0.266 mg/g), Mg (1.53, 1.80 and 1.73 mg/g), Ni (BDL, 0.0005 and BDL mg/g) and Pb (0.0125, 0.0175 and 0.0145 mg/g) for grade I, II and III, respectively. Heavy metals such as As, Co and Cu are below detection level (BDL) for all grades.

Alditol acetate and uronic acid derivatives of Jhingan gum grade I, grade II and III were synthesized. All synthesized derivatives of gums as well as standards were analyzed by Agilent technology-GCMS (with 5975 C, inert XL EI/CI MS detector) at IARI, New Delhi. The MS method was standardized to get optimum separation for the analysis of the samples. DSC spectra of jhingan gum showed the presence of broad peaks confirming the amorphous nature of the gum. The Tg (glass transition) was found to be at 87.82 °C, 88.25 °C and 90.65 °C for jhingan gum grade I, II and III, respectively (Fig. 42).

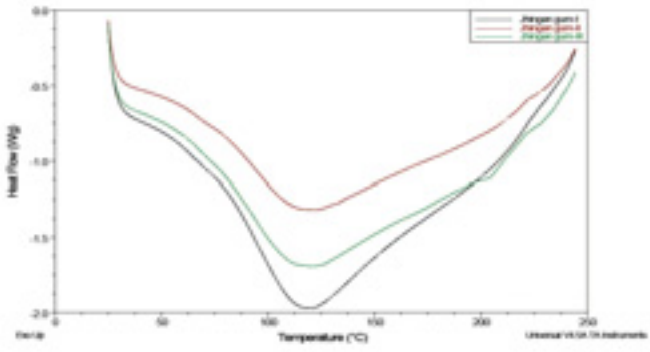


Fig. 42. DSC graph of Jhingan I, II and III

Samples of jhingan gum (grade I, II and III) were comparatively studied and tested for the presence of functional groups. FT-IR graphs of jhingan I, II and III revealed the broad areas of absorption between 3393-3402 cm^{-1}, corresponding to O-H stretching absorption due to inter and intra-molecular hydrogen bonds. Band around 2931 cm^{-1} is due to C-H stretching absorption whereas 1616-1636 cm^{-1} bands are due to the free carboxylate groups from uronic acid present in the gum.

3.4 Development of pilot-plant of dewaxed decolourised lac (DDL) for training, demonstration and process refinement

Study on solvent extraction system, process of operations, use of different solvent were carried out for determining type and suitability for pilot scale DDL preparation. A visit of Renshel Export Pvt. Ltd., Purulia (W. B.) was conducted in July, 2015 to get familiarized with the process and machineries used in lac industry for DDL preparation. For manufacturing dewaxed/DDL shellac on plant scale, requirement of machineries and equipment will be dissolution vessel, filter presses (PP closed type) for dewaxing and charcoal removal (using cloth), refluxing and distillation unit, chiller and heating system. The existing lab method uses filter paper for both wax and charcoal removal which is unsuitable for up-scaling the process. Regarding quality it was informed that clarity in alcoholic solution of DDL is an important parameter. Information on flow and life of product was not available. Solvent (spirit) loss during process may be 1-1.1 kg/kg of DDL produced (25% of initial solvent quantity used).

Preparation of DDL from 100 gm seedlac was carried out for process validation and optimization for designing pilot plant. A total seven trials were carried out with 100 gm seedlac varying lac-solvent ratio as per details given below with 20 % and 10 % charcoal treatment. Quality parameters of seedlac (fresh *kusmi* from IRF) in first trial were (flow, 60 mm; life, 55 min; colour,16 and in subsequent to first trial flow, 54 mm; life, 52 min; colour, 6) (Table 20).

During trial it was observed that low yield of DDL initially may be due to use of filter paper for removing wax during preparation in lab process which retains 25 % resin (approx.) along with wax and for increasing yield initial straining of solution and wax filtration was carried out in one step in subsequent trials in thick cotton cloth. The colour value of both DDL samples at S. No. 5 & 6 was 4 from QEL with no difference. However, when measured with Hunter lab colorimeter L, a & b values for first sample were 49.33, 8.22, 22.95 and for second sample 33.6, 7.66, 19.20. Appreciable difference in L (lightness) was observed. As no BIS for DDL is available and manufacturer producing at commercial level, are not mentioning flow and life for the product and needs monitoring for assessing its quality.

Filtration time was also studied under different lac-solvent ratio 1:4, 1:6, 1:8, 1:10. It was observed that although filtration was faster in lab with increasing solvent value for both wax removal and charcoal removal but time duration was nearly constant upto 1:6 ratio and higher for higher ratio due to filtration

Table 20. Quality parameters of dewaxed decolourised lac (DDL)

S. No.	Colour of seedlac	Charcoal (%)	Lac-solvent ratio (w/v)	Yield (%) of DDL	Colour of DDL	Wax (%)	Impurity (%)	Acid value	Flow (mm)	Life (min.)
1	16	20	1:4	65	10	0.30	1.43	75.0	35	18
2	6	10	1:4	60	4	0.60	0.12	68.5	55	20
3	6	20	1:4	65	2	0.29	1.13	68.5	48	20
4	6	10	1:4	66	3.6	0.50	0.57	69.6	96	30
5	6	10	1:6	75	4	0.55	0.10	74.0	108	23
6	6	10	1:8	70	4	0.70	3.65	74.3	65	25
7	6		10		1:10		80		To be tested from QEL	

of higher volume with increase in solvent ratio. Time required for wax removal was 3 hrs. (approx.) and 2 hrs. (approx.) for charcoal removal upto solvent ratio 1:6. More time in lab was required in wax filtration due to cold filtration carried out for wax removal compared to hot filtration for charcoal removal. With increasing solvent ratio there was trend of retaining lesser amount of resin with impurities during filtration when measured in lab and resulted in better yield with increasing solvent ratio.

Process flow diagramme and schematic arrangement and diagramme of equipment for establishment of pilot plant for DDL has been prepared. Specification for type and size of equipment like vessel, pump filtration unit as per requirement has been estimated. However, these for distillation and reflux system unit is under process.

3.5 Control of deacetylation of gum Karaya during storage for quality retention

Fresh 15.0 kg sample of gum Karaya was procured from M/s DK Enterprises, Hyderabad and the samples were analyzed for physico-chemical parameters. Loss of drying (per cent by mass) 17.4, volatile acid (per cent by mass) 13.64, swelling property (ml) 220/0.5 g and water absorption (ml) 180/0.5g for fresh sample of gum Karaya was determined.

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 replicates for each film (Fig. 43). The analysis of packed gum samples (Ist quarter) for the determination of the parameters like loss on drying, volatile acid, swelling property and water absorption was carried out.

Fig. 43. Gum Karaya samples packed in LDPE, HDPE, ACP and PP film

The analysis of packed gum karaya sample (Ist quarter) showed volatile acid value (%) as 12.6, 12.9, 12.3 and 12.12 respectively and swelling index (ml) for 65, 65, 85 and 90 respectively for samples wrapped in LDPE, HDPE, ACP and PP film with normal seal and kept at ambient temp. Similarly, the volatile acid value (%) and swelling index (ml) determined for the samples wrapped in LDPE, HDPE, ACP and PP film filled with nitrogen gas and kept at ambient temp. and the acid value found as 11.4, 12.06, 10.9 and 12.3, respectively and the swelling index 65, 55, 75 and 90, respectively.

The samples of gum Karaya (each weighing 50 g) were packed in LDPE, HDPE and PP films for keeping them in ambient and cold conditions with 3 replicate for each film. The analysis of packed gum karaya sample (Ist quarter) showed volatile acid value (%) as 12.36, 13.68, 12.48 and 12.72 respectively and swelling index (ml) for 100, 85, 70 and 140 respectively for samples wrapped in LDPE, HDPE, ACP and PP film with normal seal and kept at cold temp. Similarly, the volatile acid value (%) and swelling index (ml) determined for the samples wrapped in LDPE, HDPE, ACP and PP film filled with nitrogen gas and kept at cold temp. and the acid value found as 11.28, 11.46, 12.42 and 12.42 respectively and the swelling index 125, 95, 140 and 110 respectively.

On comparing the data of 1st 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. and (4) filled with nitrogen gas and kept at cold temp. displayed that there is not much change in the acid value amongst all the above treatments (Fig. 44).

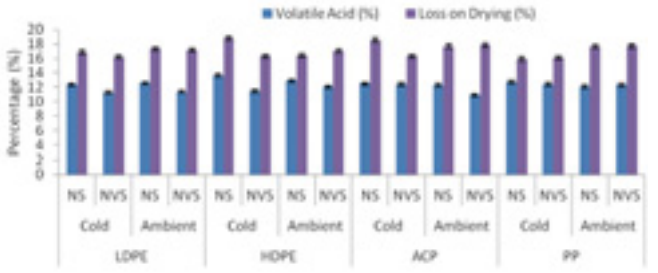


Fig. 44. Effect of packaging material and storage condition on volatile acid and loss on drying of gum Karaya samples (Ist quarter)

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

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. 45).

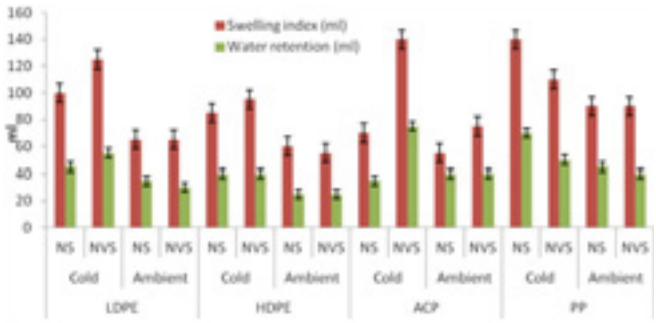


Fig. 45. Effect of packaging material and storage condition on swelling index and water retention of gum Karaya samples (Ist quarter)

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

4. Value Addition, Application Development and Product Diversification

4.1 Synthesis and evaluation of guar gum derivatives

Hydroxypropyl derivative of guar gum was synthesized using non-aqueous solvent method in alkaline medium and in the presence of propylene oxide under vacuum condition (HPG 1 and 2) as well as under nitrogen atmosphere (HPG 3, 4 and 5). The synthesized derivative was characterized by diffrential scanning calorimetry (DSC) and thermogravimetric analysis (TGA/DTA). DSC thermogram (Fig. 46) of the derivative revealed that the glass transition temperature (Tg) of hydroxypropyl derivative is higher than the native guar gum indicating greater thermostability of the derivative.

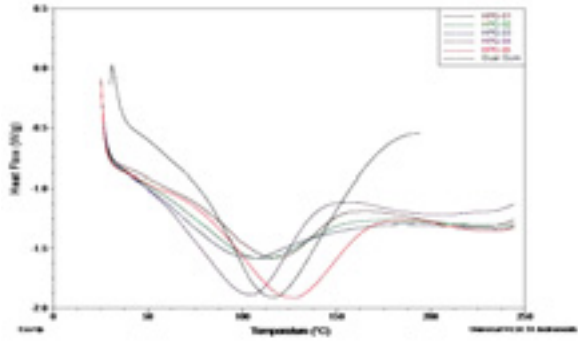


Fig. 46. DSC thermogram of Hydroxypropyl derivative of guar gum

The TGA study clearly indicated that the hydroxypropyl derivative have higher decomposition temperature (680-750 °C) than the native guar gum (540 °C). So the hydroxypropylation of guar significantly increases the thermostability of the derivative (Fig. 47).

Cationic derivative (Hydroxypropyl trimethyl ammonium chloride) of guar gum (HPTAG 5, 8 and 9) was synthesized using non-aqueous solvent method in alkaline medium and in the presence of cationization reagent (3-chloro-2-hydroxypropyl trimethylammonium chloride) and purified and dried for further analysis and characterization. The reaction condition was standardized as 40-50 °C and 3 hr. reaction time and 80 % aqueous isopropanol was the ideal solvent and reacting sodium hydroxide and cationization reagent in the ratio of 2:1. The cationic derivative of guar was free flowing, yellowish white and odourless powder (Fig. 48).

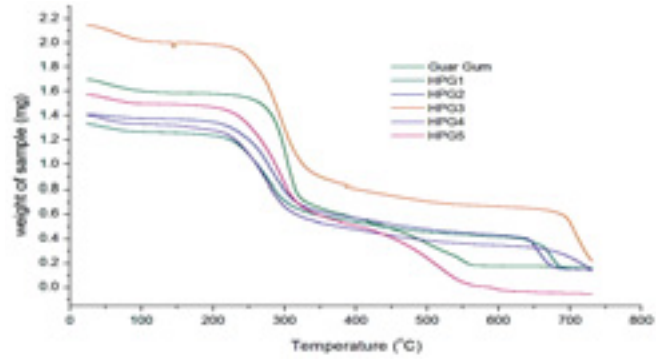


Fig. 47. TGA results of Hydroxypropyl derivative of guar gum

Fig. 48. Cationic derivative of guar gum

Viscosity of the synthesized derivative was determined using Brookfield viscometer. The viscosity of 1% solution ranges from 340 cP to 3200 cP (using LV-4 spindle, 20 rpm). It was observed that with the increased reaction time, the viscosity reduced substantially. The highest viscosity obtained at 3 hr. reaction time. The pH value of the cationic derivative solution ranges from 5.77 to 6.55 and it is slightly acidic in nature.

FT-IR spectra of the cationic derivative (Fig. 49) of guar showed a band at 1490 cm^{-1} that can be assigned to C-N stretching vibration due presence of tertiary amine group, which is absent in guar gum. The

additional band in cationic guar is clear confirmation of incorporation of the cationic moiety onto the polysaccharide backbone. Elemental analysis of the cationic derivative was carried out to determine the degree of cationization on the guar gum. Nitrogen percent in the derivative was substantially increased indicating the derivatization in the carbohydrate back bone of guar gum. Degree of substitution (Ds) of the cationic guar was estimated based on the nitrogen content and Ds of the cationic derivative was in the range 0.257-1.274. Transparency of the solution increased with the higher degree of cationization of the cationic guar derivative.

The cationic derivative of the guar gum was characterized by DSC analysis and the thermogram revealed that the the glass transition temperature (Tg) was higher than the native guar gum which indicates higher thermo-stability of the derivative.

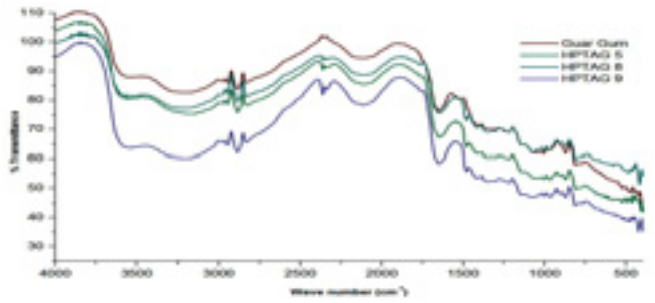


Fig. 49. FT-IR spectra of cationic derivative of guar gum

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

Synthesis of borax cross-linked guar gum hydrogels was done with varying percentage of borax crosslinker (5, 10, 15, 20 & 25 %). Synthesized hydrogels were characterized by FT-IR analysis. Swelling index of the hydrogels in distilled water was calculated and found up to 160 g/g (Fig. 50).

Fig. 50. Cross-linked guar gum hydrogels

For flocculation efficiency evaluation, kaolin-water suspension (0.1%) was used as turbid solution with stirring at 80 rpm for 5 min. and then settling time of 10 minutes. Initially various doses of the materials were tried for preliminary flocculation studies and optimized as 0.5 ppm to 2.5 ppm. Six beakers containing 0.1% solution of kaolin in distilled water were used out of which one kept untreated (control) and other five were fortified with the different doses of the polymers, from 0.5 ppm to 2.5 ppm (Fig. 51). The suspension was stirred thoroughly for uniform mixing and then uniformly stirred at 80 rpm for 5 minutes. After 10 minutes settling time, the supernatant samples were drawn and turbidity was measured in Nephelometer.

Fig. 51. Flocculation evaluation with Jar test apparatus

Flocculation efficiency of synthesized hydrogels and raw material (guar gum) was evaluated at various pH (5, 7 & 10). It was evident from the result that, cross-linking with borax has improved the flocculation efficiency of hydrogels as compared to raw guar gum. Maximum flocculation was obtained at 1.5 ppm dose of the hydrogel (Fig. 52).

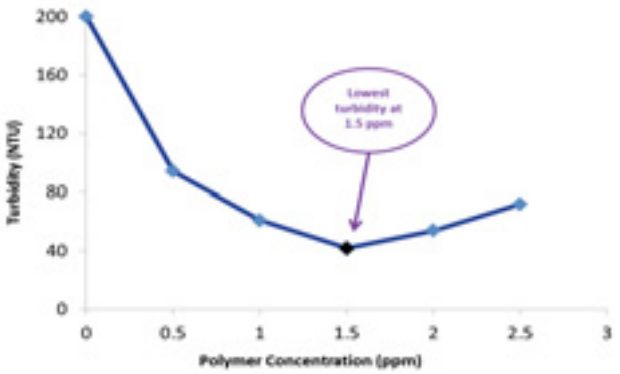


Fig. 52. Graph showing turbidity vs concentration of the hydrogel

4.3 Green synthesis of silver nanoparticles capped in gum *acacia* for bactericidal application

The synthesis of silver nanoparticles (AgNPs) of *Acacia nilotica* gum exudates, collected from Bilaspur (Chhattisgarh) (G3) and Jabalpur (Madhya Pradesh) (G5), was carried out by autoclaving the reactants (gum and silver nitrate solutions), at 121 ^{0}C and 15 psi. Before carrying out the synthesis, the protein content present in the gum exudates was determined by Lowry method and the O.D. value was found to be 0.75 and 0.53 respectively in comparison to the standard Bovine serum albumin (BSA) (0.36) used. Autoclaving makes the silver nanoparticles intrinsically safe and sterile in environmentally benign solvent water. After autoclaving, the appearance of yellow colour in the reaction mixtures is a clear indication of the formation of silver nanoparticles by the gum. The synthesis of silver nanoparticles 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 silver nanoparticles (Fig. 53). Silver ions are reduced to silver nanoparticles by the polyhydroxylated gum and the proteins present in the gum subsequently encapsulate and stabilize these particles along with saccharide molecules.

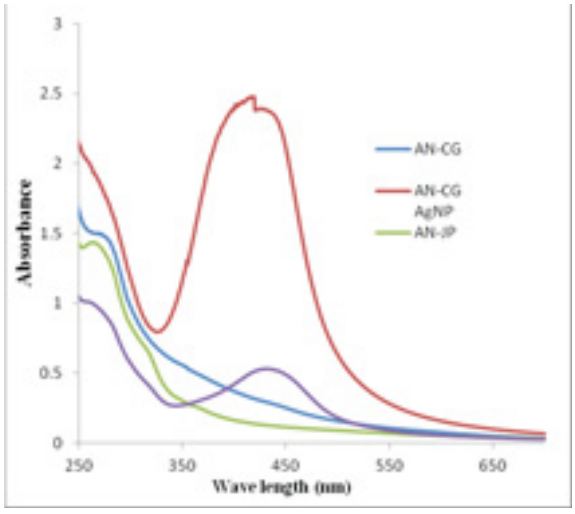


Fig. 53. Formation of *Acacia nilotica* gum-based AgNPs

Similarly, reactions were carried out to synthesize silver nanoparticles (AgNPs) by reacting different concentrations of *Acacia senegal* gum exudates (0.5% to 3.5 %) collected from ICAR-CAZRI, Jodhpur (Raj.) and 1.0 mM solution of silver nitrate adopting autoclaving methodology followed by their confirmation by UV-VIS Spectroscopy (Fig. 54).

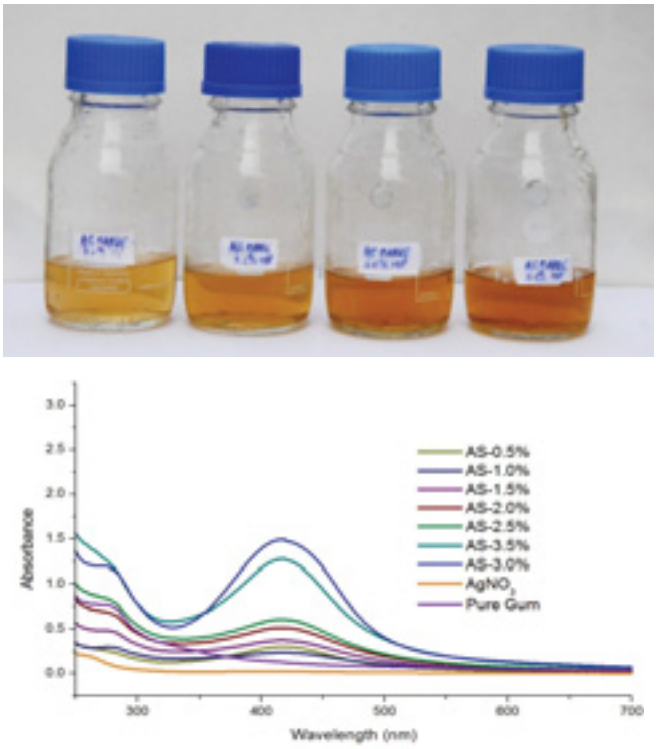


Fig. 54. Effect of concentration on the formation of *Acacia senegal* gum-based AgNPs

4.4 Development of coating formulation for paper packaging materials

Shellac was modified in aqueous and solvent system and formulations were developed for coating of paper packaging materials. The formulations were found to be homogeneous, applied on packaging paper and studied for coating properties. The films were found to be smooth, uniform and glossy. Films showed flexibility, no cracks, detachment was observed after bending the films. Scratch resistance and impact resistance were quite satisfactory. Films showed good water and acid resistance.

The formulations were studied for thermal behaviour with differential scanning calorimeter (DSC). It was observed that two formulations showed encouraging results, they could resist the temperature up to 150 ^{0}C, no melting was observed (Fig. 55).

The coated packaging papers were evaluated for mechanical properties such as tensile strength, tensile modulus, elastic modulus, elongation, tear resistance and toughness of the films. It was observed that strength of the paper increased after coating the papers. Highest tensile strength and modulus was found 16.6 MPa and 1.634 GPa respectively. Highest elongation was recorded 4.2 %. Elastic modulus of the

coated paper was calculated to be 4.397 MPa while toughness of the films was 0.52 MPa. Elastic modulus is the ratio between the stress applied and strain produced, indicating the material's resistance to elastic deformation. Tearing resistance of the coated paper was measured and found that the papers coated with the modified formulations showed higher resistance (32.2 Newton) than that of control (24.8 Newton) (Table 21).

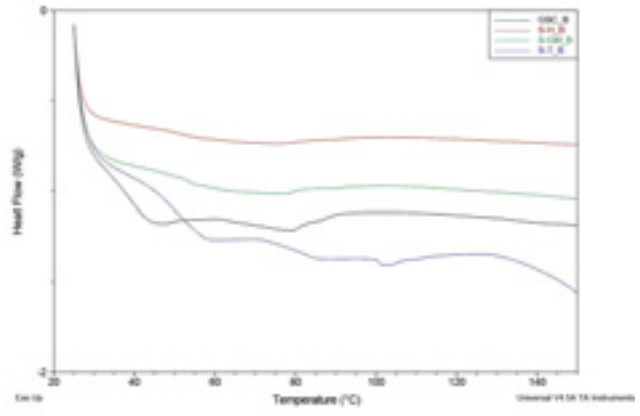


Fig. 55. DSC thermograms of films of modified lac compositions

Table 21. Strength of the paper packaging materials coated with the modified lac compositions

Samples/ Properties	PCM-01	SCM-01	SG-55M	SH-55M
TS (MPa)	14.876	16.601	15.803	15.742
TM (GPa)	1.357	1.634	1.416	1.38
Elongation (%)	3.958	3.953	4.197	3.58
Elastic Modulus (MPa) (Stress/ strain)	3.758	4.2	3.765	4.397
Toughness (MPa)	0.351	0.52	0.499	0.438
Tearing resistance (Newton)	24.8	28.4	24.9	32.2

Contact angle measurement of the coated papers against water was studied to see the hydrophobicity of the formulations. It was found that the papers coated with the modified formulations showed higher contact angle than that of control indicating increased hydrophobicity of the coating formulation (Fig. 56 a & b).

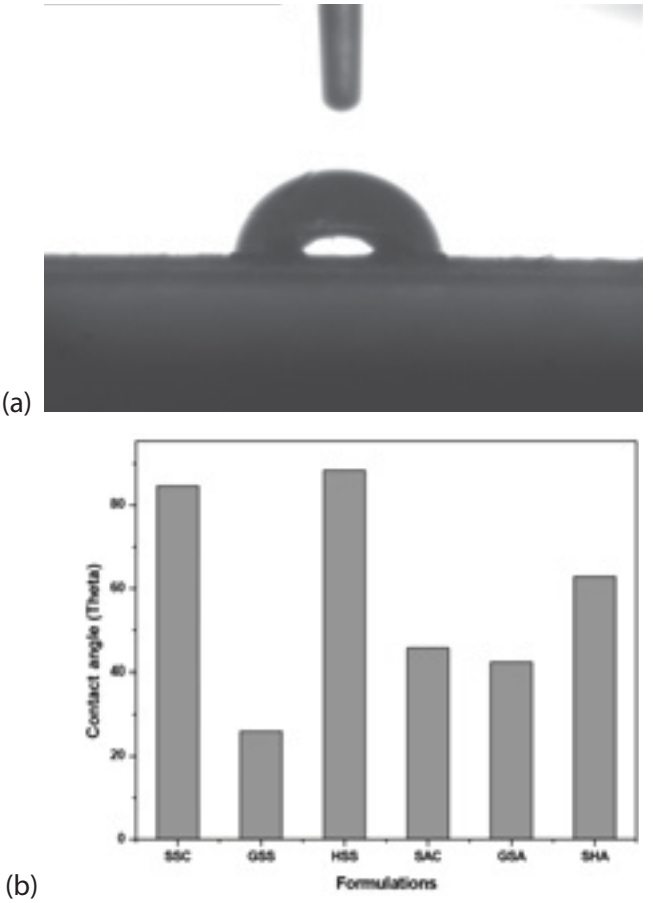


Fig. 56. Contact angle image (a) of one of the composition and contact angle graph (b) of different modified lac compositions

The papers coated with the modified lac formulations were examined for morphological character with Scanning Electron Microscopy (SEM). The coated papers showed smooth and even surface and holes were blocked indicating hindrance in permeability to gas and water vapour through the papers (Fig. 57a & b).

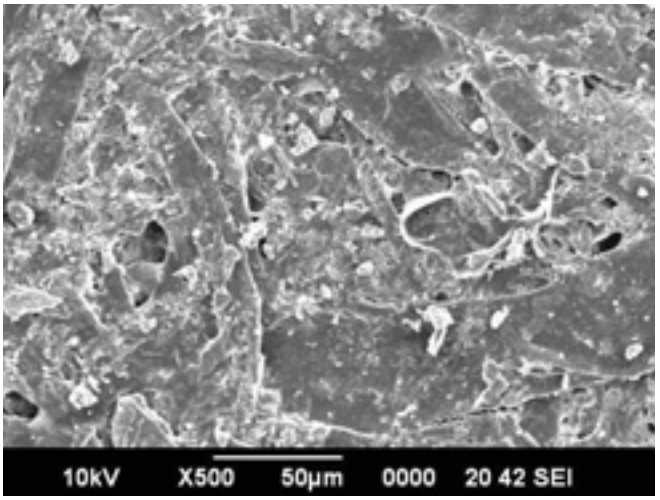


Fig. 57a. SEM image of packaging paper control

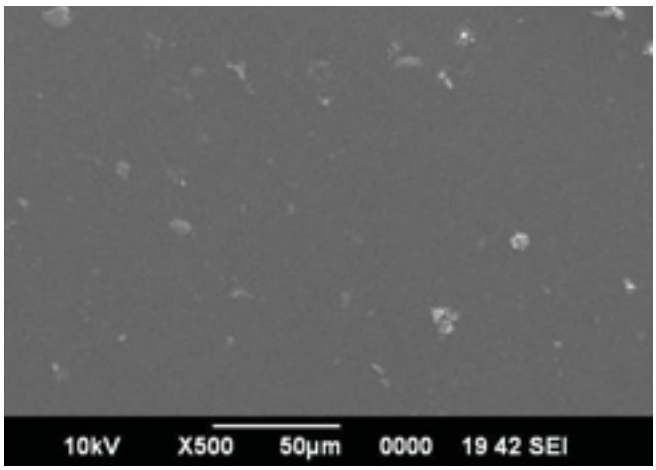


Fig. 57b. SEM image of packaging paper coated with modified lac composition

4.5 Popularization of natural nail shine (Lac-based nail polish)

Nail polish has become an indispensable part of the fashion these days. Nail polishes are synthetic resin and pigment based and can reach stomach along with food materials while eating, during feeding to children and due to nail-biting habits. Now there is increased interest in use of natural materials particularly in foods and cosmetics, in view of safety. Lac resin (shellac) is a permitted food additive in several countries and is completely safe.

A natural nail polish formulation (IINRG-NPL-05) has been developed by ICAR-IINRG, Ranchi, based on lac resin and can be applied to nails of fingers and toes for its decoration (Fig. 58). It provides very glossy, hard, smooth and durable finish on nails. It is quick drying and non-hazardous to health. It conforms to the requirements of BIS standard (IS: 9245:1994). 400 numbers of packets each having two nail polish bottles were sent to Council for distribution in the AGM meeting. Nail polish samples were also supplied to M. Sc. forestry students for publicity and popularization of the product.

Fig. 58. Lac Nail Shine

4.6 Extending post harvest life of pomegranate

As per demand, work was carried out in collaboration with MPKV, Rahuri and NRCP, Solapur, for both on-farm and off-farm application of lac-based formulations. Both centres, primarily working with cv. Bhagwa cultivar, reported statistically significant results regarding the retention of physico-chemical characteristics of the fruits and reduction in spoilage during post harvest storage. Parameters studied included physiological loss in weight (PLW), shrinkage, glossiness, decay loss, TSS, acidity and TSS/acid ratio.

When treated with IINRG formulations, the life of the fruits were extended upto 16 days when stored at room temperatures. Coating, followed by cold storage extended the life upto 61 days. Enhancement in cosmetic appearance of the fruits, through increase in glossiness, was an added advantage (Fig. 59).

Fig. 59. Coating of pomegranate with ICAR-IINRG formulations

4.7 Externally Funded Project

Use of natural resins and gums for preservation and value addition of fishery products (Ministry of Food Processing, Govt. of India)

Work on development of Basa catfish nuggets using vegetable gums as binding and texturising was completed during the year under report. Proximate analysis of the nuggets indicated that moisture content decreased from 78.9 to 74.0% and fat content, from 6.1 to 5.4%. with increasing concentration of gum, protein content went up from 15.5% in control to 19.3% in treated samples. Control sample underwent maximum cooking loss (~3.5%), whereas both treatments T4 (2% guar gum, w/w) and T7 (2% gum *acacia*, w/w), exhibited minimum loss (~ 2.7%) (Fig. 60). In all the treated and stored samples (0 ^{0}C, 60 days), the presence of bacteria, yeast and mould

were well within permissible limits (≤ 3.0 x 102 cfu/g and ≤ 2.8 x 101 cfu/g, respectively). CIE L*a*b* values indicated significant lightening of the product during prolonged storage at 0 ^{0}C). Textural and sensory evaluation data also indicated that vegetable gums such as guar gum and gum *acacia* could be incorporated successfully in fish nuggets to improve their texture and sensory attributes.

In addition to basic chemical structure (including carbohydrate backbone and side chains), processing parameters are equally important for determining the final characteristics of natural gums. The study of engineering properties of 14 Nos. natural gums was therefore carried out during the year under report. The study revealed that babool gum showed the highest porosity. Babchi gum showed excellent flowability. Similarly, different gums exhibited difference in engineering parameters such as water holding capacity and oil holding capacity, angle of repose, static coefficient of friction and solubility, possibly due to (1) intrinsic chemical structure (2) effect of grinding and (3) effect of drying.

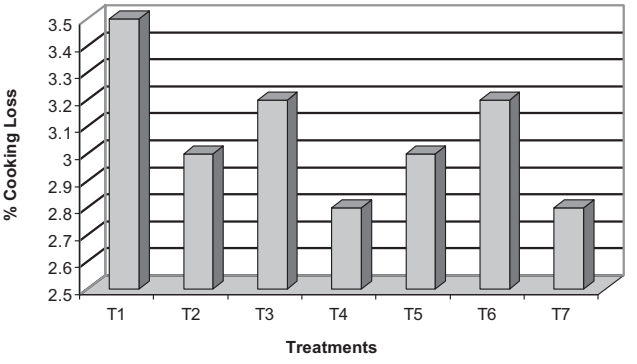


Fig. 60. Cooking loss in catfish nuggets (T1, control; T4, guar gum; T7, gum *acacia*)

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 various types of training programmes on scientific lac cultivation, processing and utilization under capacity building and entrepreneurship development programme. It continuously assess 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 beneficiaries is presented in Table 22.

Table 22. Skill development programmes on Scientific lac cultivation, processing and utilization

S. No.	Name of programme	No. of Courses/ Camps	No. of beneficiaries
Skill Development Programmes			
1.	Farmers training programme on Scientific lac cultivation, processing and utilization (5 days)	09	207
2.	Master trainers' programme on Scientific lac cultivation, processing and utilization (6 days)	23	778
3.	Educational programme on Production, processing and application of NRG (10 days)	02	50
4.	Lac based product demonstration training (3-10 days)	08	09
5.	Short term HRD programme on Lac promotion and development for the executives of NEH Region (3 days)	01	27
6.	Short term training programme on Current trends in lac production on *Flemingia semialata* & sustainable lac production technologies (3 days)	01	37
	Total	**44**	**1108**
Other training programmes			
7.	One day HRD programme on Integrated pest management in lac cultivation	01	25
8.	On-farm training programme on Scientific lac cultivation	26	2751
9.	On-farm Motivational / supplementary training programme on lac cultivation	05	244
10.	In-campus one-day orientation programme on lac cultivation	82	6482
	Total	**114**	**9502**
11.	Workshop/ FIG /Educational Programme on lac cultivation	19	1909
	Grand total	**177**	**12519**

The detailed information on all programmes have been given in Appendices.

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 207 farmers from different districts of four states *viz.* Jharkhand, Odisha, Assam and Maharashtra participated in the programme. The participants were sponsored by various organizations (Appendix-I).

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

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 uses". A total of 778 participants were trained as trainers through 23 different courses. These were sponsored by various

organizations of Jharkhand, Odisha, Assam, Nagaland, Chhatisgarh, Madhya Pradesh and West Bengal states (Appendix-I).

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

Three Agricultural Educational Institutions namely Sam Higginbottom Institute of Agriculture Science & Technology, Allahabad (Formerly Allahabad Agriculture Institute, Allahabad), Institute of Agriculture Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) and Guru Ghasidas University, Bilaspur (Chhattisgarh) has nominated their agricultural graduate students and M.Sc. Forestry students for 10 and 15 days education programme on production, processing and uses of natural resin and gums. A total of 50 students participated through two courses under this educational programme scheme (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. The details are shown in Table 23.

Table 23. Lac based product demonstration training

Sl.	Name & Address	Sponsoring Agency	Duration	Subject
1.	Sri Roshan Khalkho, Ashokpuram, Opp.-Ashok Nagar Road No.-4, Livene's Lane, Argora, Ranchi (Jharkhand).	Self	12.01.15 to 21.01.15	Aleuritic Acid
2.	Sri Hasmukh Patel, Pr. Scientific Officer, MGIRI, Wardha (Maharashtra).	Self	12.01.15 to 16.01.15	1. Lac glaze 2. Water soluable lac 3. Non-spirit MSV-005 4. Lac wood shine
3.	Sri Sagar Suresh Bhai Parekh, M/s Serena Chemicals, Mumbai.	M/s Serena Chemicals, Mumbai	16.02.15 to 25.02.15	Aleuritic acid
4.	Sri Indrapal Verma, Distt. - Korea (Chhattisgarh).	Self	10.3.15 to 13.3.15	1. Air-drying type insulating varnish, 2. Non-spirit MSV-005 3. Shellac based glazing varnish.
5.	Sri D. Radhakrishnan, M/s Digitex Colour Solution, Salem (Tamilnadu).	M/s Digitex Colour Solution, Salem, Tamilnadu	13.4.15 to 19.4.15	Lac dye (technical grade)
6.	Sri Vivek Agarwal, M/s Ganga Lac Factory, Khunti , and Sri Anil Saraogi, M/s Jagdamba Lakh Udyog, Khunti, Ranchi (Jharkhand).	M/s Ganga Lac Factory, Khunti M/s Jagdamba Lakh Udyog, Khunti	22.4.15 to 01.5.15	Aleuritic acid
7.	Sri Krishnendu Dutta B-14/66, Kalyani, Nadia (West Bengal).	Self	01.6.2015 to 10.6.2015	1. Aleuritic acid 2. Lac dye 3. Hydrolysed lac
8.	Sri Akash Gavel, Jajgir-Champa (Chhattisgarh).	Self	26.10.2015 to 04.11.2015	1. Dewaxed bleached lac 2. Lac processing

Other programmes

Processing and procurement of sticklac and scientific lac cultivation on *Flemingia semialata* was also organized.

On-farm training programme on scientific lac cultivation

ICAR-IINRG has organized twenty six on-farm training programme on lac cultivation in collaboration with various GOs and NGOs of different states. A total of 2751 farmers were participated from different districts of Jharkhand and Chhattisgarh. The participants were nominated by Forest Divisions of Jharkhand and Chhattisgarh states**,** JASCOLAMPF, Ranchi and NGO namely *Adivashi Mahila Vikas Samittee*, Gumla and *Nav Jeevan* Hospital, Satbarwa Palamu (Appendix-II).

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

A total of 244 participants were trained in on-farm motivational/ supplementary training programme on lac cultivation in collaboration with various NGOs and GOs of Jharkhand. The participants represented three districts of Jharkhand *viz.* Ranchi, Khunti and Gumla (Appendix-II).

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

In-campus, one day orientation programme (82 Nos.) on natural resins and gums were organized in collaboration with GOs and NGOs of different states and 6482 farmers, school children, college students and executives were visited the institute for this purpose. These were nominated by various agencies (Appendix-III).

Workshop/ FIG /Educational programme on lac cultivation

A total of 1909 persons participated in workshop/ Farmers Interest Group (FIG) /Educational programme on lac cultivation in collaboration with various NGOs and GOs of different states. The participants represented different districts of two states *viz.* Jharkhand and Odisha (Appendix-IV).

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

Based on the information generated under market research project, a data base has been maintained in the NIC. During 2015, 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 53 stakeholders including farmers, traders, exporters, processors/manufactures, research scholars, GOs, NGOs, etc. (Fig. 61) (Appendix-V). Data on NRG production, processing, EXIMA were also sent to IASRI for Agriculture Research Data book.

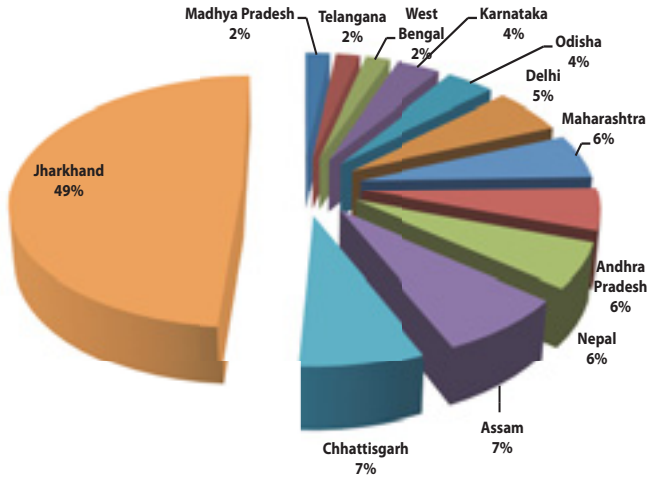


Fig. 61. State-wise beneficiaries

6. Technology Evaluation, Refinement, Dissemination and Demonstration

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

A database of NRG stakeholders especially farmers (1022 Nos.) and industries/ entrepreneurs (48 Nos.) was prepared. Six month advisories on scientific lac cultivation, practices and uses were prepared to be sent to farmers and other interested stakeholders. To send the advisories to different stakeholders, a registration work was completed in the name of *iinrgictproject@gmail.com* on *m-kisan* website. To make thirty four documentary video films, an agency was identified and in the first phase nineteen documentary video films have been finalized to prepare.

6.2 Market Research on NRGs

About 952 stakeholders including 90 institutions, 628 farmers, 40 traders, 64 processors/wholesalers/ exporters, 130 resource persons were interacted through visits telephonic conversations in 42 districts of 13 states. Secondary data on NRG production was collected from various central and state government organizations. Total production of NRG has been increased from 1160314 tons in 2013-14 to 1196308

tons in 2014-15 (Table 24). It shows an increase of about 3.1 % over the previous year. However, due to high market price fluctuation a decline in guar gum production is observed during 2015-16.

Table 24. Quinquennial view of total NRG production, export and import

Year	Total NRG	Export		Import	
		Quantity (in tons)	Value (in ₹lakhs)	Quantity (in tons)	Value (in ₹lakhs)
2010-11	668340.72	377311.60	308622.90	68750.76	67950.40
2011-12	773636.07	641570.16	1696636.17	80734.60	71497.81
2012-13	837482.00	340384.75	2176118.62	89746.33	78534.90
2013-14	1160314.10	483060.85	1217055.20	89535.92	96501.64
2014-15*	1196308.00	671746.91	980243.17	NA	NA

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

On the basis of survey in the market and processing centers of different lac producing states, the estimated national production of sticklac during 2014-15 was approximately 16,978 tons (Fig. 62). Jharkhand state ranked 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and Odisha. These five states contribute around 90 % to the national lac production (Fig. 63). Total production of lac was observed around 19.18 % less than the previous year and 29.3% decline in lac production was recorded from Jharkhand. It expected to increase lac production during 2015-16.

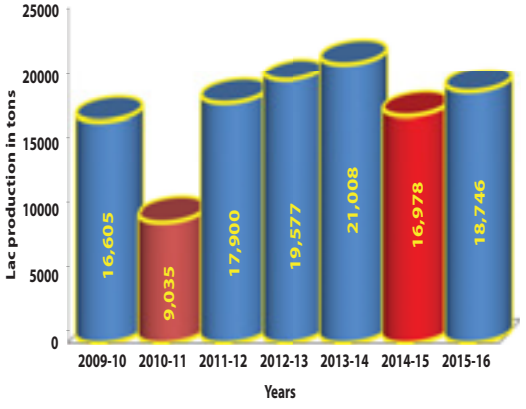


Fig. 62. Lac production in India during recent years

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 has shown decreasing trend from Jan. 2014 to Dec. 2015. The information on the price revealed that price range of *kusmi* sticklac and *rangeeni* sticklac at various levels of market has declined. Subsequently, the per kg price of processed lac products namely seedlac, shellac, button lac and bleached lac also declined (Fig. 64).

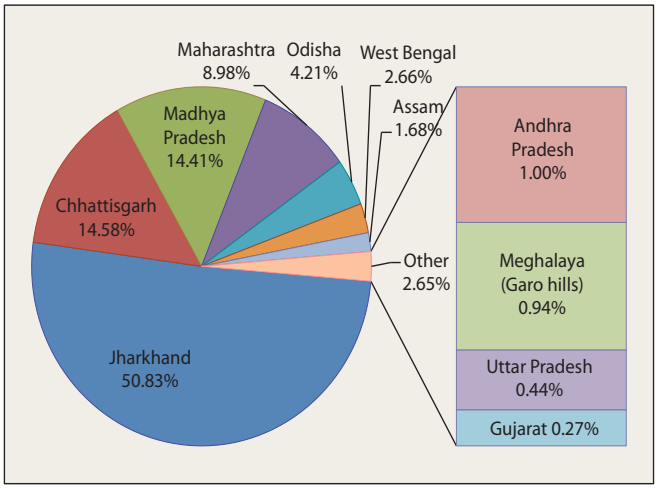


Fig. 63. State-wise contribution in lac production

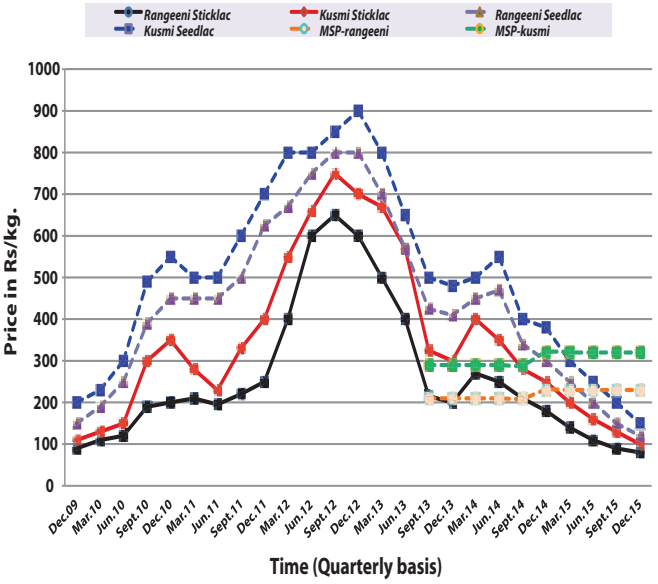


Fig. 64. Movement in prices of scraped lac and seedlac

On the other hand price level not recovered throughout the year due to the poor involvement of the processors. Other resins and gum production is declined this year also. Overall, NRG production level during 2014-15 is estimated comparatively higher than the previous year. The collection rate for *karaya* gum ranged from ₹20,000/-, ₹15,000/- and ₹11,000/- per quintal for grade I, II and III, respectively.

Retail price of *guggul*, babul gum (*A. arabica*) and *salai dhoop* was recorded as ₹1000/kg, ₹160/kg and ₹240/kg, respectively. During last quarter of 2014, price of rosin and turpentine oil ranged from ₹65-91/kg and ₹87-88/litre, respectively (Source: HP State Forest Corporation Ltd.). Export price of aleuritic acid ranged from 9000/kg in December 2012 to 2738/kg in December, 2015. Similarly price of ambrettolide ranged from 20,000/kg in July 2013 to 7898/kg in Dec. 2015.

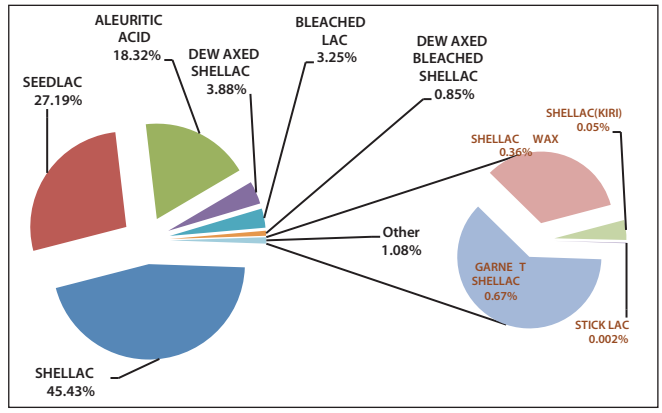
The exported quantity of the lac and lac based products have decreased by 19.48 % during 2014-15 over the previous year and it was valued about ₹32249.6 lakh (Fig. 65).

International price of various grades of *guar* gum ranged from $ 1784/t to $ 3971/t during the year of 2014-15 (Fig. 66). Export of NRG showed an increasing trend (in quantity), but decreased (in value) in 2014-15 in comparison to 2013-14. Based on the final data available till November 2015, a sharp decline in export is noted. Consequently, the total value of NRG export particularly for guar gum was less than previous two year 2012-13 and 2013-14.

The Foreign Trade Policy, 2015-20, is notified by Central Government, in exercise of powers conferred under Section 5 of the Foreign Trade (Development & Regulation) Act, 1992 (No. 22 of 1992) [FT (D&R) Act], as amended. Under this a scheme namely Towns of Export Excellence (TEE), government has already recognized 33 towns as export excellence towns. It has been decided to add Vishakhapatnam and Bhimavaram in Andhra Pradesh as towns of export excellence. Due to awareness amongst the lac growers, strain wise lac production data revealed that the share of *kusmi* strain increased sharply since 1990 onwards (Fig. 67).

6.3 Impact assessment of technological interventions

Under impact assessment studies, data has been compiled and analysed. Major scientific interventions



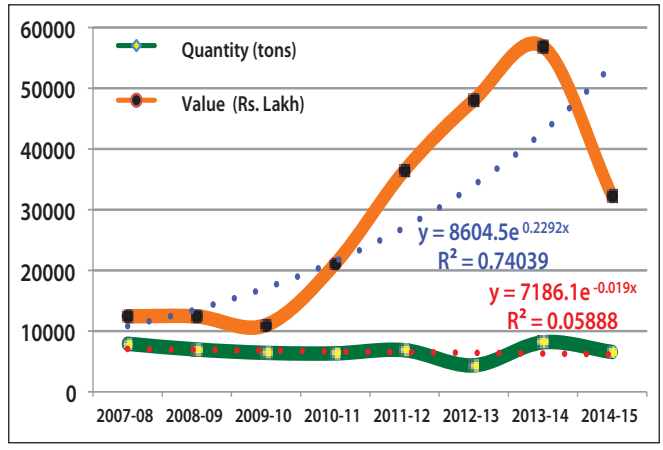


Fig. 65. Composition and trends in overseas demand of lac & its value added products

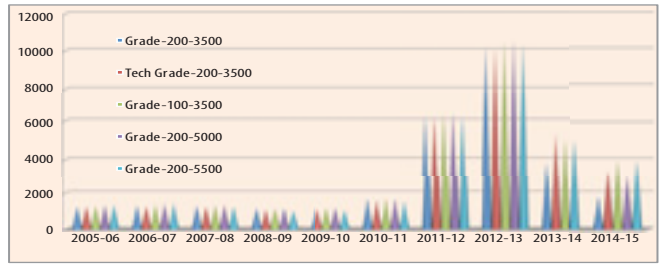
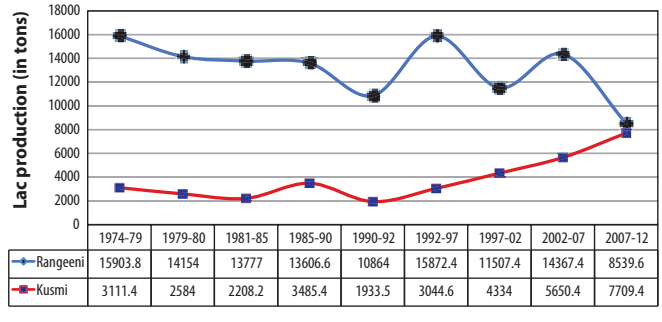


Fig. 66. International price level of different grades of guar gum during previous years



	1974-79	1979-80	1981-85	1985-90	1990-92	1992-97	1997-02	2002-07	2007-12
Rangeeni	15903.8	14154	13777	13606.6	10864	15872.4	11507.4	14367.4	8539.6
Kusmi	3111.4	2584	2208.2	3485.4	1933.5	3044.6	4334	5650.4	7709.4

Fig. 67. Strain-wise lac production in India during five year plans

in lac cultivation were categorized based on the activities like pruning, broodlac inoculation, *phunki* removal, pest management and post harvest management. Adoption of improved method of pruning, broodlac inoculation, *phunki* removal, pest management and post harvest management was increased. Adoption level for pest management was observed very low. This showed that skill development for pest management is not getting momentum as it needs non-credit support through backward linkages to the stakeholders. Analyses also indicated that farmers were acquainted with the advantages of scientific practices over conventional methods. Convergence with the service providers at district level is an essential component for effective results of skill development. Impact of adoption level resulted as increased productivity level across various category of households. Extension functionaries have good opportunities for minimizing the yield gap through skill development activities. Institutional barriers may be removed with more emphasis on extension and trainings for rural youths to check the migration for employment from rural to urban sector.

6.4 Other extension activities undertaken by Transfer of Technology Division

Lac crop surveillance

The institute experts visits different lac growing areas from time to time in order to collect information on crop status and monitor the crop for rectification in technology. The technological needs are transferred to collaborating institution and farmers. During the period, crop monitoring was carried out in West Bengal, Jharkhand, Karnataka, Assam etc. (Appendix-VI).

Participation in Exhibition/*Kisan Mela*

The experts from IINRG, Ranchi participated in different exhibition/*kisan mela* organized by different agencies during 2015 and provided technical expertise on NRG to their stakeholders. Altogether institute has participated in two exhibition/*kisan mela* and around 6600 beneficiaries were benefited and made aware about the technologies of IINRG (Table 25).

Table 25. Participation in exhibition/*kisan mela*

Name of the programme with venue	Duration	No. of Participants
Annual *Kisan Mela*, RK Mission, Getelsud, Angara, Ranchi	12-13 February, 2015	1200
ASC India Expo at NDRI, Karnal (Haryana)	03-06 February, 2015	1000
Regional Agri Fair, CPRI, Patna, Bihar	19-21 February, 2015	3000
Mahila Maha Sammelan organized by XISS, Ranchi at Loyola Ground, Khunti	18 April, 2015	400
Advantage Jharkhand: Food Processing Investor Summit at Khel Gaon, Ranchi	20-21 April, 2015	500
Foundation Stone laying ceremony of new Institute of ICAR at Piprakothi, Motihari, Bihar	20-21 August, 2015	1000

Kisan gosthi/Workshop/FIG/Interface meetings

The Institute has organized/participated kisan gosthi/ Workshop/FIG/Interface meetings in collaboration with various institution**.** A total of 19 such events were conducted (Table 26).

Table 26. *Kisan gosthi* / Workshop / FIG / Interface meetings

S. No.	Venue	Collaboration	Date
1.	Kuchaita (Sarrgigarh), Rourkela	SEET, Rourkela	22.01.15
2.	Torpa, Khunti	KVK, Khunti and TRDS, Torpa	23.01.15
3.	Lagam, Silli, Ranchi	Gunj Parivar	31.01.15
4.	Torpa, Khunti	TRDS, Torpa	31.01.15
5.	Getelsud (Angara), Ranchi	R.K.Mission, Ranchi	13.02.15
6.	Kisan Bhawan, Rania	JASCOLAMPF, Ranchi	09.03.15
7.	Arki, Khunti	JASCOLAMPF, Ranchi	10.03.15
8.	Lamps Campus, Palkot	JASCOLAMPF, Ranchi	11.03.15

S. No.	Venue	Collaboration	Date
9.	Lamps Campus, Chainpur	JASCOLAMPF, Ranchi	13.03.15
10.	Lamps Campus, Sesai	JASCOLAMPF, Ranchi	14.03.15
11.	Lamps Campus, Anandpur	JASCOLAMPF, Ranchi	18.03.15
12.	Panchyat Bhwan, Barka Duiel, Bano	JASCOLAMPF, Ranchi	20.03.15
13.	Lamps Campus, Bharno	JASCOLAMPF, Ranchi	24.03.15
14.	Hatioda (Gurundia), Rourkela	SEET, Rourkela	18.04.15
15.	Torpa, Khunti	TRDS, Torpa	22.05.15
16.	Baghia, Rania, Khunti	TRDS, Torpa	06.06.15
17.	Arki, Khunti	TRDS, Torpa	15.07.15
18.	Arki, Khunti	TRDS, Torpa	21.07.15
19.	Arki, Khunti	TRDS, Torpa	19.09.15

Field Demonstration conducted

Table 27. Field demonstrations/OFTs conducted

S. No.	District/ State	Location/ Site	Technology	Number of host plants utilized	Crop	Input provided	Linkages
1	Sitapur, U.P.	KVK, Sitapur	Winter *kusmi* lac on *Ziziphus mauritiana*	30	*Aghani*, 2015-16	Broodac- 30 kg *kusmi* broodlac & pesticides	KVK, Sitapur, U.P.
2	Sitapur, U.P.	KVK, Sitapur	Winter *kusmi* lac on *Flemingia semialata*	1000	*Aghani*, 2015-16	Broodac- 45 kg *kusmi* broodlac & pesticides	KVK, Sitapur, U.P.
3	Ramgarh, Jharkhand	Sugia, Ramgarh	Winter *kusmi* lac on *Albizia procera*	20	*Aghani*, 2015-16	Broodac- 40 kg *kusmi* broodlac & pesticides	Progressive farmer Sri Prem Lal Mahato
4	Khunti, Jharkhand	Nikhitpur, Torpa, Khunti	Winter *kusmi* lac on *Ziziphus mauritiana*	50	*Aghani*, 2015-16	Broodac- 75 kg *kusmi* broodlac & pesticides	TRDS, Torpa, Khunti
5	Banka, Bihar	Salaiya, Banka	Winter *kusmi* lac on *Ziziphus mauritiana*	150	*Aghani*, 2015-16	Broodac- 150 kg *kusmi* broodlac & pesticides	Ramkrishna Vivekananda Seva Ashram, Deoghar

Entrepreneurship development

Technology adoptions by entrepreneurs

One entrepreneur of Nadia district of West Bengal started production of 2.5 tonnes of aleuritic acid per month after obtaining training from ICAR-IINRG Ranchi.

Promotion of lac based handicrafts through sale

Lac based handicrafts of worth Rs. 14,847 sold during the period.

Liaisoning with lac processing industry

To establish liaison with lac industry and identification of problems in processing, visits were made to lac processing units situated in the states of Jharkhand, Chhattisgarh, West Bengal and Kerala. Processing units at these places are manufacturing seed lac, shellac, bleached lac, button lac, dewaxed decolorized lac and lac dye. One industry M/s Chelat Labs in Kochi, Kerala manufactures Gasket Shellac Cement Compound (Table 28).

Table 28. Liaisoning with Industry

S. No.	District (State)	Date of Visit	Industry	Products Manufacturing
1.	Dhamtari (C.G.)	20.3.2015	M/s Indian Shellac Industries	Seedlac
2.	Khunti (Jharkhand)	25.3.15	M/s Indian Shellac	Seedlac, Bleached lac
3.	Khunti (Jharkhand)	25.3.15	M/s Tajna Shellac Industry	Seedlac, Shellac, Bleached lac
4.	Balarampur, Purulia (W.B.)	26.3.15	M/s Jaiswal Shellac Industry	Seedlac, Shellac and Aleuritic Acid
5.	Aluva, Kochi (Kerala)	09.4.2015	M/s Chelat Labs	Gasket Shellac Cement Compound
6.	Khunti (Jharkhand)	29.4.2015	M/s Gupta Brothers (Shellac) Pvt. Ltd.	Seedlac, Shellac, Button lac and Lac dye
7.	Ramgarh and Bokaro	12.5.2015	Peterwar area and local market	Seedlac
8.	Jaipur (Rajasthan)	29.5.2015 to 09.6.2015	Traditional bangle makers	Lac bangles and lac based handicraft items
9.	Khunti(Jharkhand)	25.6.2015	Indian shellac industries/ Tajna shellac/ Parvati lac udyog	Seedlac, Shellac and Bleached lac
10.	Kolkata (W.B.)	07.7.2015	SHEFXIL, Kolkata	Export promotion for all the lac based value added products
11.	Sakti (Jajgir-Champa, (C.G.)	09.12.2015	M/s Bajranglal Agarwal, Sakti	Seedlac, Button lac and Bleached lac (trial run started)
12.	Sakti (Jajgir-Champa, (C.G.)	09.12.2015	M/s D. Manoharlal (shellac), Sakti	Shellac (different grades), DDL
13.	Dhamtari (C.G.)	10.12.2015	M/s Indian Shellac Industries	Seedlac
14.	Dhamtari (C.G.)	10.12.2015	M/s Indian Seedlac Industries	Seedlac
15.	Dhamtari (C.G.)	10.12.2015	M/s Shubham Shellac Industry	Bleached lac
16.	Dhamtari, (C.G.)	10.12.2015	M/s Aishwarya Lakh Products	Bleached lac
17.	Dhamtari (C.G.)	10.12.2015	M/s Thakuria Lac Industries	Button lac (seedlac production closed)
18.	Dhamtari (C.G.)	10.12.2015	M/s Thakuria Shellac Factory	Seedlac and Button lac
19.	Dhamtari (C.G.)	10.12.2015	M/s Arvind Shellac Factory	Seedlac and Bleached lac
20.	Dhamtari (C.G.)	10.12.2015	M/s Rokadia lac Products	Seedlac
21.	Dhamtari (C.G.)	10.12.2015	M/s Rokadia Shellac Industries	Seedlac
22.	Dhamtari (C.G.)	10.12.2015	M/s Sigma Shellac Industries	Seedlac
23.	Dhamtari (C.G.)	10.12.2015	M/s Goel Shellac Industry	Button lac
24.	Kanker (C.G.)	11.12.2015	M/s Noori Shellac Industries, Aturgaon-Kulgaon, Kanker, Chhattisgarh	Seedlac

The major problems identified during the visits were higher cost of processing due to extensive labour requirement, very high fluctuation in price, decrease in overseas demand and low internal consumption, unpredictable demand of bleached lac and button lac and poor supply of *rangeeni* lac crop. In order to minimize the problems in lac industry some suggestions like development of integrated lac processing unit comprising crushing, washing, drying, grading and polishing; development of gravity based grader for removal of stone, wood and sand particles from seed lac were made. Government intervention is also needed to regulate the price of seedlac and sticklac to stabilize its highly fluctuating price. In view of these suggestions, modernization and automation of the lac processing should be taken on priority basis to reduce the drudgery and labour requirement.

Technical guidance/Advisory

Technical guidance and advisory were given to different institutions/ stakeholders from industry (Table 29).

Table 29. Liaisoning with Industry

S. No.	Stakeholder	Nature of Advisory
1.	Sahayog Community Coordination Network (CCN Sahayog), Visakhapatnam (A.P.)	Non-hazardous and environment friendly management of lac factory effluent
2.	Additional PCCF, Jharkhand	Status of lac processing in Jharkhand
3.	Ankiit Shellac Factory, Balarampur	Aleuritic acid
4.	Sri Chirag Damani, M/s Serena Chemicals, Mumbai	Lac factory effluent management
5.	Chelat labs, Aluva, Cochin	Gasket Shellac Cement Compound
6.	Saraogi Shellac Overseas Corp. Kolkata	Isoambrettolide
7.	Bajarang Lal Agrawal Lac Industry, Sakti (Chhattisgarh)	Bleached lac
8.	Shri Tapan Singh M/s Ecosafe Technologies, Tupudana, Ranchi	Lac based varnishes
9.	Anurag Nilesh Soy, Hulhundu, Ranchi	Lac based Varnishes
10.	Kalicharan Machhuwa, Bundu, Ranchi	Gasket Shellac Cement Compound
11.	Vivek Agarwal and Anil Saraogi, Khunti	Aleuritic acid, Gummy mass, Gasket Shellac Cement Compound and isoambrettolide
12.	Somnath Dutta, M/s K D Udyog 24-Parganas (WB) and Mrs. Sarbani D Mitra, Glenville, New York USA	Aleuritic acid, gummy mass and lac dye
13.	Roshan Tirkey, Bano, Simdega	Aleuritic acid bleached lac
14.	Deepak Kumar, M/s Aadhya International, Mumbai	Dewaxed decolourized lac and Kinnow Fruit coating formulation

Tribal sub-plan (TSP)

Table 30. Activities conducted under Tribal sub-plan

Activity	Accomplishment
Capacity Building	Two in-campus training programmes on scientific lac cultivation, processing and uses, each of 5 (January 2015) and 6 (March 2015) days duration, respectively, were organized at ICAR-IINRG Ranchi and a total 38 tribal participants from Rourkela (Odisha) were benefited..
Field Demonstration	Three field demonstrations were conducted on *kusmi* lac cultivation (*Jethwi*-2015) on 67 *kusum* trees of 30 farmers (3 FIGs each having 10 farmers) in Kendughati, Hatioda, Sargigarh and Kucheita villages of Rourkela (Sundergarh), Odisha. A total of 300 kg broodlac was inoculated in February 2015. Pesticides were sprayed twice to protect the crop from pest. Harvesting was done during July 2015. A total yield of 2004 kg broodlac and 309 kg rejected scraped lac along with 158 kg *phunki* was obtained.
Farmers Adoption programme	Forty tribal farmers were identified and 4 FIGs were formed each having 10 farmers from Sargigarh, Hatioda, Kendughati and Kucheita villages of Rourkela (Sundergarh), Odisha. Farmers were provided training on scientific lac cultivation and critical inputs for lac cultivation including broodlac, pesticides, lac cultivation tools and rocking sprayer (Gatore). Thus, 400 kg broodlac, 20 kg *sutli*, 40 *dauli*, 40 secateurs, 40 scraping knife, 4800 number of 60-mesh nylon net and required insecticides and fungicides were distributed to the 40 farmers including 4 rocking sprayer (Gatore) and 12 bucket in group. Broodlac was inoculated in February 2015. Pesticides were sprayed twice to protect the crop from pest. Harvesting was done during July 2015. A total yield of 2669 kg broodlac and 386 kg rejected scraped lac along with 196 kg *phunki* was obtained by the beneficiaries.

Activity	Accomplishment
Interface Meeting/ Workshop	A Research-Extension-Farmer-Interface Meeting-cum-Workshop on lac cultivation was jointly organized with SEET, Rourkela at Kucheita (Rourkela, Odisha) on 22.01.2015. More than 100 farmers participated in the event.
Exposure visits	Exposure visit of 200 tribal farmers from Ranchi and adjoining areas in the *Kisan Mela*-cum-Exhibition 2015 held at ICAR-IINRG on 29th January 2015.
Field visits by experts	Field visits by the experts of ICAR-IINRG for identification of beneficiaries, formation of FIGs, selection of host trees for inoculation, method demonstrations for different lac cultivation practices, training, lac crop monitoring of field demonstrations and farmers adoption programme at Sundergarh (Odisha).

NEH sub-plan

Table 31. Activities conducted under NEH sub-plan

Activity	Accomplishment
Capacity Building	Three capacity building prtogrammes including an Orientation programme for the 75 farmers & executives of Meghalaya state, one week training programmes for 12 lac farmers of Chirang and Kamrup districts, and one week master's training programmes was organized for three lac master trainers of Chirang district.
Field Demonstration	Five FLDs were conducted of *kusmi* lac cultivation on *ber* trees in Chirang District of Assam areas of more than 500 acres land nearby the bank of Aie river.
Field visits by experts	Field visit was organized at Aiepoali, Aiedubri, Shantipur, Aiepoali area of Forest, South Kajalgaon, Gendergaon of Sidli block of Dhemaji District of Assam to monitor the NEH activities on lac production during May 03-05, 2015 along with NGOs, public representatives & officials of BTC.
Interface Meeting/ Workshop	A Workshop/HRD Programme on "Lac cultivation for the tribals of NEH Region" at ICAR-IINRG Ranchi was organized from April 27-29, 2015.

KVK Khunti

Table 32. Activities conducted under KVK Khunti

Activities	Details
Front Line Demonstration	In *Kharif* season, FLD on farmers' field for Sahbahagi Dhan in Direct Seeding & Transplanting method at four locations of Khunti district was organized in collaboration of ICAR centre i.e. CRURRS, Hazaribagh. Lac based demonstration was conducted in Khunti district. FLD on chickpea was planned in 10 ha of land in Khunti district of Jharkhand.
Kisan Gosthi	Organized two *kisan gosthi* at different places in Khunti district.
SAC	Scientific advisory committee was constituted to provide necessary guidance and support to carry out the mandated activities of KVK in a more planned and scientific manner.
Training Programme (One Week)	One week training programme on scientific lac cultivation was organized at ICAR-IINRG Ranchi during June 29 to July 03, 2015 in collaboration of DOA & KVK Khunti.
Exhibition-cum-Exposure visit	A group of 60 farmers makes an exposure visit at Barhi, Hazaribagh, Jharkhand to see the exhibitions organized by NHM and ICAR New Delhi on 28.6.2015. On this occassion they also attended inaugural function of IARI, Jharkhand where participants got benefitted from the speech of Hon'ble Prime Minister of India.

Activities	Details
Annual Zonal Workshop	Official attended and presented a detail progress report of IINRG –KVK Khunti for 2014-15 during Annual Zonal Workshop organized at ICAR-CIFRI, Barrackpore, W.B.
Documentary Film	A documentary film on IINRG activities was telecast via Doordarshan Ranchi
Monsoon preparedness	Monsoon preparedness and an interaction session was organized in Baghia village of Rania block of Khunti district (Jharkhand). It was advised that lac crop can be opted as an optional crop in anticipation of less rainfall during monsoon 2015.

6.5 Externally Funded/Consultancy Projects

Lac (culture) cultivation and processing unit establishment (Jharkhand Govt.)

A Memorandum of Understanding (MoU) for the period 2015-16 was signed by Deputy Commissioner, Khunti; ICAR-IINRG, Ranchi and Torpa Rural Development Society, Tapkara Road, Torpa (Khunti) to facilitate accelerated and sustainable transformation of increased lac productivity, processing and use diversification in Khunti district through the project. The following activities were executed during the period (Table 33).

Table 33. Activities performed under the project in Khunti area

S. No.	Activity	Observation/Beneficiaries
1.	FIG meeting	A Farmers Interest Group meeting was organized at TRDS, Torpa, Khunti on 22nd May, 2015, in which 37 beneficiaries participated.
2.	Field demonstration	A field demonstration on lac processing through Small Scale Lac Processing Unit (SSLPU) at TRDS, Torpa was facilitated by ICAR-IINRG experts. A demonstration of lac processing by newly established unit was conducted on 21st July, 2015 in the presence of all the stakeholders of Arki area.
3.	Residential training programme	A residential training programme on 'Preparation of Lac Bangles' was facilitated at TRDS, Torpa during 28th September to 14th October, 2015 in which 65 women SHG members from three villages (Bishunpur, Marcha and Baghia) participated.
4.	Research–Extension-Farmer Interface meeting	A Research–Extension-Farmer Interface meeting on lac production was organized in collaboration with Torpa Rural Development Society, Torpa, Khunti at farmers building, block Arki on 15th July, 2015. The objective was to disseminate the lac cultivation technologies among of more farmers to support their livelihood and maximizing benefits from lac production through value addition of lac. Approximately 250 beneficiaries (15 SHGs) of project from 9 villages of Torang, Kochang and Birbanki village panchayat of Arki block of Khunti district participated in the meeting. A Research–Extension-Farmer-Interface meeting on lac production was also organized on 21st July, 2015 in which around 300 beneficiaries from 14 villages of 4 village panchayats (Torang, Kochang, Birbanki and Barinchitkel) covering 25 SHGs were present along with all the guests and experts. A Research –Extension- Farmer- Interface meeting on lac production and marketing was organized at Arki, Khunti on 18th Sept., 2015. Interaction was made with approximately 200 farmers including SHGs member participated in the programme on the issue of lac cultivation, processing and marketing problems along with other information shared by BDO, Arki.

S. No.	Activity	Observation/Beneficiaries
5.	Small Scale Lac Processing Unit (SSLPU)	A SSLPU was established at block building of Arki. The unit was inaugurated on 21st July, 2015 by Deputy Commissioner (Khunti), Mr Prasad Krishna Baghmare. On this occassion, Chairperson, Zila Parishad, Dr. AK Jaiswal (Acting Director), Dr. N Prasad, Head PPD Division, Dr. AK Singh, Senior Scientist and PI of the Project, ICAR-IINRG, Mr. Vinay Kumar (DPO, Khunti), Sister Defini Sequera (Director, TRDS), other officials, public representatives and around 300 beneficiaries were present. A SSLPU was established at Rania block of Khunti district (Jharkhand) as a new technological intervention under a collaborative project of the ICAR-IINRG Ranchi. Dr. PK Waghmare, D.C., Khunti, inaugurated the unit as Chief Guest on 31st August, 2015. Officials from various line departments and local representatives were present on this occassion. Nearly 200 participants including farmers, members of SHGs, local representatives, scientists, and officials participated during the programme.
6.	Non-credit input support	About 500 kg *kusmi* broodlac inoculated by beneficiaries.
7.	Crop monitoring & SHG meetings	About 21 visits for crop monitoring and 8 SHGs meetings were organised in Murhu, Rania and Arki block of Khunti.
8.	Output from technological interventions	Beneficiaries are getting Rs. 60-70/kg more prices after processing of lac. A total of 130 kg seedlac was sold to Indian Shellac Ltd., Khunti and another lot of about 600 kg is ready for sale at the SSLPUs. Lac processing is started at Rania unit. Two training programmes were facilitated on lac processing and processing of 180 kg lac is in process.
9.	Promotion in exhibitions	Two women SHGs and one TRDS staff participated in *Saras Mela* -India International Trade Fair at New Delhi by putting stall of lac handicraft items viz. lac bangle, flower pot, paper weight etc. during 14-27 November 2015. They received good response for their lac handicraft items from visitors. SHG members of the three groups of Bisunpur village participated and put up their stall of lac handicraft items at Jharkhand State Foundation Day programme at Khunti on 14th November 2015.
10.	Publicity	Progress of project published in ICAR News entitled, "Small Scale Lac Processing Unit Established at Khunti Jharkhand" with web address: the activities http://www.icar.org.in/en/node/9764. All activities were also well covered in local news and media for wider dissemination of the interventions in Khunti area.

Evaluation of lac cultivation and processing activities in Chhattisgarh under *Swarnjayanti Gram Swarozgar Yojana* Special Project

Chhattisgarh State Minor Forest Produce Ltd. (CGMFP), Raipur, at the instance of and as per the guidelines of *Swarnjayanti Gram Swarozgar Yojana* (SGSY) constituted an evaluation committee to evaluate the project entitled "Lac Cultivation Processing in all District of Chhattisgarh" by Chhattisgarh State Minor Forest Produce Ltd. Raipur. The study was assigned to the ICAR-Indian Institute of Natural Resins and Gums, Ranchi to assess the impact of Centrally Sponsored Schemes in selected six lac growing districts of Chhattisgarh State and Rs 1.8 lakh as consultancy charges. 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 innervations by CGMFP under the SGSY" has been 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 outcomes of the project is shown in Table 34.

More than 300 tons of lac was produced by the 3500 households of 177 SHGs during the reporting period. Project implementation was a successful effort through which resources were mobilized and an amount of ₹876.89 lakh was generated with gainful employment opportunities. Out of total 177 SHGs about 66% SHGs were able to generate an income more than ₹1.0 lakh. Due to this intervention, tribal people with the available local resources in the proximity started to harvest more than 10 kg/tree scraped lac from the *kusum* and 1 kg/tree of scraped lac from *palas*, respectively. Planning and implementation of the scheme were satisfactory except processing unit establishment. Non-credit inputs seems to be a major motivation factor for the members of SHGs.

Sustainable income generation through scientific lac cultivation in West Bengal

Paschimanchal Unnayan Parshad (PUP) accomplished two phase of the project namely 'Sustainable income generation through scientific lac cultivation'. ICAR-IINRG, Ranchi was assigned to assess the impact of PUP sponsored schemes in selected three lac growing districts of the state with consultancy charges of Rs.11.5 lakh.

Table 34. Lac production and income generation (in ₹)

Particulars	Jagdalpur	Kanker	Balod	Mahasamund	Bilaspur	Balarampur	Total /Average
Lac production (in Qt.)	1685.0	339.8	67.2	202.4	351.1	494.1	**3139.6**
No. of host trees inoculated	7466	2500	2500	25000	25000	33500	**95966**
Yield per tree (kg)	22.57	13.59	2.69	0.81	1.40	1.47	**3.27**
Lac production /household	169	68	13	40	70	99	**90**
Income in 2010 (Pre)/hh	10000	15000	4163	10000	13760	4000	**9500**
Income in 2015 (Post)/hh	35000	25000	8000	15000	15000	20000	**19500**

A total of 437 beneficiaries selected randomly and other concerned personnel were interviewed regarding the various aspects of lac cultivation and its disposal. All possible socio-economic features of the identified households, observation at the time of field visit and interaction with the beneficiaries have been made during the survey (Fig. 68). Any improvement in terms of economic gain, employment generation and infrastructure development were the major indicators of recording the data. Non-credit inputs across the beneficiaries under the scheme were distributed individually as well as in group under the jurisdiction of identified 208 entrepreneurs. Average cost of non-credit inputs was estimated about ₹550/ beneficiary and total cost per beneficiary was ₹3930 for 8442 beneficiaries. Tabular analysis and graphic presentation used to estimate the value of indicators. Adoption of scientific lac cultivation practices due to increase in awareness through skill development programmes for the beneficiaries enabled them to maximize the utilization of available lac host trees from 5.9 to 11.9 (increased from 22.6 % to 44.0 %) owned by them (Fig. 69).

Consequently, due to increase in awareness through skill development programmes and non-credit input support to the beneficiaries enabled them to boost the income level by 31 %. Accessibility status of agri-inputs found to be decreased by 2.1 %. Hence, other activities may also be supported during the motivational trainings. More than 40 kg of lac was produced by households after intervention and it was only 10 kg/ household before intervention. Project implementation was a successful effort through which existing resources were mobilized and income level increased with gainful employment opportunities in study area. An opinion poll about all the aspects of scientific lac cultivation like intended to extend lac cultivation, knowledge upgradation,

further knowledge dissemination to fellow farmers, profitability, economic feasibility and comfort level indicated that more than 95 % respondents agreed on this policy intervention.

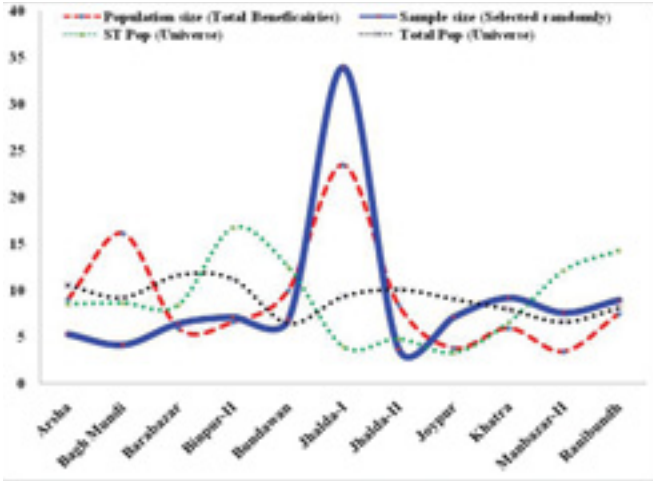


Fig. 68. Distribution of sample, beneficiaries, tribals and total population across the study area

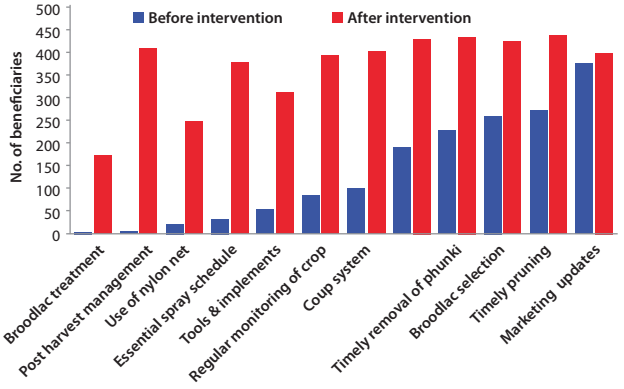


Fig. 69. Impact of capacity building programmes and awareness about scientific lac cultivation methods in study area

6.6 Success Stories

Thematic area : Young Entrepreneurship in Lac processing
Sri Bhisma Tandi
Village : Kotmer
Block : Dharmagarh
District : Kalahandi, Odisha
Mob.No. : +919777707247

Description of the lac cultivation activity

Sri Bhisma Tandi is an example of Young Entrepreneurship in Lac processing. Under a scheme he got the opportunity to establish a Small Scale Lac Proceeding Unit (SSLPU) in 2012. Initially, 500-1000 kg of sticklac was processed for seedlac production. For further marketing he contacted ICAR-IINRG, Ranchi and he remained in touch with the experts for price discovery and market intelligence services of the institute. As a result, he could get the good price for seedlac and this encouraged him for more production.

General Profile

Age	:	23 yrs
Education	:	Sr. Secondary
Landholding	:	0.25 acre
Experience	:	2 yrs.
Working Area	:	Small scale lac processing unit
Social recognition	:	Young Entrepreneurship

Impact Sri Bhisma Tandi and his group of youths from locality started to collect more sticklac from the farmers. Onwards 2013, the group collected about 15-20 tons of sticklac and the SSLPU produced about 10-12 tons of seedlac annually. Due to this entrepreneurial intervention through the establishment of SSLPU, it influenced the life of stakeholders in different manner. Before these interventions, lac growers were getting lower price in the weekly markets. After this interventions, the lac growers could get competitive market price and exploitation of local traders minimized. Thus it benefitted the local people indirectly. This processing unit saved the transportation cost of bulky material *i.e.* sticklac and transformed it in seedlac which fetched more price. Thus every kg of raw material increased the price by 15-40 %. Annually the group could get the net income ranging from Rs. 1.5 lakh to Rs. 4.0 lakh. At the time of starting of this entrepreneurial task, Sri Bhisma Tandi and his peer group of youths were unemployed. After this business activity started, the group of 10 numbers of youths got employment and their family got economical support. Moreover, other youths were also encouraged for lac cultivation and other income generating activities in the locality. This initiative by Sri Bhisma Tandi has become a good example of Young Entrepreneurship in the locality.


Winter season *Kusmi* lac cultivation on *Swadi palas* at farmers' field

Kusmi lac culture is performing well on *swadi palas*, a variant of common *palas*. Putadag village in Angarha block, Ranchi was selected for evaluating the potentiality of *swadi palas* for *kusmi* lac production. Farmer harvested *arilac* well before maturity of broodlac in the month of December-January. They are getting more income from selling *arilac*. Farmers were trained on scientific lac cultivate (*kusmi*) on *swadi palas* during winter season. In the initial year (2012-13), out of 74 kg *kusmi* broodlac inoculated on 18 trees of *swadi palas*, farmer harvested 299 kg *arilac* and sold in the market @ Rs. 500/- per kg and earned Rs. 1,49,600/-. In subsequent year (2013-14) they harvested 220 kg *arilac* from 37.5 kg *kusmi* broodlac inoculated on 15 trees and earned Rs. 66,000/- by selling *arilac* @ 500/- per kg. In 2014-15 farmer inoculated 120 kg broodlac on 36 trees and harvested 859 kg *arilac*. They sold *arilac* @ Rs. 150/- per kg and earned Rs. 1,28,850/-. The average *arilac* output ratio ranged from 3.8 to 7.8.

ICAR Network Projects

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

1.1 ICAR-IINRG, Ranchi (Lead centre)

Chemical profiling and rheological study of *Buchanania lanzan* (*piyar*) gum exudates

Seven samples of gum exudates of *Buchanania lanzan* Spreng. were collected from Bilaspur (Chhattisgarh); Simdega and ICAR-IINRG farm (Jharkhand); Dindori and Umaria (Madhya Pradesh) and Mirzapur (Uttar Pradesh) for studying variations in their major phytochemicals, physico-chemical properties and antioxidant activity adopting standard procedures. Twenty percent and ten percent concentrations of gum exudates were used for determining their viscosity (cP) at ambient temperature. The antioxidant potential of the gum exudates was evaluated by free radical scavenging activity using 1, 1-diphenyl-2-picryl hydrazyl (DPPH) assay. Following important findings were as under:

- Flavonoids, saponin, amino acid / protein and carbohydrates were found in all the gum exudates.
- All of them showed intra-specific variations in the physico-chemical properties *viz.* moisture level, color parameters (L, a, b), ash content, elemental (CHN) level (%), specific rotation [α] in H_2O, deg. and heavy metals (mg/g).
- Tannin was present only in the black gum exudates collected from Madhya Pradesh and Chhattisgarh. Also, antioxidant activity was found only in samples with tannin and the magnitude was related to tannin level in the gum.
- *Buchanania lanzan* gum exudates, at twenty per cent and ten per cent concentrations, exhibited shear thinning / pseudo plastic flow pattern in their viscosity.

The findings of the present study clearly demonstrated the pronounced qualitative and quantitative intra-specific variation in piyar gum exudates collected from different places in respect of their phytochemicals, physico-chemical parameters and antioxidant activity, which may categorically be attributed to their different geographical locations and climatic conditions around the resource gum tree, its age and nature of soil etc. The presence of major phytochemicals in the gum exudates would make the gums quite useful for treating various ailments / maladies.

Physico-chemical, rheological and edibility test of *Prosopis juliflora* and *Balanites aegyptiaca* gum exudates from Rajasthan

Physico-chemical characterization of *Prosopis juliflora* and *Balanites aegyptiaca* gum samples *viz.* solubility, pH, moisture level (%), ash content (%), colour parameters (L, a, b), specific rotation [α] in H_2O, deg., elemental (CHNS) level (%), heavy metals (mg/g), tannin content (mg/g), viscosity (cP value) and FT-IR were studied. Gums were thermally characterized using differential scanning calorimetry (DSC), thermo-gravimetric analysis (TGA) and differential thermal analysis (DTA) following standard procedures.

- Both the gum exudates showed Newtonian behaviour with viscosity being shear rate independent and concentration dependent, as viscosity of 20.0 % solution was more than 10.0 % solution. *P. juliflora* gum exudates displayed less viscosity than *B. aegyptiaca* gum exudates using spindle number LV-2 at 28.5 ^oC.
- Short term acute toxicity test of both the gum exudates, *P. juliflora* and *B. aegyptiaca,* was carried out at IICT, Hyderabad following OECD guidelines 420 (2001) on albino rats and it was found that both the gum exudates have LD_{50} values greater than 2000 mg/ kg and can be used by both human and animals with a degree of safety & tolerance

Comparative evaluation of selected physico-engineering properties of different major and minor gums

Physico-engineering properties of the major and

minor gums were determined. The properties analyzed were colour parameters (L, a, b), angle of repose, angle of internal friction, true density, bulk density, moisture content and porosity of various gums (*moringa, olibanum, karaya, arabic, guggul, piyar, jhingan and gum ghatti*). Following conclusions were drawn:

- Values of L, a, b (colour parameters) indicated that *moringa* gum was lighter in colour and *olibanum* darkest amongst gum samples studied. In general, lighter colour gums fetch more price in the market and contain less impurity and tannin content.
- Average bulk density of gums was minimum for *guggul* (0.59 g/cc) and maximum for *arabic* and gum *ghatti* (0.79 g/cc).
- Average value of true density was minimum for *guggul* and *olibanum* (1.11 g/cc) and maximum for gum *arabic* (1.43 g/cc).
- Average porosity value was minimum for *ghatti* (36.80 %) and maximum for *moringa* (52.0 %) gum.
- Average value of angle of repose was minimum for *piyar* (29.99 ^{0}) and maximum for *guggul* (45.0 ^{0}) gum.
- Average value of angle of internal friction for white board/novapan/particle board surface was minimum for *arabic* (22.69 ^{0}) and maximum for gum *karaya* (29.93 ^{0}) on mild steel surface, respectively.

Marker-trait association for growth and oleoresin traits of chir pine (*Pinus roxburghii* Sarg.)

This investigation was carried out on a progeny testing trial of *Pinus roxburghii* at College of Forestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh), in collaboration with Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, Solan Centre, to evaluate the half sib progenies at phenotypic traits (growth and needle characteristics), genotypic level using different molecular markers and carry out association mapping for the phenotypic and genotypic data. Molecular characterization of 62 genotypes of the half sib chir pine progenies was investigated using ISSR (Inter Simple Sequence Repeats) and SSR (Simple Sequence Repeats) primers. Both revealed good diversity amongst the different genotypes.

The results showed that there were many significant associations between the markers used and different traits studied. Diameter at breast height (DBH) was associated with NZPR554 and SPAG7.14 (9.884 per cent contribution from each) and PT63718 (7.700 per cent contribution). Crown length was found associated with NAD3-1 (R^2=0.149511), PT110048 (R^2=0.149511) and PT48210 (R^2=0.100452). Though no marker used in the study was directly associated with oleoresin yield, but markers associated with traits, with which oleoresin yield had strong association like diameter at breast height. Hence, evaluation of the chir pine diversity can be very useful for qualitative and quantitative improvement of different traits studied, and the marker trait association can aid the tree improvement program of chir pine.

Field guide for identification of major resin and gum producing plants

In the effort to prepare photographic catalogue of common resin and gum producing trees, several field visits were conducted covering Chail, Kufri, Kandaghat regions of Himachal Pradesh; Ranchi, Taimara, Bundu, Dalma, Giridih, Betla regions in Jharkhand; Amaravati, Nagpur regions in Maharashtra, four districts of Tamil Nadu *viz.* Vellore, Tirivannamalai, Kanchipuram and Tiruvalluar and regions of Eastern Ghats *viz.* Jawadhu hills, Kavalur forest area, Alangayam, Yelagiri forest hills and Thiruthani hills. 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*) (Fig. 70), 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*), Guar (*Cyamopsis tetragonolobus*), Okra (*Abelmoschus esculentus*), *Cassia tora*, Tamarind (*Tamarindus indica*), etc. were taken.

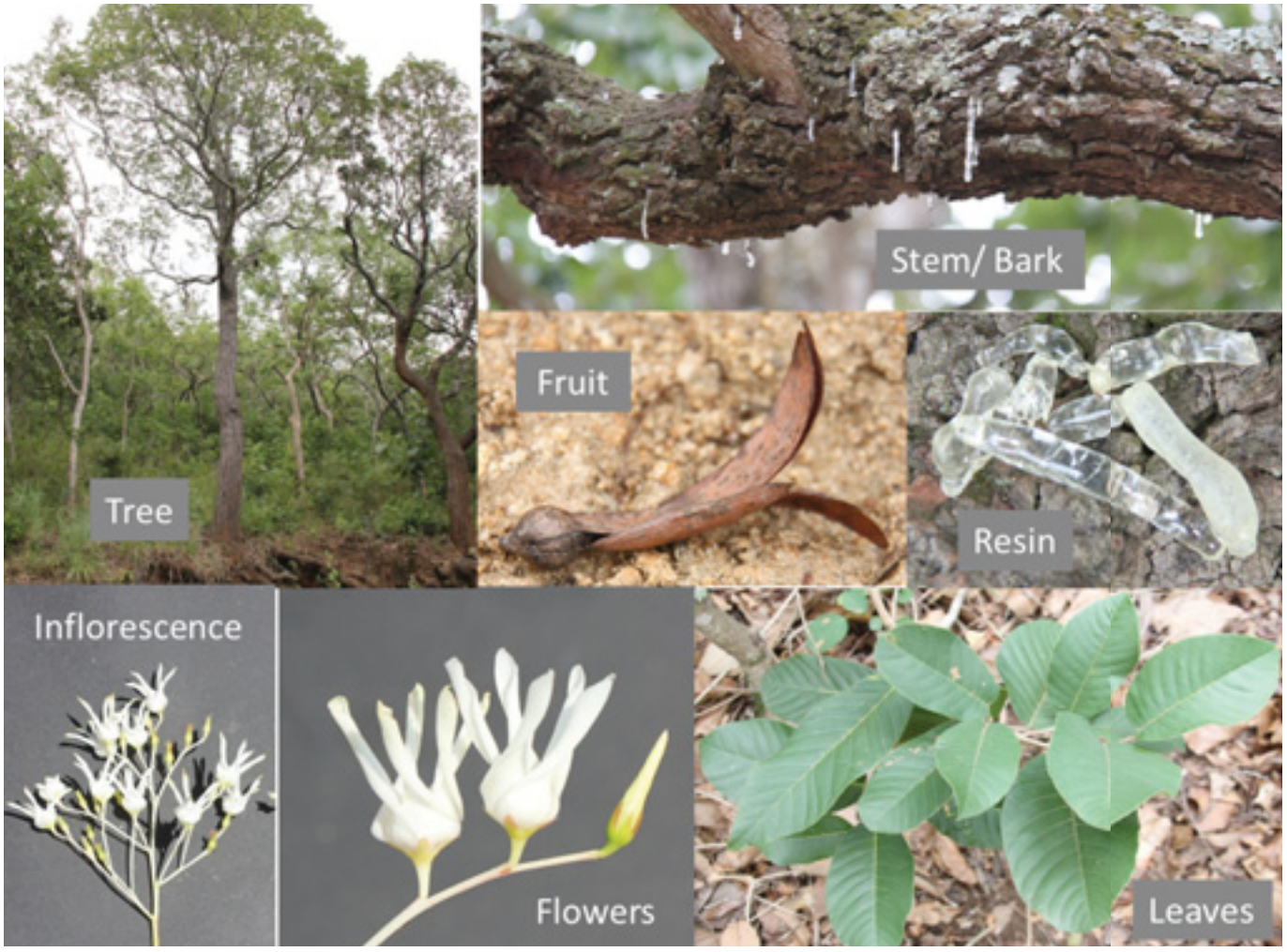


Fig. 70. Template showing different plant parts of the *Shorea talura* (A resin producing tree)

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 upto 3.0%, confirming an enhancement in the nanoparticle synthesis (Fig. 71).

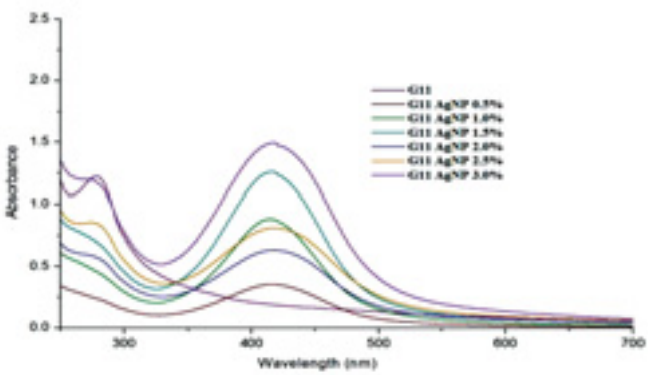


Fig. 71. UV-VIS spectra of *Buchanania lanzan* gum exudates collected from Bilaspur

1.2 Project on Gum Arabic at ICAR-CAZRI, Jodhpur

Gum production from lesser known and another important arid species

Trees of known gum yielding species *viz. Acacia tortolis,*

Acacia nilotica, Prosopis alba, Anogeissus pendula and *Prosopis juliflora* were treated by CAZRI gum inducer at CAZRI, Kailana afforestation experimental area and CAZRI research farm. Average gum yield was maximum (196 g/tree) for *Acacia tortolis* and minimum (80 g/tree) for *Prosopis alba*. Lesser known gum yielding species *viz. Acacia leucophloea, Anogeissus rotundifolia, Balanites aegyptiaca* and *Prosopis cineraria* were also selected and treated with CAZRI gum inducer at different locations. Average gum yield was maximum (196 g/tree) for *Anogeissus rotundifolia* and minimum (120 g/tree) for *Prosopis cineraria* (Table 35).

Effect of management practices and dose of gum inducer on gum production of *Acacia senegal* in rocky land form

Experiment was laid out (2010-11) on rocky range land of Bhopalgarh in Jodhpur district to assess the gum production from even aged *A. senegal* trees with and without management practices in factorial randomised block design with 3 replications. Experimentation continued during the year 2014-15 with 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 and normal dose with an absolute control. Normal dose contained 195 mg ethephon/ml of solution (4 ml).

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 2014-15 resulted in production of gum to the tune of 65.00 g/tree in case of half concentration of the normal dose treatment and 182.0 g/tree in case of normal dose treatment. Only manuring of the trees resulted in production of 228.00 and 165.00 g gum/tree, respectively in half concentration of normal dose treatment. It was found that full concentration of CAZRI gum inducer + irrigation + manuring resulted in production of gum *arabic* to the tune of 211.00 g/ tree. This clearly showed that with little tree management in form of manuring and watering with gum inducer application, substantial increase in gum yield is possible.

Seed production and gum yield in *Acacia senegal* as affected by temperature and management practices

Seeds of *A. senegal* are valuable commodity as they are used as vegetable in western Rajasthan. Hence, data related to seeds production was monitored and analyzed. Five years data indicated that trees which were treated with half concentration of gum inducer together with manuring (T-8) produced maximum quantity of seeds per tree. The treatment of only half concentration of gum inducer (T-2) resulted in poorest seed setting. Irrigation + manuring + half concentration of gum inducer (T-11) was the second best treatment as far as seed production after treatments was concerned (Fig. 72).

Table 35. Tree structural traits and gum yield at Kailana afforestation area CAZRI research farm of different trees species.

Trees Species		Tree Height (cm)	CD (cm)	Canopy Diameter (cm)	Average Gum Yield (g/ tree)
Known gum yielding species of the region	*Acacia tortolis*	495.00	50.52	302.00	196.00
	Acacia nilotica	391.00	40.30	180.00	125.30
	Prosopis juliflora	310.00	23.00	265.00	110.00
	Prosopis alba	210.00	17.54	115.00	80.69
	Anogeissus pendula	555.00	39.90	549.00	100.00
Lesser known gum yielding species of the region	*Anogeissus rotundifolia*	655.00	90.50	515.00	196.10
	Balanites aegyptiaca	396.00	32.50	200.00	139.00
	Prosopis cineraria	496.00	75.67	350.00	120.00
	Acacia leucophloea	710.00	52.22	510.00	130.89

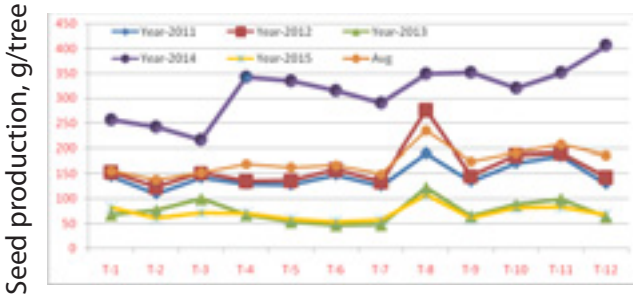


Fig. 72. Graphical representation of seed production in *A. senegal* as affected by management practices for gum exudation

Temperature vs oleo-gum resins production in *Commiphora wightii* using CAZRI gum inducer and *guggul* oleo-gum resin inducer

During this year, oleo-gum resin production from *Commiphora wightii* at Kailana Afforestation Area of CAZRI, Jodhpur was analysed. *Guggul* plants were treated by CGI (CAZRI gum inducer) and GGI (*guggul* gum inducer) each. Plants were also kept as control (conventional blaze treatment). Though the oleo-gum resin production started in the month of December, maximum quantity was produced in the month of January in case of both the treatments and as well in control. The average day temperature was 14.5 ºC in the month of January. The results indicated that with increase in temperature, the production of oleo-gum resin decreased sharply (Table 36). However, higher quantity of oleo-gum resins was tapped using CGI.

Extension and adoption of gum inducing technique

From 2008-09 to 2014-15, farmers in more than 45 target villages of arid Western Rajasthan earned revenue of more than Rs. 4.32 crores from the sale of gum *arabic* produced using CAZRI technology. In this way since 2008-09 per year an additional revenue flow to the tune of Rs. 1.60 lakhs /village/ year maintained regularly till date in the said villages. Moreover, from 2008-09 to 2014-15, CAZRI generated revenue of more than Rs. 16.80 lakhs by way of sale of CAZRI gum inducer. This self sustaining technology is now expanding in other parts of the country involving other natural gum/resin yielding tree species in addition to *A. senegal*.

1.3 Project Centre at ICAR-CAFRI, Jhansi

Development of agroforestry models including gum and resin yielding trees

On ICAR-CAFRI Research farm

Various agroforestry models, based on gum yielding trees, have been established in CAFRI Research farm and monitoring of their survival and growth is done regularly. In agri-horti-silviculture model maximum survival and plant height was recorded in *A. senegal* while minimum survival and growth was noticed in *Carissa carandus*. Lemon/Karonda fruits were harvested and during the rabi season, wheat (HUW 234 Z-1) was sown as an intercrop. After six years of planting, natural oozing of gum was observed in *A. senegal* for the first time. In horti-silviculture-I model, due to severe casualty of *A. senegal*, it was replaced with *A. nilotica* in July 2014. Maximum survival was recorded in *Terminalia arjuna* (100 %) while *A. senegal* (boundary plantation) recorded maximum height (459.00 cm). In horti-silviculture–II model, *A. nilotica* had maximum growth. Survival of *A. senegal* in block plantation on rocky site was 100 % and plants attained mean height of 345.50 cm with collar diameter of 6.91 cm. In general, survival and growth of *A. nilotica* was better than *A. senegal*. In agri-silvi model (Field No. 40 and 41), *A. senegal* represented better survival and growth than *A. nilotica*.

On farmers' field

Different agroforestry models have been developed at farmers' field in Garhkundar - Dabar (GKD) – (Bundelkhand region) watershed and Ambabai village. After 66 months of planting, *A. senegal* recorded more survival (78 %) than *A. nilotica* (53 %) in GKD watershed. Out of planted horti-cultural species, guava had

Table 36. Temperature vs oleo-gum resin production in *guggul*

Month	Average temperature during treatment date (°C)	Average control yield (g)	Average yield (g) by CGI	Average yield (g) GGI
5th Dec., 2014	22.50	36.00	115.9	85.40
28th Jan., 2015	14.50	44.32	160.00	109.30
25th Feb., 2015	22.00	29.36	98.00	65.10
27th March, 2015	32.50	8.30	7.80	6.50

shown maximum survival (98 %) while, karonda the least (12 %). Aonla recorded maximum GBH and plant height. In terms of plant height *A. senegal* was better than *A. nilotica.* Survival percentage of newly planted *A. senegal* on field bunds ranged from 50 to 100 % in GKD watershed. In Ambabai village, after 42 months of planting, survival of *A. senegal* was 54 % with plant height of 233 cm and collar diameter 6.13 cm.

Standardization of gum tapping from *Butea monosperma*

In February 2015, field trial was conducted on naturally occurring 15-20 years old trees of *B. monosperma* for standardization of gum tapping techniques. To regulate the depth of cuts (0.5 cm, 1.0 cm and 1.5 cm each) on stem bark of tree (Fig. 73), a bill hook was used which was purposely designed and got fabricated locally with the help of Scientist, Farm Machinery, IGFRI, Jhansi. Findings revealed that 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 (Fig. 74).

Fig. 73. Oozing of gum from *Butea monosperma* by different depth incision experiment

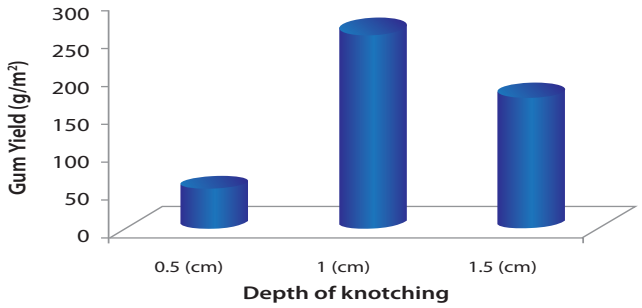


Fig. 74. Effect of different depths of incision on stem-bark on gum yield of *Butea monosperma*

1.4 Project on Guar Gum at VNMKV, Parbhani

Combination of more than one type of hydrocolloids is commonly used in food products to modify rheological characteristic and satisfy processing requirement in the industry. Chocolate flavoured milk and yoghurt were prepared using various combinations of guar and *arabic* gums.

Preparation of chocolate flavoured milk

Chocolate flavoured milk was prepared using milk, sugar, cocoa powder and blend of guar and *arabic* gum (both gums in equal proportions) (Table 37). Blend was used in various concentrations of 0.0, 0.1, 0.2, 0.4 and 0.6 %. The cow milk was standardized to 2.0 % fat and 8.5 % SNF (solid not fat) by using Pearson's square method. Standardized milk was then preheated to 35-405 °C, added with cocoa powder, sugar, blend gum and then continuously stirred to obtain a homogeneous mass pasteurized by holding LTLT (low temperature long time treatment) method, cooled rapidly to 5 °C, bottled and refrigerated (5 °C) till its utilization. Viscosity of chocolate flavoured milk was determined using Brookfield Viscometer (Model: LV) and spindle No. S-62 at different speed.

Table 37. Formulation of chocolate flavoured milk

S. No.	Samples	Blend of gum (%)	Milk (lit.)	Sugar (g)	Cocoa Powder (g)
1	A (Control)	Nil	1	90	10
2	B	0.1	1	90	10
3	C	0.2	1	90	10
4	D	0.4	1	90	10
5	E	0.6	1	90	10

A, 0.0 % blend; B, 0.1 % blend ; C, 0.2 % blend ; D, 0.4 % blend and E, 0.6 % blend of gum

Viscosity of chocolate flavoured milk increased from 9.6 to 60.0 cP at 50 rpm and 8.4 to 52.2 cP at 100 rpm as the blended gum concentration increased. The sample containing 0.4 % of blend of gum recorded 58.8 cP (at 50 rpm) and 41.5 cP (at 100 rpm) viscosity value being suitable for the preparation of chocolate flavoured milk. The data regarding sensory evaluation of flavoured milk, using 9 point hedonic scale, pointed out that increase in level of addition of blend gum decreased the score for colour and flavour (Table 38). The sample containing 0.4 % of gum blend was found to be overall acceptable and improved the mouth feel and consistency of chocolate flavoured milk.

Table 38. Sensory evaluation of chocolate flavoured milk

Sample	Colour	Flavour	Mouth feel	Consistency	Overall acceptability
A	7.5	8.0	7.5	7.5	7.8
B	7.5	8.0	7.7	7.7	7.9
C	7.4	7.9	7.8	7.8	7.9
D	7.2	7.1	8.0	8.0	8.0
E	6.8	6.7	6.9	6.9	6.9
S.E.	0.041	0.029	0.038	0.025	0.025
C.D. at 5%	0.126	0.089	0.067	0.079	0.079

A, 0.0 % blend; B, 0.1 % blend ; C, 0.2 % blend ; D, 0.4 % blend and E, 0.6 % blend of gum

Preparation of yoghurt

Yoghurt was prepared using cow milk, microbial starter culture and blend of guar and *arabic* gum (both gums in equal proportions). Blend was used in various concentrations of 0.0, 0.1, 0.2, 0.4 and 0.6 % (Table 39). The cow milk was standardized to 3.0 % fat and 8.5 % SNF by using Pearson's square method. After addition of blended gum, milk was pasteurized at 63°C for 30 min, cooled to 42 °C and starter culture was added at the rate of 2 % and transferred to glass beaker, inoculated at 42 °C till the desired coagulum was formed.

Table 39. Formulation of yoghurt

S. No.	Samples	Blend of gum (%)	Milk (lit)
1	A (Control)	Nil	1
2	B	0.1	1
3	C	0.2	1
4	D	0.4	1
5	E	0.6	1

A, 0.0 % blend; B, 0.1 % blend ; C, 0.2 % blend ; D, 0.4 % blend and E, 0.6 % blend of gum

Setting time of the yoghurt was reduced with increase in the concentration of the gum blends and was minimum (4.22 h) in 0.6 % concentration. The viscosity of yoghurt, determined at 60 rpm, was in the range of 502 to 560 cP. The highest viscosity of 560 cP was observed in case of 0.6% gum blend concentration. The percent syneresis decreased with the increase in levels of gum blend concentration in yoghurt. Hence, minimum syneresis (11.90 %) was recorded in case of yoghurt prepared from the 0.6 per cent gum blend concentration. No marked change in pH and acidity of yoghurt was recorded, irrespective of the added blend of gum and their concentrations. The total solids of yoghurt were found to be in the range of 12.1 to 14.1 % and it was concluded that as the level of gum blend concentration increased, the total solid content also increased. From sensory evaluation of yoghurt (Table 40), it is reported that in case of body and texture the maximum score is recorded for the level at 0.2 % of gum blend concentration. Incorporation of 0.2 % of blend of gum in yoghurt was found to be overall acceptable and it improved the texture of yoghurt without wheying off. Being hydro colloidal in nature, the blends of gum are very useful as additives for improving the consistency and reducing whey separation in yoghurt.

Table 40. Sensory evaluation of yoghurt

Sample	Colour	Body and texture	Flavour	Overall acceptability
A	8.0	7.5	8.0	7.8
B	7.8	7.8	8.0	7.9
C	7.8	8.0	8.0	8.0
D	7.5	7.5	7.1	7.5
E	6.9	7.0	6.7	6.9
S.E.	0.037	0.034	0.020	0.025
C.D. at 5%	0.116	0.106	0.061	0.079

A, 0.0 % blend; B, 0.1 % blend ; C, 0.2 % blend ; D, 0.4 % blend and E, 0.6 % blend of gum

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

Progeny experiment (chir pine) at main campus, Solan

Experiments were carried out for determination and regression analysis of morphological parameters among different progenies (*Pinus roxburghii*) and zenith angles at main campus (Dr. YSPUH & F, Solan).

Extinction coefficient (K)

The extinction coefficient (K) represents the attenuation characteristic parameters of the light intensity in the *P. roxburghii* progenies in the vertical direction to represent different values of canopy at different altitude angles. The significant difference was observed among the different progenies and zenith angles. Among different progenies, the extinction coefficient ranged from 0.5797 to 0.3615, the highest was recorded in Sandrohal-P5 and the lowest was in Leda 10. Among the different zenith angles the maximum value (0.7461) of extinction coefficient was observed at 4.50° and lowest (0.1526) at 75.50° zenith angle. Among the interaction between progenies and zenith angle, the highest (0.9989) value of extinction coefficient was recorded in Kaldoo 5 at 4.50° zenith angle and lowest (0.100) in Kopra 5 at 75.50° zenith angle.

Transmission Coefficient for Solar Beam Radiation Penetration (TR)

The incident light, reflecting solar radiation, can be considered as parallel light beam reaching ground, which is the major light component of plant photosynthesis. The distribution of incident light in a population is determined by the population structure. It is generally considered that light decreases from top to bottom layers of the population, and even the lowest layer of the population would receive this light. The TR reflects the distribution of incident light in the crop population, relating to the transmittance of crop population and the interception of light. Effects were significant on TR from different progenies, zenith angles and progenies × zenith angle. The distribution and transmission of light was highest at 40.50° and after that decreased gradually as the zenith angle increased. When the zenith angle increased from 40.50° to 75.50°, TR decreased from 1.6834 to 0.8768. The maximum TR of value 1.083 was observed in Jubbal PT-green centre. Among the interaction between progenies and zenith angle the highest transmission coefficient (2.289) was observed in Leda P8 at 40.50° zenith angle and the lowest in Leda P8 (0.7244) at 58.50° zenith angle.

Leaf distribution (LD)

Leaf distribution (LD) refers to the scattering density in leaves at each direction. This index characterizes the spatial distribution characteristics of the canopy leaves of the population. There were significant differences in leaf distribution at different azimuth angles among different progenies. The highest LD value of 0.7774 was recorded in Jainagar-PT-Yellow Base. The leaf distribution at 0-36° azimuth angle was recorded to be highest (0.9339) which was found to be statistically at par with 36-72°, while the leaf distribution at 144-180° was found to be the lowest (0.3149). The interaction among progenies and leaf distribution was also found to be significant at 5 per cent level of significance. The maximum (0.9739) leaf distribution was noticed in Kaldoo P5 at 0-36° azimuth angle and minimum (0.0897) was observed in Kaldoo P9 at 144-180° azimuth angle.

Regression between oleoresin yield and oleoresin viscosity

The regression between oleoresin yield and viscosity of oleoresin is presented below. The R square value of 0.8130 (Fig. 75) indicated that about 81.30 per cent of oleoresin yield content was determined by the viscosity of oleoresin.

Regression between oleoresin yield and viscosity

Oleoresin yield (Y)	Oleoresin viscosity (X)	R^2
-0.1316 (0.0145)	*1824.2 (119.88)	0.8130

*Significant at 5 % level of significant

Values in parenthesis are standard error

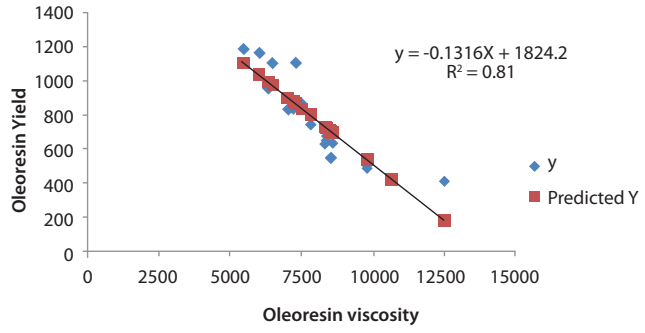


Fig. 75. Relationship between oleoresin yield and oleoresin viscosity

Simple correlation coefficients between morphological parameters and oleoresin yield

The values for simple correlation coefficients, worked out between morphological parameters and oleoresin yield parameter (Table 41). Out of 21 combinations of simple correlation, only 3 combinations were found to be positive and 2 combinations were observed to be negative and significant at 5 per cent level of significance. Correlation coefficients for rest of the parameters were found to be non-significant.

Evaluation of Table revealed that the oleoresin yield was positively and highly significantly correlated with transmission coefficient for solar beam radiation penetration (0.4862). The highly significant and positive correlation coefficient was elucidated between mean leaf angle and leaf area index (0.4372), leaf distribution and transmission coefficient for solar beam radiation penetration (0.5218). The highest negative and significant correlation was observed between extinction coefficient and leaf distribution (-0.7203) followed by transmission coefficient for diffuse radiation and leaf area index (-0.5202) and transmission coefficient for solar beam radiation penetration and extinction coefficient (0.4586).

Multiple regression analysis of morphological parameters with oleoresin yield

To estimate the oleoresin yield, multiple linear regression equation was fitted with 6 different characters (Table 42). The regression model were tried by considering oleoresin yield as dependent variable and leaf area index, mean leaf angle, transmission coefficient for diffuse radiation, extinction coefficient, transmission coefficient for solar beam radiation penetration and leaf distribution as independent variables. The coefficient of multiple determination (R^2) was 0.5051; hence, 50.51 per cent of total variation in oleoresin yield (g) was explained by these 6 characters. The regression coefficient for transmission coefficient for solar beam radiation penetration was found to be statistically significant, while the regression coefficients for other parameters were found to be non-significant.

Morphological parameters of different diameter classes at Bhota, Forest division- Hamirpur (HP)

Extinction Coefficient

The significant differences were found amongst the different diameter classes and zenith angles for extinction coefficient. The maximum extinction coefficient (0.6517) was recorded in 30-35 cm and the lowest (0.5125) in 55-60 cm. Among the different zenith angles the highest value (0.7573) of extinction coefficient was observed at 4.50° and lowest (0.2989) at 75.50° zenith angle. The interactions between diameter classes and zenith angles were also found to be significant at 5 per cent level of significance. The highest (0.851) value of K was recorded in 30-35 cm diameter at 4.50° zenith angle and lowest value (0.263) in 45-50 cm diameter class at 75.50° zenith angle.

Transmission Coefficient for Solar Beam Radiation Penetration (TR)

The variation in transmission coefficient among different diameter classes were tabulated and critical perusal of data revealed that highest transmission coefficient of value 1.0303 was recorded in 30-35 cm diameter class and lowest value (0.965) was found in 40-45 cm. The effect of zenith angle was also found to be significant at 5 % level of significance. The maximum transmission coefficient (1.7146) was recorded at 40.50° zenith angle and minimum (0.7975) at 31.50°. The interaction between diameter classes and zenith

Table 41. Correlation between morphological parameters and oleoresin yield

	Leaf area index	Mean leaf angle	Transmission coefficient for diffuse radiation	Extinction coefficients	Transmission coefficient for solar beam radiation penetration	Leaf distribution
Leaf area index	1					
Mean leaf angle	0.4372*	1				
Transmission coefficient for diffuse radiation	-0.5202*	-0.2925	1			
Extinction coefficients	0.0121	-0.0356	0.0759	1		
Transmission coefficient for solar beam radiation penetration	-0.0997	0.0540	0.0122	-0.4586*	1	
Leaf distribution	0.0871	0.2821	0.0187	-0.7203	0.5218*	1
Oleoresin yield	-0.3649	-0.2924	0.0219	-0.2545	0.4862*	0.0885

* Correlation is significant at the 5 % level (r = 0.413)

Table 42. Functional relationship (multiple regressions) between morphological parameters and oleoresin yield

Oleoresin yield (g) (Y)	Leaf area index (X_1)	Mean leaf angle (X2)	Transmission coefficient for diffuse radiation (X_3)	Extinction coefficient (X_4)	Transmission coefficient for solar beam radiation penetration	Leaf distribution	R^2
-3059.7 (2658.27)	-266.06 (290.37)	-2.213 (6.80)	-2061.68 (1234.85)	-1259.93 (1585.29)	6396.5* (2399.38)	-1554.5 (1371.70)	0.5051
$Y=--3059.7-266.06X_1 -2.213 X_2 -2061.68X_3-1259.93 X_4 +6396.5 X_5-1554.5X_6$							

*Significant at 5 % level of significant

Values in parenthesis are standard error

angles was also found significant at 5 per cent level of significance. The highest transmission coefficient of 2.0817 was observed in 45-50 cm diameter at 40.50° zenith angle which was observed to be significantly at par with 30-35 cm diameter class at 40.50° zenith angle (2.0753) and lowest transmission coefficient of 0.7075 was found in 45-50 cm diameter class at 31.50° zenith angle.

Leaf distribution (LD)

The significant difference was observed in leaf distribution among different diameter classes at different azimuth angles. Among the diameter classes, the highest LD value 0.6180 was recorded in 55-60 cm diameter and lowest (0.4932) in 40-45 cm diameter. The leaf distribution at different azimuth angles was also found significant at 5 per cent level of significance. The leaf distribution at 108-144° azimuth angle was recorded to be highest (0.7737), while the leaf distribution at 216-252° was found to be the lowest (0.2584). The interaction among diameter classes and leaf distribution was also found to be significant at 5 per cent level of significance. The maximum (0.9362) leaf distribution was noticed in 55-60 cm diameter at 108-144° azimuth angle and minimum (0.1543) was observed in 50-55 cm diameter at 252-288° azimuth angle.

1.6 Project on Karaya Gum at IGKVV, Raipur

Development and standardization of gum tapping technique for *Sterculia urens* and *Azadirachta indica*

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. Various concentrations of ethephon were used *viz.* 1.98 %, 3.9 % and 39 %. Ethephon is available in the market by different trade names *i.e.* Tagpon, Ethrex, E-Super, Ethrel. Tagpon and ethrel were used for experimental purpose. Drill method (Fig. 76) was used for application of ethephon and compared with mechanical method. Higher level of ethephon was quite effective for higher production of gum. The level of 3.9 % ethephon is also effective for the trees having higher tree girth in karaya (Fig. 77). The suitable period for first treatment of ethephon was found to be last week of March to first week of April and second treatment may be applied after one month in May. As compared to arc method, the drilling method for application of ethephon was found superior in karaya.

Fig. 76. Gum tapping in karaya by drill method

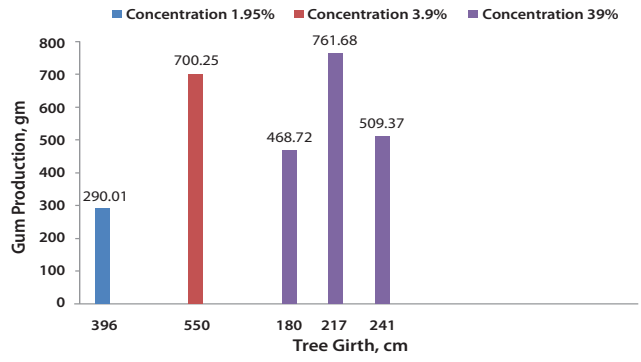


Fig. 77. Gum production of karaya with different concentration of ethephon with different tree girth at Chikli (Gariaband)

Azadirachta indica

Six tapping dates for neem were compared for gum exudation at different relative humidity and temperature from January to June 2014. The gum production started in March last week (26th March) when the average temperature increased up to 26.7 °C and relative humidity was 55.6 %. Ethephon (E-super and Ethrel) @ 2 ml and 4 ml (0.39 %) was used for initiating gum exudation. Gum exudation in neem started from the month of March when the treatment was applied in the month of January and the second dose was applied in the month of April (Fig. 78). Maximum gum production was observed in the month of May. E-super was found superior as compared to ethrel at the same level of dose. Mechanical method of gum tapping was not effective in neem.

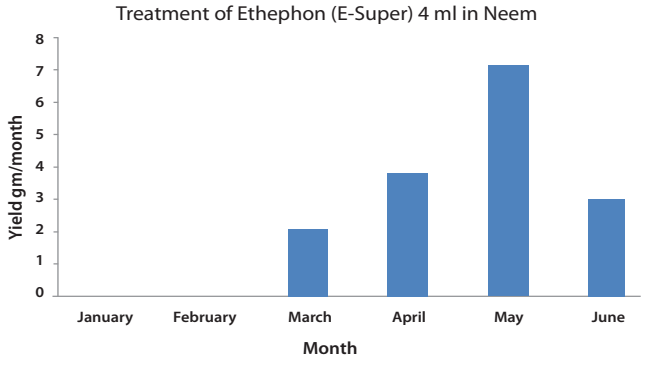


Fig. 78. Effect of ethephon (4 ml, 0.39 %) in different months on gum production in neem

Characterization of genetic diversity of karaya gum tree (*Sterculia spp*)

For testing ill effect of chemical treatment (ethephon) on plant health, seeds from treated (with ethephon) and untreated trees (*S. urens*) were collected and sown for germination and seed vigour test. Indirect vigour test method, via measurement of seedling growth rate, (a) dry weight of seedling (b) speed of germination (induction period for seed germination) and (c) seedling length (d) germination % and (e) survival % of seedlings, were carried out. The effect of orientation of seed placement and depth of sowing on seedling emergence in *S. urens* was also studied. Following conclusions were drawn from the experiments:

- There was non-significant difference in seed germination in ethephon treated and non-treated tree.
- The germination per cent decrease with time and the maximum germination per cent (90-98 %) was observed in June just after collection of seeds. After one year of collection it gives only 20-30 % germination.
- The seed in horizontal (micropyler end sideways) position and inverted position (micropyler end downward) take less time for initiation of germination *i.e.* 5 days, 5 days and 18 h respectively as compared to vertical (micropyler end upward) position of seed (6-7 days).
- Maximum germination (80 %) occurred from seeds in the horizontal and inverted orientation.
- 2-3 cm depth of seed in soil is favorable and takes less time for germination when sown in inverted or horizontal position of seed.
- Germination percentage was 80-95 % in different proportions of soil and sand, and was higher in sand as compared to other combinations.

1.7 Project on *Guggul* at JNKVV, Jabalpur

Response of foliar application of plant growth regulator and nutrients on *Commiphora wightii* for *guggul* production

Experiments were carried out to study the response of foliar application of plant growth regulators and nutrients on *Commiphora wightii* for *guggul* gum production in the Chambal ravines during 2014-15. There were total five treatments (4 treatments +1 control) in the trial, namely, T_1-humic acid, T_2-urea, T_3 micro nutrient, T_4 plant growth regulator and T_5 control. Data related to leaf area, chlorophyll content, amino acid profile, oozed gum collection and gum quality were analyzed. The mean leaf area was maximum (1.63 cm^2) in T_4, while highest mean of total chlorophyll content (20.43) was in T_1, highest mean gum ooze (0.46 ml/ incision) and mean weight (0.49 g/ ooze) was found in T_3 treatment. Three amino acids (aspartic acid, proline and tyrosine) were observed in T_1, while aspartic acid and proline in T_2, T_3, T_5 and only aspartic acid in T_4. The proline content was highest in T_3 followed by T_2, T_5 and T_1. The guggulsterone content (E+Z) in guggul gum was highest (1.81 %) in T_1 while lowest (0.53 %) in T_5.

All the quality and quantity parameters were

influenced by the foliar spray of micro nutrients (T_3). Therefore, the highest gum ooze (0.46 ml), gum yield (0.49 g), amino acids (0.048 %) and guggulsterone E (0.032 %) was highest in T_3, except guggulsterone Z which was highest (1.80 %) in humic acid (T_1) (Fig. 79).

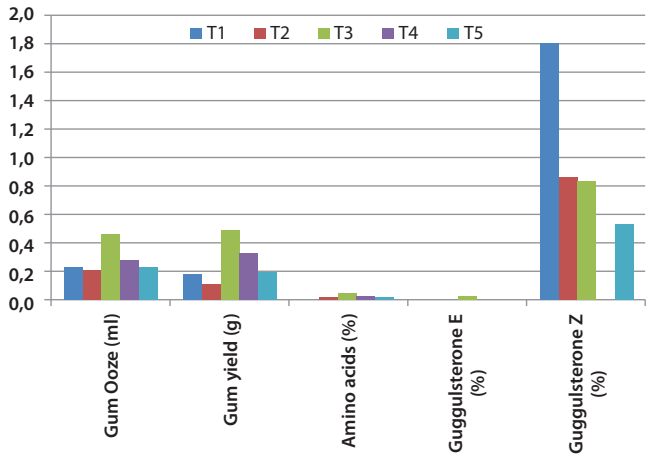


Fig. 79. Effects of foliar application of plant growth regulator and nutrients on the quality and quantity parameters of *guggul* gum.

Response of soil and vermi compost on germination of *Commiphora wightii*

Germination of *guggul* seeds is very low. Hence, experiments were carried out to investigate the effect of medium soil on the germination of *guggul* seeds with four treatments (T_1 Chambal soil, T_2 Black soil, T_3 Chambal soil + Vermi compost and T_4 Black soil + Vermi compost), which was laid out in six replications in CRD. The medium was filled in the root trainer and *guggul* seeds collected from Morena were sown during the year 2014-15 in JNKVV, Jabalpur. The germination per cent, mean length of plumule and radicle, mean dry weight of plumule and radicle, vigour index and root-shoot ratio, all were recorded highest in T_3 followed by T_1. T_3 was found to be the best medium for raising of *guggul* seedlings.

1.8 Project on Tamarind Seed Gum at TNAU, Coimbatore

Tamarind pod and seed characterization was taken up for optimizing the pod and seed size so that maximum tamarind kernel powder recovery is achieved. The tamarind pods were collected from 39 places from four states *viz.* Tamil Nadu, Kerala, Karnataka and Andhra Pradesh and were used for the characterization of tamarind pod, tamarind seed and morphological qualitative descriptors of tamarind pod, pulp and seed.

Characterization of tamarind pod (with respect to source)

Pods were graded in to one seeded, two seeded, three seeded, four seeded, five seeded and multi seeded (Fig. 80) by utilizing one kg of bulk pod in each source. The maximum number of pods (55) per kg was found in tamarind samples from Nellore source (Andhra Pradesh, two seeded) and minimum number of pods (4) per kg was found in tamarind samples from Krishnagiri source (Tamil Nadu, one seeded), Vellore source (Tamil Nadu, five seeded) and Punganur source (Karnataka, one seeded). Among the four states, Velanthavalam (Kerala) source recorded a maximum fruit length of 16.90 cm (multi seeded pods) and Uttarakarenji (Karnataka) source recorded a minimum fruit length of 1.60 cm (one seeded pods). Dindigul source (Tamil Nadu, one seeded) recorded maximum pod width of 3.12 cm and Ariyalur source (Tamil Nadu, three seeded) recorded minimum pod width of 1.14 cm, among the four states. Maximum and mininum tamarind pod shell thickness was found to be 0.151 cm (Theni source, Tamil Nadu) and 0.052 cm (Kollegal source, Karnataka), respectively. Pulp contributed highest from Thumkur source (Karnataka) and lowest from Dindigul source (Tamil Nadu). Also, seed content accounted to be lowest from Thumkur source (Karnataka) and highest from Dindigul source (Tamil Nadu). These findings support the fact that in tamarind fruit if pulp is in maximum percentage then seed is minimum and vice-versa. In 1.0 Kg tamarind pod, the pod shell, fibre, pulp and seed content varied from 36.97 to 20 %, 7.35 to 2.19 %, 36.51 to 21.83 % and 50.12 to 28.4 % respectively.

Fig. 80. Grading of tamarind pods

Characterization of Tamarind seed (with respect to source)

Weight of tamarind seeds varied from 43.50 to 104.85 g/100 seeds with minimum and maximum values for Toothugudi source (Tamil Nadu) and Bangadupettai source (Andhra Pradesh) respectively. Among all sources, the maximum and minimum seed length was found to be 1.55 cm (Dharmapuri, Tamil Nadu source) and 1.15 cm (Thumkur, Karnataka source) respectively. Also, the maximum and minimum seed width was found to be 1.17 cm (Aasan, Karnataka source) and 0.83 cm (Kadambur, Tamil Nadu source) respectively. Grading of seeds was done based on size wise seed weight/ Kg of tamarind seed and size wise seed counting/ Kg of tamarind seed. 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). Maximum (873) and minimum (48) number of small seeds/kg were found in Anandapur (Karnataka) and Palagkad (kerala) source respectively. Also, maximum (896) and minimum (136) number of medium size seeds/kg were found in Thavanikarai (Karnataka) and Chiradurga (Karnataka) source respectively. Whereas, seeds from Umili (Karnataka) source had maximum seed count (948)/ kg for larger seeds.

Morphological qualitative descriptors of tamarind pod, pulp and seed

Tamarind from all the sources were grouped based on pod shape (curved and straight) (Fig. 81), pulp colour (brownish yellow and brownish dark) (Fig.82), seed shape (irregular and bowl shaped) (Fig. 83), seed colour (brown and brownish dark), seed brightness (non-brilliant and brilliant appearance) and seed roughness (rough and smooth appearance).

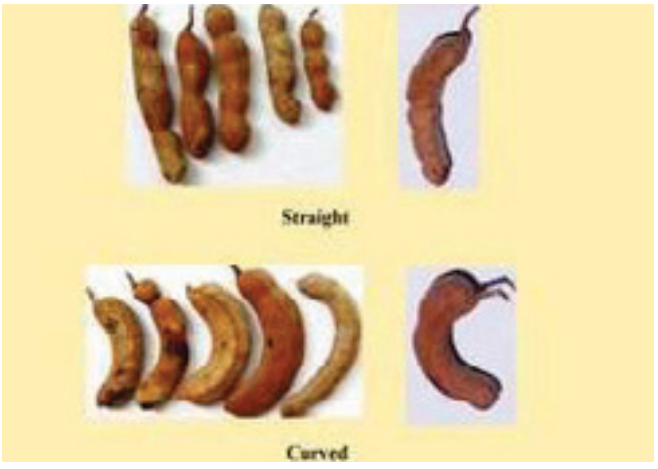


Fig. 81. Tamarind pod shape (straight and curved)

Fig. 82. Tamarind pulp colour (brownish yellow and brownish dark)

Among fourteen sources from Tamil Nadu, curved shape was recorded in seven sources and other seven sources had straight tamarind pod. In Kerala, curved shape was observed in the sources *viz.* Palagkad, Pathari and straight shape was recorded in Velanthavalam source. In Andhra Pradesh, curved shape was observed only in the Hosur source and the rest three sources had straight shape of pod. Whereas in Karnataka, nine sources had curved shape and other eight sources had straight shaped tamarind pod.

Fig. 83. Tamarind seed shape (irregular and bowl)

In Tamil Nadu, brownish yellow tamarind pulp was recorded in sources *viz.* Gobichettipalayam source, Pollachi source, Dharmapuri source, Krishnagiri source, Perambalur source, Vellore source and rest of the eight sources had brownish dark pulp. All three sources from Kerala had brownish yellow tamarind pulp. From Andhra Pradesh source, except Hosur, all sources had dark brownish pulp of tamarind. In

Karnataka, brownish yellow was recorded in the sources *viz.* Udaiyarpalayam source, Aasan source, Thumkur source, Therakanambi source, Kollegal source and Chiradurga source, whereas, other sources contained brownish dark colour tamarind pulp.

In Kerala, all three sources *viz.* Palagkad source, Velanthavalam source and Pathari source were recorded with bowl shaped seed. Whereas in Andhra Pradesh the entire five sources were recorded with irregular seed shape. In Tamil Nadu, irregular seed shape was found in the sources *viz.* Madurai source, Gobichettipalayam source, Salem source, Toothugudi source, Ariyalur source and other sources had bowl shaped seed shape. In Karnataka, out of seventeen sources, eight sources had bowl shaped seed and others had irregular seed shape.

Some sources from both Karnataka and Tamil Nadu had brown coloured tamarind seed and some sources had tamarind seed colour as brownish dark. In Andhra Pradesh, brown seed colour was observed in Gundur and Bangadupettai source, whereas brownish dark colour was observed in Tirupathi, Nellore and Hosur source. Two sources from Kerala had brownish dark seed and Palagkad source registered brown colour seed.

Velanthavalam and Pathari source of Kerala recorded brilliant appearance in seed brightness. In Andhra Pradesh, brilliant appearance of seed brightness was accounted in Nellore and Bangadupettai source. Non-Brilliant appearance was reported in Kadambur, Dharmapuri, Toothugudi and Ariyalur source of Tamil Nadu and other sources had brilliant appearance of seed brightness. Eight sources from Karnataka had brilliant appearance, while seeds with non-brilliant appearance was reported in Gundalpet, Thavanikarai, Punganur, Aasan, Thumkur, Nanjangudu, Sorranakarai, Kollegal and Umili source.

Some sources from all four states (Tamil Nadu, Kerala, Karnataka and Andhra Pradesh) had tamarind seed with rough appearance and some sources had seeds with smooth appearance. Hence, no specific trend was observed regarding seed roughness for a particular state.

1.9 Project on Natural Dammars at KAU, Thrissur

Documentation of *Canarium strictum* and *Vateria indica* in Kerala

The black resin obtained from bark of *Canarium strictum* is known as black dammar or dhoopa. This medicinal evergreen tree species is highly appreciated for its aromatic resin (Fig. 84). This gigantic tree occurs in the evergreen forests of Western Ghats and Eastern Himalayas in India which attains a height up to 40 m. In Kerala it is seen in all evergreen forest and collection of black dammar is localized in different areas.

Fig. 84. *Canarium strictum* tree and black dammar

White resin obtained from wood of *Vateria indica* (critically endangered species) is known as white dammar (Fig. 85). This tree is very popular due to its valuable uses as timber and medicinal importance. In Kerala, white dammar trees are abundant and mainly seen in semi evergreen and wet evergreen forests. These evergreen trees attains a maximum height of 30 m and are found in South-Western India from North Kanara in Karnataka to Tirunelveli in Tamil Nadu through entire Kerala (also in plain). White dammar production in Kerala is very low due to the difficulties in extraction. Tribals reported that very few tress of *Vateria indica* produce dammar, hence no artificial resin tapping method is employed and resins are collected from natural incisions only.

Fig. 85. *Vateria indica* tree and white dammar

Presently, black dammar and white dammar are collected from forests throughout the Kerala State, with the exception of core areas of wildlife sanctuaries. In Kerala, 8 scheduled tribe cooperative societies are involved in the dammar collection. In Kerala, dammar

production is mainly confined with *Canarium strictum* trees and tribals are mainly involved in dammar harvesting. Marketing is done mainly through tribal societies, VSS (Van Samrakshana Samiti) and private traders. Approximately, 17 tons of black dammar and 460 kg of white dammar is produced from Kerala every year.

Anatomical studies of *Canarium* bark

Fresh *Canarium* bark was collected from the sample tress at different forest areas for studying anatomical properties. The transverse section of bark (Fig. 86) contains periderm and phloem elements. Periderm is a protective tissue of secondary origin. It replaces the epidermis when the axis is increased in girth and the epidermis is destroyed. Inner to the periderm occur a thick zone of collapsed phloem which includes thick tangential blocks of sclereids and long darkly stained thick tangential lines of collapsed phloem. Inner to the collapsed phloem zone is a narrow zone of none-collapsed phloem. In this zone there are limited numbers of small sclereid masses. The phloem cells are intact and fairly well preserved. Many sieve tubes are present in this area. These tubes are mature and conducting in nature. The resin of *Canarium* oozes out from these sieve tubes, which are abundantly present in the bark. Anatomical studies revealed that the sieve tube frequency showed an initial increase in the 50 to100 cm girth class whereas it decreased with advancing girth classes.

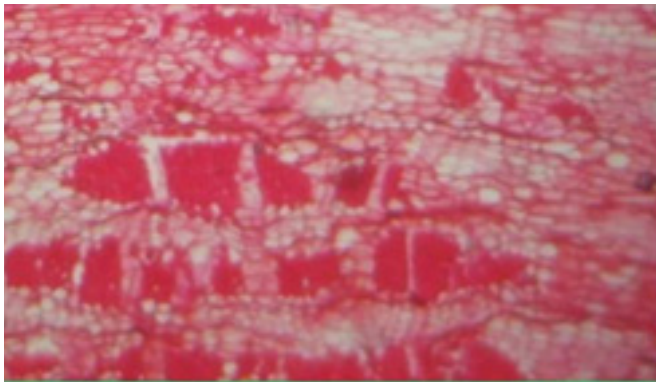


Fig. 86. Transverse section of *Canarium bark*

Anatomical studies of *Vateria* sap wood

Sap wood of *Vateria* (Fig. 87) was collected from different girth classes (<50 to >150). The wood specimen for *Vateria* was studied for anatomical characters by rotary microtome. Sap wood of *Vateria* is diffuse porous. Vessels are solitary or mixed with multiples of two or three vessels. Vessels are diagonal or radial in pattern with three sizes *viz.* small, medium and large. The most important feature of this wood is the presence of gum/ resin canal. They are arranged in a continuous line, adjacent to vessels and are always surrounded by epithelial cells. The number of gum/ resin canal varies with the tree girth. Gum/resin canal frequency in *Vateria* sap wood was studied for various girth classes. It is noticed that as girth increases, the frequency of resin canal is also increased. However the increase was found to be non-significant. Conversely with frequency, the resin canal area significantly increased with increase in girth.

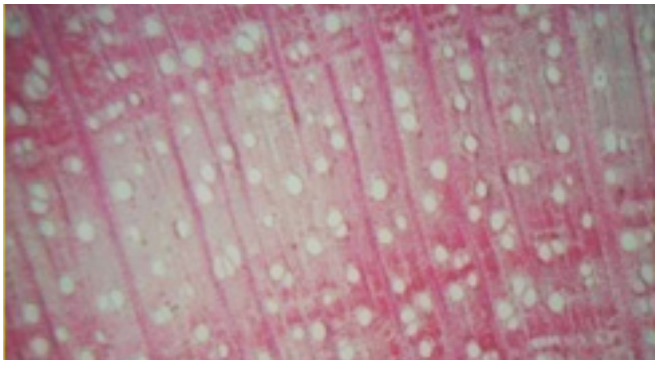


Fig. 87. Transverse section of *Vateria indica* sap wood

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

Field survey in Jaintial Hills District

Initial field survey was conducted in Jaintial Hills District to collect the data on harvesting of resins from Khasi pine and information on ethno-botanical uses of pines and it's byproducts. In Meghalaya, *Pinus kesiya* is found in subtropical pine forest (9/C2- Forest type India, Champion and Seth's Forest Type Classification) which is predominantly in the higher reaches of Shillong plateau in Khasi and Jaintial hills. Meghalaya Forest Department has banned felling of khasi pines from 1996, but Jaintial Hills Autonomous District Council (JHADC) allowed harvesting of pine trees having > 30cm diameter at breast height (DBH) from the community or private lands. Some farmers and forest dwellers collect resins in small scale by de-barking and chopping of pine trees. Also, highly resinous wood is used as torchwood (Fig. 88). Oleoresin collected is used for the treatment of minor skin ailments like dryness of skin, cracked heels, as skin protection against harsh winter wind etc. Apical young shoots of *Pinus kesiya* is consumed for a week to get relieved from cough.

Fig. 88. Torch wood from pines

Initiation of Bore hole method for oleoresin tapping

For oleoresin tapping study, *Pinus kesiya* grown in agroforestry experimental field of ICAR Research Complex for NEH Region Umiam, Meghalaya were tagged and three different diameter classes *viz.* 30-40 cm, 40-50 cm and >50 cm were selected. Three bore holes per tree were made (Fig. 89) on the selected trees every month and oleoresin excreted was collected in a polythene bags for a month period and weight was measured. The tapping of oleoresin was started in the month of November 2014 and continued till September 2015. Resin yield is presented in Fig. 90. In November, highest oleoresin collection yield was found in 40-50 cm diameter class (294.14 g/ tree) followed by >50 cm diameter class with resin yield 233.68 g/tree. Oleoresin collection was least (176 g/ tree) in 30-40 cm diameter class. Trend was almost similar in all months. Among 10 months, resin yield was higher in the months of November-January and March-April. During July-August, resin yield was very less (< 50 g/tree).

Fig. 89. Resin tapping at the Umiam, Meghalaya

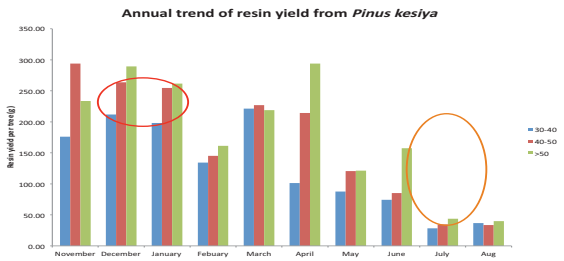


Fig. 90. Graphical representation of resin yield from *Pinus kesiya*

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 during year 2015 on *F. macrophylla* with *F. semialata. Semialata* bud grafted on *macrophylla,* inarching between *F. semialata* and *F. macrophylla* and cleft grafted *semialata* on *macrophylla* showed varied success rate (10, 30 and 90 % success rate was achieved respectively for budded, inarched and grafted plants (Fig. 91).

Fig. 91. Vegetative propagation of *F. semialata* on *F. macrophylla*

Forecasting of lac insect larval emergence

The study was undertaken 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 during summer season (*baisakhi* 2014-15) and rainy season (*katki* 2015) crops of *rangeeni* strain. Photographs were taken of female cell with yellow spot appearance and developing embryo in the mother cells were observed (Fig. 92) under microscope (16x). Time lag relation (in days) between initiation of larval emergence and different stages of yellow spots varied greatly. Time taken for actual larval emergence to begin was 20.10 ± 5.06 days and 9.54 ± 2.07 days respectively in stage zero compared to 1.80 ± 0.78 and 1.55 ± 0.51 days in stage five during *baisakhi* and *katki* (Fig. 93 & 94).

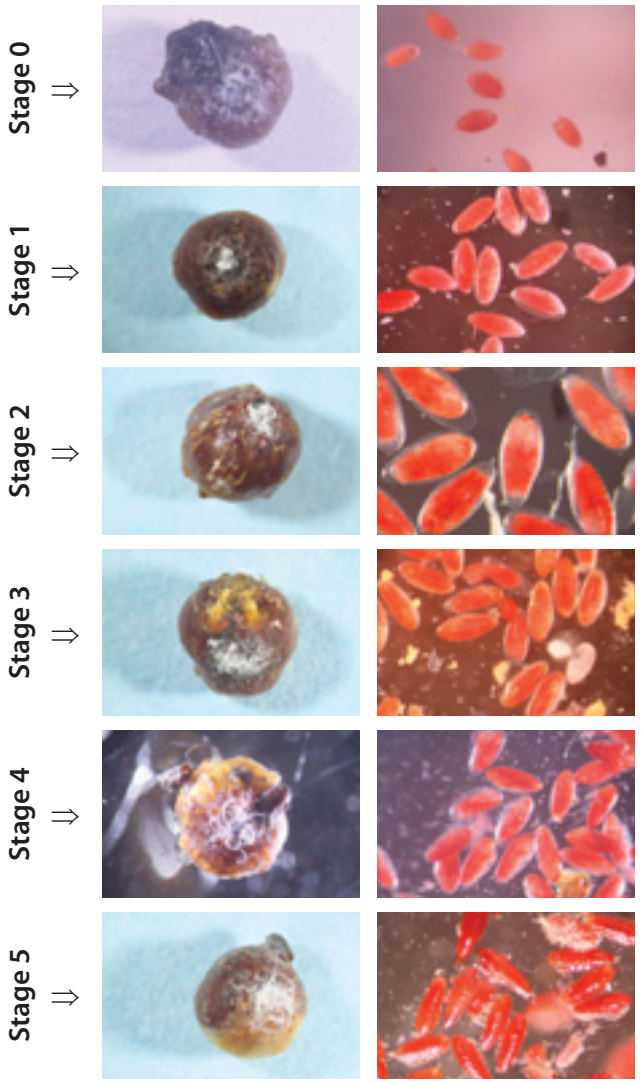


Fig. 92. Different stages of yellow spots and corresponding embryonic development of lac insects during *katki* 2015

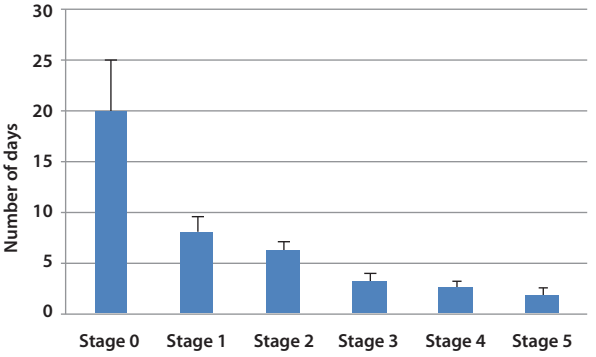


Fig. 93. Time lag relation (in days) between initiation of larval emergence and different stages of yellow spot during *baisakhi* 2014-15

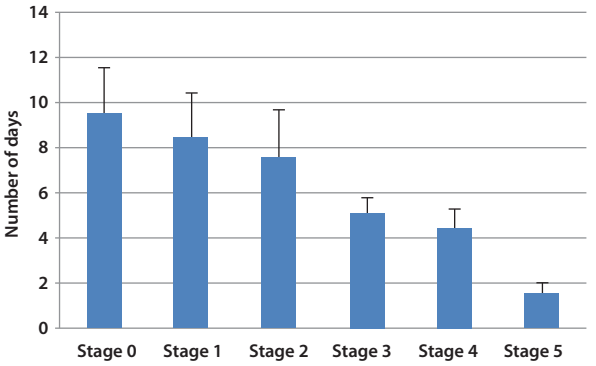


Fig. 94. Time lag relation (in days) between initiation of larval emergence and different stages of yellow spot during *katki* 2015

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 *ber* for *baisakhi* 2014-15, *katki* 2015 and *jethwi* 2015. Maximum lac crawlers emerged on 12, 4, 6 days after harvesting of broodlac and the crawlers continued to emerge upto 24, 26 and 24 days after harvesting of broodlac during *baisakhi* 2014-15, *katki* and *jethwi,* 2015, respectively (Fig. 95 to 97).

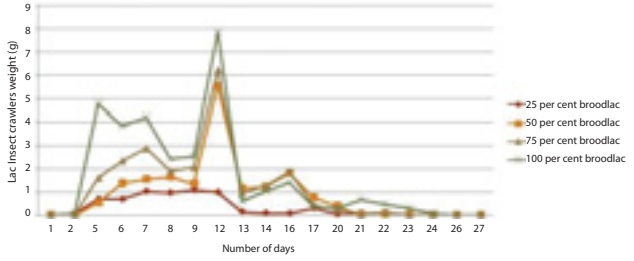


Fig. 95. Crawler emergence in different quality of broodlac during *baisakhi* 2014-15

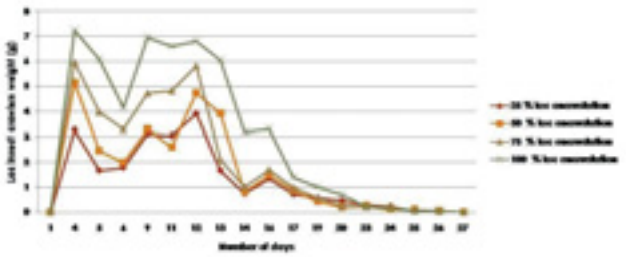


Fig. 96. Crawler emergence in different quality of broodlac during *katki* 2015

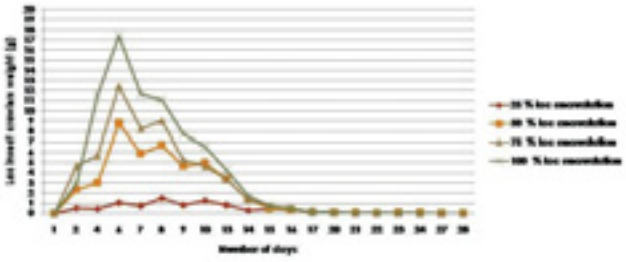


Fig. 97. Crawler emergence in different quality of broodlac during *jethwi* 2015

Exploring possibility of *salix* as lac host

Dr. SS Bhat also collected six different fast growing clones of *Salix* from Dr. YS Parmar University of Horticulture and Forestry, Solan (Himachal Pradesh) for lac cultivation trials at the institute. Preliminary results have shown good opportunity for lac cultivation from the species (Fig. 98 & 99).

Fig. 98. Lac evaluation on fast growing willow clones

Fig. 99. *Kusmi* lac encrustation on *Salix* clone, Austre

Elemental analysis of lac insect/resin

A preliminary analysis of elements present in the lac resin secreted by *Kusmi* lac insect on *palas* was undertaken using Inductively Coupled Plasma Optical Emission Spectroscopy (ICPOES). Fourteen elements were observed and their concentrations recorded are summarized in the Table 43. Calcium, Iron, Magnesium, Sodium, Potassium were found to be in larger quantity as compared to other elements in lac insect as well as resin produced by it when grown on *swadi palas* and *kusum*.

Measurement of physio-chemical properties in *F. semialata*

Net photosynthesis rate, leaf stomatal conductance and transpiration rate were measured in the fully expanded leaf of *F. semialata* in both the conditions *i.e.* un-inoculated as well as inoculated, using Hand-Held Photosynthesis System (CI-340 CID, Inc., USA). Photosynthesis was expressed as µmol of CO_2 consumed m^{-2} sec^{-1}, stomatal conductance as mmol CO_2 consumed m^{-2} sec^{-1} and transpiration rate as mmol of water transpired m^{-2} sec^{-1}. The results showed that the there is increase in the net photosynthesis rate and leaf stomatal conductance upon inoculation as compared to un-inoculated condition (Table 43) as lac insect feeding on sap exerts biotic stress in the plant. In order to cope up with the stress plants probably trigger the biochemical processes to meet the increased demand of photosynthates by insect as well as by the plant itself. Lac insect feeding does not seems to affect the transpiration rate in the leaf.

Table 43. Elemental analysis of lac insect/resin

Element	*Swadi palas* resin (*Kusmi*) (µg/g)	*Kusum* lac resin (*Kusmi*) (µg/g)	*Kusum* lac insect (µg/g)
Calcium	616	29	203
Cadmium	4.55	0.5	1
Cobalt	BDL	BDL	2.5
Chromium	8	0.5	2.5
Copper	43.5	2	52.5
Iron	110	5	23.5
Magnesium	171.5	41	1065.5
Manganese	4.5	10	4
Molybdenum	9.05	BDL	BDL

Element	*Swadi palas* resin (*Kusmi*) (µg/g)	*Kusum* lac resin (*Kusmi*) (µg/g)	*Kusum* lac insect (µg/g)
Nickel	BDL	BDL	BDL
Lead	120	5	8.5
Zinc	70	14	134.5
Sodium	350	BDL	BDL
Potassium	910	314.5	4758
BDL, Below Detectable Limit			

Molecular characterization of newly collected lac insect samples

Lac insect samples collected from Manipur, Nagaland, Assam and Tamil Nadu on different host plants were characterized using *cox1* marker. For characterization of housekeeping genes, DNA was isolated from lac insects and amplified with cytochrome oxidase gene specific primers. The amplified products were checked on 1% agarose gel and sent for sequencing. Lac insects collected from Manipur on *Ziziphus mauritiana* revealed 97 % homology with both LIK31 and LIK23 (both *K. chinensis* lines). Lac insects collected from Manipur on *F. religiosa* were found to have 90 % homology with LIK31 and 89 % with LIK23. Lac insects collected from Manipur on *Hibiscus* showed 97 % homology with both LIK31 and LIK23. The *cox1* product of lac insects collected from Manipur on *Malvaviscus* showed 98 % homology with both LIK31 and LIK23. In case of lac insects collected from Manipur on *M. phillipensis* there was 97 % homology with both LIK31 and LIK23. Lac insects collected from Nagaland (on *L. chinensis)* revealed 95 % homology with both LIK31 and LIK23. Lac insects collected from Assam (on *F. religiosa*) were found to have 99 % homology with LIK31 and 98 % with LIK23. Lac insects collected from Tamil Nadu (on *A. saman*) showed 99 % homology with both LIK12 and LIK26.

Network Cooperating Centres

2.2 Assam Agricultural University, Jorhat (Assam)

Surveys were conducted in Karbi Anglong, Lakhimpur, Jorhat, Golaghat, Kamrup, and Dima Hasao districts of Assam and Purulia, Bankura and Medinipur districts of West Bengal to locate lac insects and their host plants. In Assam different stages of lac insects were observed on *Cajanus cajan,* "Senamlongdak", *F. religiosa* and *L. chinensis.* A new lac host plant locally known as *makhonda* has been identified from Assam (Fig. 100). In West Bengal, the common host plants observed were *S. oleosa, B. monosperma, Ziziphus spp* and *A. saman.* In order to conserve the lac insects, broodlac was inoculated on the already grown host plants such as *F. semialata, F. macrophylla* and *Cajanus cajan,* naturally grown *F. religiosa, Ziziphus spp* and *L. chinensis.* Establishment of insects on the former three host plants was satisfactory compared to that on the naturally grown ones. Eight insect pests belonging to different insect orders were recorded on *F. macrophylla* (Table 44). Studies on pest complex of lac insects from the collected samples revealed the presence of predators, most commonly *E. amabilis* and *Chrysoperla carnea.* To create awareness on lac cultivation among the local farmers, various leaflets and bulletins were prepared in regional languages and distributed in some selected villages.

Fig. 100. Makhonda, new host plant recorded for lac insect

2.3 Central Agricultural University, Imphal (Manipur)

A survey was conducted in five districts of Manipur namely Imphal-West, Imphal-East, Bishnupur, Churachandpur, and Thoubal covering 50 villages during January –December 2015 showed the natural presence of lac insect, *K. chinensis.* The host plants were abundant but no lac insects were found in two districts (Churachandpur, and Thoubal) whereas in other three districts naturally occurring lac insects were found and their population varied from host to host (Table 45). Lac host field gene bank has been established in an area of 900 m^2 and different host plants *viz., C. cajan, F. semialata, F. macrophylla, Hibiscus spp, M. penduliflorus* have been raised in the field for subsequent crop inoculation (Fig. 101).

Table 44. Pest recorded on *F. macrophylla* under potted condition at AAU, Jorhat

S. No.	Pest	Common name	Order	Family	Destructive stage	Plant part affected
DEFOLIATORS						
1	*Archips micaceana* Walker	Tortrix moth	Lepidoptera	Tortricidae	Larva	Leaves
2	*Archips spp*	Bell moth/ Tortrix moth	Lepidoptera	Tortricidae	Larva	Leaves
3	*Hyposidra talaca* Walker	Black inch worm	Lepidoptera	Geometridae	Larva	Leaves
4	*Orgyia spp*	Yellow tussock moth	Lepidoptera	Erebidae	Larva	Leaves
5	*Monolepta signata* Olivier	Flea beetle	Coleoptera	Chrysomelidae	Adult	Leaves
6	*Somena scintillans* Walker	Yellow tail tussock moth	Lepidoptera	Lymantriidae	Larva	Leaves
SUCKING PEST						
7.	*Aphis craccivora* Koch	Black aphid	Hemiptera	Aphididae	Nymph & adult	Suck the sap from leaves and stem
8.	*Megacopta spp*	Bean Plataspid	Hemiptera	Plataspidae	Nymph & adult	Suck the sap from leaves and stem

Table 45. Abundance of lac insect, *K. chinensis* in different districts of Manipur

Name of District	Host Plants	No. of host plants observed	Host plants found infested (%)
Imphal-West	*Malvaviscus penduliflorus*	33	24.24
	Ziziphus spp	18	0
	Ficus spp	6	50
Imphal-East	*Malvaviscus penduliflorus*	23	39.13
	Ziziphus spp	18	11.11
	Ficus spp	5	20
Bishnupur	*Malvaviscus penduliflorus*	23	0
	Ziziphus spp	7	14.29
	Ficus spp	15	20
Churachandpur	*Malvaviscus penduliflorus*	7	0
	Ziziphus spp	4	0
	Ficus spp	3	0
Thoubal	*Malvaviscus penduliflorus*	6	0
	Ziziphus spp	5	0
	Ficus spp	3	0

Fig. 101. Raising of host plants at CAU, Imphal for ***ex-situ*** conservation of lac insects

2.4 Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)

An extensive survey was conducted in 46 districts of three states *viz.* Rajasthan, Gujarat and Haryana during 2015-16 to identify the host plants and to locate the presence of lac insect genetic resources prevailing in the region. Lac insect samples were collected from 36 locations from different host plants. During survey several host plants were observed infested with lac insects (Table 46). Among them *ber* and *apal* were found more abundant as potential hosts of lac insect in Rajasthan as compared to other host. In Saurashtra region of Gujarat, *Acacia spp, Albizia spp.* And other host plants were also found on which considerably high settlement of lac insects was seen. A great diversity in lac host plants was observed in Haryana where besides *apal, ber, babool, bargad,* several species of *Acacia* and other plants were noticed bearing high settlement of lac insects. The plant materials of all uncommon hosts were collected and preserved as herbarium for further identification. During the survey, lac insect was found on *Ashapal, Polyalthia pendula* from the Rajasthan College of Agriculture campus, Udaipur, probably new record of lac insect host (Fig. 102). Lac museum-cum-laboratory has been establishment in the department of Entomology, RCA, MPUAT, Udaipur and field gene bank for lac insect conservation is under progress. Two popular articles, one pamphlet, four posters and two news article on lac cultivation have been published by the centre for distribution and to create awareness amongst the farmers.

Fig. 102. *Rangeeni* lac insect on *Polyalthia pendula* tree

Table 46. Host plants and lac insect intensity in different agro-climatic zones of three states of semi arid western plain

States	Agro-climatic zones covered	Districts covered	Lac host plants observed	Potential lac host plants
Rajasthan	Arid Western Plains	Jodhpur	*Ber, Pipal, Babool, Paras pipal*	*Pipal*
	Humid Southern Plains	Baran, Bundi, Jhalawar, Kota, Banswara, Dungarpur	*Bargad, Gular, Khair, Ber, Pipal, Babool*	*Ber, Pipal*
	Hyper Arid Partially Irrigated Zone	Churu	*Ber, Pipal, Babool*	*Pipal*
	Internal Drainage Zone	Nagaur	*Ber, Pipal, Babool*	*Pipal*
	Semi Arid Eastern Plains	Ajmer, Dausa, Jaipur	*Ber, Pipal, Babool*	*Ber, Pipal*
	Sub Humid Southern Plains	Udaipur, Chittorgarh, Pratapgarh, Rajsamand, Bhilwara	*Palas, Ber, Pipal, Babool, Paras apal, Ashapal, Keekar, Custard apple*	*Ber, Pipal*
	Transitional Plains of Luni Basin	Jalore, Jodhpur, Pali, Sirohi	*Palas, Ber, Pipal, Babool, Bargad*	*Pipal*
Gujarat	North Gujarat Zone	Gandhinagar, Ahmedabad, Deesa, Palanpur, Mehsana, Banaskantha, Patan, Visnagar Vijapur	*Palas, Ber, Pipal, Babool*	*Pipal*

States	Agro-climatic zones covered	Districts covered	Lac host plants observed	Potential lac host plants
	North Saurashtra	Jamnagar, Rajkot and Bhavnagar	*Ber, Pipal, Babool, Gulmohar, Acacia spp, Paras pipal*	*Pipal, Gulmohar, Acacia spp*
	South Saurashtra	Junagarh, Kodinar, Talaja, Jetpur	*Ber, Pipal, Babool, Acacia spp, Albizia spp*	*Pipal, Acacia spp, Albizia spp*
	North-West Zone	Banaskantha, Surendernagar	*Palas, Ber, Pipal, Babool*	*Pipal*
	Middle Gujarat Zone	Kheda, Anand	*Ber, Pipal, Babool*	*Pipal*
Haryana	Eastern Zone	Parts of Rohtak, Gurgaon	*Pipal, Babool, Acacia spp, Albizia spp, Bargad*	*Acacia spp, Albizia spp, Pipal*
	Western Zone	Hissar, Rohtak, Sirsa, Gurgaon	*Pipal, Babool, Ber, Acacia spp, Albizia spp, Bargad*	*Acacia spp, Albizia spp*

2.5 Punjab Agricultural University, Ludhiana (Punjab)

Surveys were conducted in seventeen districts of Punjab to locate lac insects and their host plants. Different stages of lac insect were found on *Ziziphus spp* and *Acacia spp* in Punjab. However, the lac insect was also reported from *L. chinensis* from Ludhiana district and on *apal* (*F. religiosa*) from Sangrur district. During survey, it was found that lac insect population was more in dry areas. *i.e.* South-Western districts of Punjab (Ferozepur, Muktsar, Bathinda, Barnala,) and Central ones (Ludhiana, Moga) as compared to sub-mountainous areas (Gurdaspur, Pathankot) and Eastern district (Nawanshehar and Roop Nagar). In order to conserve lac insects, broodlac was inoculated on already grown host plants, *C. cajan, F. macrophylla* and *F. semialata*. Development of field gene bank for conservation of lac insect biodiversity is under progress and lac host-park is being established (Fig. 103). Lac insect museum and training hall has been fully established at the centre. Different aspects of lac cultivation, *viz*. natural enemies, insect pest infestation on host plants, different biological features and molecular characterization of lac insect collected from different locations of Punjab are being studied.

Fig. 103. Lac insect and lac host park under establishment at the Entomological Research Farm, PAU, Ludhiana

2.6 Professor Jayashankar Telangana State Agricultural University, Hyderabad (Telangana)

Surveys were conducted in Adilabad district which showed natural occurrence of lac insect on *ber*, ornamental plant, *Hibiscus* and pigeon pea. *Ber* was found as major host for naturally occurring lac insect in Northern Telangana Zone.

2.7 Sher-e-Kashmir University of Agricultural Science and Technology, Jammu (Jammu & Kashmir)

A scientific leaflet carrying information on the lac insect infested branches/ trees was distributed to the localities of survey areas in order to collect the insect from all possible locations with people participation. The same was also used for procuring information

regarding location of lac insect infested trees in various parts of Jammu. Old and un-pruned trees of *ber* were closely observed for natural infestation. Infested branches were located and detail regarding the same was recorded carefully with marking the specific tree and branches using tags for subsequent collection at proper time. Naturally occurring matured lac insects were collected from 7 locations in Jammu Division. All collections were maintained in the lac insect gene bank at Division of Entomology of SKUAST, Jammu (Fig. 104). One broodlac farm has been established in Vijaypur of Samba district (Fig. 105). Four lac hosts *viz. ber, palas, khair* and *Ficus spp* were in plenty in the region but lac infestation was observed only on *ber* trees. Development of field gene bank for conservation of lac insect biodiversity and lac insect museum is under progress at the centre.

Fig. 104. *Ex-situ* conservation of lac insect germplasm at SKUAST-Jammu

Fig. 105. Brood lac farm at Vijaypur in Samba district

2.8 Kerala Forest Research Institute, Thrissur (Kerala)

Survey was conducted in Karnataka, Tamil Nadu and Kerala for natural abundance of lac insects and host plants. Out of 14 districts of Kerala 9 districts were surveyed and lac insects were recorded on *A. saman, Amherstia nobilis, Peltophorum pterocarpum* and *F. religiosa*. Six districts of Karnataka (Mysore, Udupi, Hassan, Tumkur, Bangalore and Kolar) were surveyed and no live lac insect was recorded from any of these districts. Six districts of Tamil Nadu (Coimbatore, Erode, Salem, Dharmapuri, Vellore and Thirunelveli) were surveyed. Live lac insect was recorded on *A. saman* in Salem, on *F. religiosa* in Erode. Heavy infestations of lac were recorded from Vellore district on *A. saman, A. lebbeck* and *Z. mauritiana*. Dead lac was observed on rain trees in Tirupur (Coimbatore), *Acacia planifrons* in Chennimalai (Erode), rain trees in Krishnagiri toll plaza (Dharmapuri) and rain tree near Thenkasi bus stand (Thirunelveli). Both live and dead lac insects were collected from these three states. Lac insects collected from various locations was successfully raised on *A. nobilis*. Mass propagation of *A. nobilis* and raising of *F. macrophylla* and *F. semialata* is being carried out for subsequent inoculation (Fig. 106 a to c).

Fig. 106 a. Stem cutting of *A. nobilis* in the root trainers

Fig. 106 b. Transferred stem cutting of *A. nobilis* with root into polythene bags

Fig. 106 c. Potted saplings of *F. macrophylla* for *ex-situ* conservation of lac insect

For better germination of *F. semialata* seeds, rubbing with ash was found to be the most efficient method with 90 % success rate. Medicinal uses of lac especially in Ayurveda were documented. Eight species of ants associated with lac insect was identified. New research proposal on 'Investigation in to the determinants of near total decline in lac cultivation in Kerala' as a sub-project has been initiated by the centre.

2.9 State Forest Research Institute, Jabalpur (Madhya Pradesh)

Intensive survey was conducted in Eastern and Western part of Madhya Pradesh State and some districts of Maharashtra State to document the occurrence of lac insect and their host plants. In Western Madhya Pradesh different stages of lac insects were recorded on *palas* (*B. monosperma*), *kusum* (*S. oleosa*), *ber* (*Z. mauritiana*), *sitaphal* (*Anona squemosa*), *sagon* (*Tectona grandis*), *gular* (*Ficus globrosa*), *babool* (*Acacia nilotica*), *mango* (*Mangifera indica*), *akashmoni* (*Acacia auriculformis*), *tendu* (*Diospyros melanoxylon*), *apal* (*Ficus religiosa*) and *siris* tree (*Albizia lebbeck*). In most districts and in most of the routes, ***palas*** was found in higher number with different diversities in Seoni, Balaghat and Mandla whereas *kusmi* lac was found in higher numbers in Bankhedi (Hoshangabad), Chichli (Narsinghpur) and Dindori. Sowing of *F. macrophylla* and *F. semialata* was done for mass multiplication in nursery beds and later transplanted in polybags and earthen pots. A Regional Lac Insect Field Gene Bank was established in ornamental nursery of State Forest Research Institute, Jabalpur (Fig. 107).

Fig. 107. A view of regional lac insect field gene bank

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

Synthesis of hydrogel from guar and moringa gum

A series of six sets of hydrogels were synthesized from guar gum (GG-g-PHEMA-cl-NN'-MBA) by varying cross-linker concentration using ceric ammonium nitrate as a free radical initiator. The optimized grade has been determined by its higher percentage grafting as well as higher cross-linking values. It was observed that the grafting percentage increases as the concentration of monomer increased. The characterization with SEM of guar gum shows a tight structure with pressed surface while its hydrogel had a porous structure due to the formation of interpenetrating network. Elemental analysis showed higher percentage of nitrogen in hydrogel which confirms the incorporation of nitrogen containing moiety in the hydrogel system.

For investigating application of guar gum based hydrogel in heavy metal absorption, reaction with graft copolymerization of purified natural guar gum (GG) between GMA in water in acidic condition (pH, 3.5) using ceric ammonium nitrate (CAN) and with

acrylic acid in basic condition (pH,12.5) (NaA) using ammonium persulfate (APS) as initiator and N,N'-methylenebisacrylamide (MBA) as crosslinker have been conducted. The mechanism of the reaction with GMA is believed to proceed through an epoxide ring-opening followed by reaction of hydroxyl groups of macromolecule. Investigation of parameters like swelling index, water absorption, functional group analysis through FT-IR and CHN ratio in hydrogel prepared is underway.

Moringa oleifera, considered as miracle tree for its various pharmaceutical applications, is full of beneficiary components. *Moringa oleifera* exudates gum based hydrogel polymers were synthesized varying the concentration of monomer, cross linker and initiator. The characterization with SEM, elemental analysis, FT-IR and thermal analysis have been completed. A provisional patent application has been filed.

Approved on–going Research Projects

S. No.	Project No.	Project Title	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/wilt 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
Core Program- III: Processing, Storage and Quality Management			
10.	1.2.032	Design and development of integrated small scale lac processing unit for conversion of sticklac-seedlac.	Dr. SC Sharma
11.	1.2.040	Characterization, chemical profiling and evaluation of gum ghatti (*Anogeissus latifolia* Wall.).	Sri N Thombare
12.	1.2.055	Physico-chemical characterization and monosaccharides profiling of jhingan gum (*Lannea Coromandelica*).	Sri Ch. Jamkhokai Mate
13.	1.2.060	Development of pilot-plant of dewaxed decolourised lac (DDL) for training, demonstration and process refinement.	Er. SK Pandey
14.	1.2.061	Control of deacetylation in gum karaya on storage for quality retention.	Dr. S Srivastava
Core Program- IV : Value Addition, Application Development and Product Diversification			
15.	1.2.041	Synthesis and evaluation of guar gum derivatives.	Dr. AR Chowdhury
16.	1.2.062	Synthesis and evaluation of cross-linked guar gum hydrogels for application in bio-remediation and in agriculture.	Sri N Thombare
17.	1.2.063	Green synthesis of silver nanoparticles capped in gum *acacia* for bactericidal application.	Dr. MZ Siddiqui
18.	1.2.065	Development of coating formulation for paper packaging materials.	Dr. MF Ansari

S. No.	Project No.	Project Title	Principal Investigator
Core Program – V: Capacity Building of Farmers' and Entrepreneurship Development			
19.	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			
20.	1.3.043	Impact assessment of technological interventions and market research on natural resins and gums (NRGs).	Dr. RK Yogi
21.	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
22.	1.3.042	Evaluation of lac mud as organic manure.	Dr. AK Singh
23.	1.3.051	Standardization of package of practices for *rangeeni* lac cultivation on *Flemingia semialata*.	Dr. AK Singh
24.	1.3.050	Information communication technology (ICT) intervention on natural resins and gums knowledge dissemination system.	Dr. Alok Kumar
Externally Funded Projects			
25.	2.3.039 (Jharkhand Govt. sponsored)	Lac cultivation and processing unit establishment.	Dr. AK Singh
26.	2.2.052 (Ministry of Food Processing, Govt. of India, sponsored)	Use of natural resins and gums for preservation and value addition of fishery products.	Dr. PC Sarkar
Network Projects (ICAR, New Delhi sponsored)			
27.	3.2.026	Network project on Harvesting, processing and value addition of natural resins and gums.	Dr. N Prasad
28.	3.1.054	Network project on Conservation of lac insect genetic resources.	Dr. KK Sharma
29.	3.3.066	Network project on High value compounds and phytochemicals.	Dr. SKS Yadav

Publication and Publicity

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- Kumar Alok and Jaiswal AK (2015). Knowledge level of students via capacity building programme on scientific lac cultivation, processing, uses and their correlates. National Seminar on Extension Innovations and Methodologies for Market –Led Agricultural Growth & Development, RVSKV, Gwalior (MP), February 26-28, p. 242.
- Kumar Alok, Jaiswal AK and Patamajhi P (2015). Queries and expectation of lac farmers: An analysis. 17th Indian Agricultural Scientists and Farmer's Congress on Agri- Innovation for Enhancing Production & Rural Employment. Bioved Research Institute of Agriculture and Technology, Allahabad, February 21-22, p. 50.
- Kumar Alok, Jaiswal AK and Singh AK (2015). MTC: Knowledge enhancement of extension functionaries on advances in lac production, processing, product development and value addition & their socio-economic status. Global Science Congress 2015 on Management of Sustainable Livelihood Systems, OUAT, Bhubaneswar, February 14-17, p. 125.
- Lal SK, Tribhuvan KU, Sinha NK, Thamilarasi K, Meena SR and Kumari K (2015). Isolation and characterization of Rhizobacteria from rice grown in Jharkhand *vis-à-vis* evaluation of their plant growth promoting activity. National symposium on Germplasm to Genes: Harnessing Biotechnology for Food Security and Health, ICAR-NRCPB, New Delhi, August 9 – 11, p. 57.
- Lohot VD, Chowdhury AR, Thombare N, Thamilarasi K, Ghosh J, Mohanasundaram A, Gunjan and Sharma KK (2015). Deciphering the biochemical basis of flower colour variation in *palas* (*Butea monosperma* Lam) Taubert. 3rd International Plant Physiology Congress, JNU, New Delhi, December 11-14.
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- Sarkar PC (2015). Application of lac resin-based coating formulations for extending post harvest life of fruits and vegetables. 4th International Conference on Natural Polymers, Bio-polymers, Bio-materials and their Composites, MG University, Kottayam (Kerala), April 10 – 12.

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- Ghosal S and Meena SC (2015). Influence of application of macro-micro nutrients and liming in acid lateritic soils of Jharkhand for lac production on *Flemingia semialata*, p. 42-43.
- Ghosh J, Lohot VD, Singhal V and Ghosal S (2015). Additive main effect and multiplicative interaction (AMMI) analysis for *Kusmi* lac yield in *ber* varieties across years, p. 38.
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- Monobrullah Md, Mohanasundaram A, Meena SC, Verma S and Sharma KK (2015). Life cycle and productivity linked parameters of *rangeeni* summer lac crop under different climatic conditions, p. 45.
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- Ghosal S and Prasad N (2014) Safal lakh utpadak kishan. PathariKrishi, BAU, Ranchi January-December (Combined), 48 p.

- Jaiswal AK and Singh JP (2015). *Schleichera oleosa* and lac cultivation. Bulletin No. 06, ICAR-IINRG, Ranchi, 38 p.
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- Pandey SK, Srivastava S and Prasad N (2015). Good manufacturing practices for bleached lac Technical Bulletin No. 03, ICAR-IINRG, Ranchi, 24 p.
- Pandey SK, Prasad N, Sharma SC and Kar AK (2015). Good manufacturing practices for aleuritic acid. Technical Bulletin No. 04, ICAR-IINRG, Ranchi, 24 p.
- Pandey SK, Prasad N, Sharma SC and Kar AK (2015). Good manufacturing practices for seedlac. Technical Bulletin No. 05, ICAR-IINRG, Ranchi, 20 p.
- Prasad N, Srivastava S, Siddiqui MZ, Sarkar PC, Ansari MF, Yadav SKS, Sharma SC and Thombare N, (2015). Recent Technologies at a glance. Technical Bulletin No. 12, ICAR-IINRG, Ranchi, 40 p.
- Prasad N, Chhaya, Kar AK (2015). Network Project on Harvesting Processing and Value Addition of Natural Resins and Gums, Folder, ICAR-IINRG, Ranchi, 12 p.
- Sharma KK, Monobrullah Md, Mohanasundaram A and Ramani R (Eds.) (2015). Souvenir and book of abstracts, National Entomologists' Meet, February 5-7, ICAR-IINRG, Ranchi, p. 165 + xxvi.
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- Yogi RK, Bhattacharya A, Jaiswal AK and Kumar Alok (2015). Lac, plant resins and gums statistics 2014: At a glance. Technical Bulletin No.7 (ISSN No. IS- 2454-8782), ICAR-IINRG, Ranchi, p. 1-68.

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- Bhattacharya A and Yogi RK. Lac associated insect fauna, p. 20-24.
- Ghosal S. Management of major lac hosts and lac cultivation, p. 50-60.
- Jaiswal AK and Kumar Alok. *Kusmi* lac cultivation on *kusum* (*Schleichera oleosa)* and *ber* (*Ziziphus mauritiana),* p. 68-74.
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- Monobrullah Md, Mohanasundaram A and Verma S. *Rangeeni* lac cultivation on *palas* (*Butea monosperma*) and *ber* (*Ziziphus mauritiana*), p. 75-79.
- Pandey SK, Prasad N and Sharma SC. Processing of lac – seed lac, shellac, bleached lac and lac dye, p. 118–130.
- Prasad N. Implements for lac cultivation, p. 140-147.
- Prasad N. Small scale lac processing unit, p. 148-156.
- Sarkar PC. Value addition and its implications in lac, p. 157–161.
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- Srivastava S. Quality requirement and standards for natural resins and gums, p. 162-175.
- Thamilarasi K. Role of biotechnology for improvement of lac, p. 25-32.
- Yadav SKS and Giri SK. Post harvest care, handling and storage of lac, p. 113-117.
- Yogi RK, Kumar Alok and Singh AK. Socio-economic silhouette and value chain analysis: An overview of lac sector, p.188-197.
- Yogi RK, Singh AK and Kumar Alok. Endo and exogenous environmental aspects of natural resins production and distribution in India, p.198-206.

Popular Articles

- Bhat SS, Sharma KK and Meena SR (2015). Integrated farming for sustainability and development. Third Concept 29(5): 54-58.
- आलोक कुमार, अजय कुमार सिंह, राजकुमार योगी एवं आर एस राजपूत (2015)। छत्तीसगढ़ में लाख उत्पादनः वर्त्तमान स्थिति एवं संभावनाएं। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 13-15।
- आलोक कुमार, अजय कुमार सिंह एवं राजकुमार योगी (2015)। धान की खेती से संबंधित कहावतें। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 39-42।
- आलोक कुमार, अजय कुमार सिंह एवं राजकुमार योगी (2015)। योगासन एवं स्वास्थ्य। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 46-53।
- अजय कुमार सिंह, आलोक कुमार एवं अनिल कुमार जायसवाल (2015)। लाख की खेती-एक परिचय। गन्ना उत्पादन तकनीक (गन्ना खेती), पृष्ठ 32-34।
- किशोर यु त्रिभूवन एवं तमिलरसी के (2015)। जैव प्रौद्योगिकी से उन्नत पौधौं का जहरीलें तत्वों एवं यौगिकों का जमीन से निर्मूलन हेतु उपयोग। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 25-27।
- वैभव डी लोहोट एवं ज्योतिर्मय घोष (2015)। हिन्दू संस्कृति में पलास का महत्व। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 30-32।
- महताब ज़ाकरा सिद्दीक़ी (2015)। बॉस्वेलिया सेराटा, राल-गोंद के औषधीय उपयोग एवं उत्पाद। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 07-09।
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- मो. फहीम अंसारी (2015)। लाख का औषधीय उपयोग। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 10-12।
- नन्द किशोर ठोंबरे (2015)। सांप, खेती और पर्यावरण का महत्वपूर्ण घटक। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 43-45।

- निरंजन प्रसाद, छाया एवं अमित कुमार कर (2015)। प्राकृतिक गोंद के विभिन्न स्रोत। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 01-06।
- निरंजन प्रसाद, छाया एवं अमित कुमार कर (2015)। जेलान गोंद एक परिचय। लाक्षा, भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 16-20।
- Ramani R, Sharma KK, Monobrullah Md and Mohanasundaram A (2015). Harnessing desirable insects and managing undesirable insects: way forward in Indian agriculture. Current Science 109(12): 2179 – 2180.

Following reports were published on respective newspapers as news item during exploration visit of Mohanasundaram A and Lohot VD to Tamil Nadu

- IINRG scientists discover lac insect in Vellore region, *The New Indian Express*, November 2, 2015.
- Scientists find lac insects in Vellore, *The Hindu*, November 2, 2015.
- Lac insect from different trees is used for pharmaceutical purpose, *Dinakaran*, November 2, 2015.
- Discovered medicinal valued lac insect at Vellore, *Dinathanthi*, November 2, 2015.
- Discovered new insect at Vellore, *Dinamalar*, November 2, 2015.
- Discovered new lac insect at Vellore and Katpadi, *The Hindu (Tamil)*, November 2, 2015.

Institute Publications

- Souvenir and Book of Abstracts, National Entomologists' Meet, book, 165 p.
- Good manufacturing practices for aleuritic acid, booklet, 24 p.
- Good manufacturing practices for lac dye, booklet, 20 p.
- Good manufacturing practices for shellac, booklet, 24 p.
- Good manufacturing practices for seedlac, booklet, 20 p.
- Good manufacturing practices for bleachedlac, booklet, 24 p.
- Natural resins and gums ICAR-IINRG Newsletter, October-December 2014, 18(4), 8 p.
- Natural resins and gums ICAR-IINRG Newsletter, January-March 2015, 19(1), 8 p.
- Natural resins and gums, ICAR-IINRG Newsletter, April-June 2015, 19(2), 8 p.
- Natural resins and gums ICAR-IINRG Newsletter, July- September 2015, 19(3), 8 p.
- Lac handicraft, booklet, 30 p.
- Lac, plant resins and gums statistics---At a glance -2014, 68 p.
- *Kusum vrikch par lakh ki kheti*, booklet, 46 p.
- *Palas vrikch par lakh ki kheti*, booklet, 58 p.
- *Ber vrikch par lakh ki kheti*, booklet, 50 p.
- *Schleichera oleosa* and lac cultivation, booklet, 38 p.
- *Butea monosperma* and lac cultivation, booklet, 50 p.
- *Ziziphus mauritiana* and lac cultivation, booklet, 46 p.
- Advances in Lac Production, Processing, Product Development and Value Addition Model Training Course, book, 206 p.
- Multi-tier mixed lac host plantation, booklet, 32 p.
- Bleached lac, folder, 4 p.
- IINRG technologies---At a glance, booklet, 40 p.
- IINRG Annual Report, book, 142 p.
- Ms D Norris memorial lecture booklet on 'An Ecological Approach for Economic Development through Natural Resins and Gums', 12 p.
- Year planner-cum-Publicity Brochure, 2015, 28 p.
- Laksha, Rajbhasha patrika, 80 p.

Tours / Visits

- Sharma SC, Sc. visited ICAR – Central Institute of Agricultural Engineering, Bhopal regarding fabrication of integrated small scale lac processing unit and modification in the developed design as per requirement, January 05 – 19, 2015.

- Bhat SS, Sc. visited Rhorokocha, Mangubandh, Kharsidag and Deoghar for interaction-cum-socio-economic survey of farmers adopting lac based integrated farming system, January 19, 2015.
- Yadav SKS, Sc. visited Asni village in Gumla district and organized farmers training on 'Scientific tapping of natural gums, January 31, 2015.
- Ansari MF, Sr. Sc. visited NIRJAFT, Kolkata; Indian Institute of Packaging (IIP) Kolkata and surveyed market of Kolkata for availability and feasibility of packaging papers, nail polish bottles and colours etc., February 03-06, 2015.
- Ghosh J, Sr. Sc. visited Putadag village, Angarah block, Ranchi for pruning of *swadi palas* trees, February 12, 2015.
- Mohanasundaram A, Sc. visited Regional Sericulture Research Station, CSRTI, Chamarajanagar and farmer's field, Thumbla, T.N. Pura, Mysore for inoculation of summer season broodlac between mulberry plantation on *F. semialata* under IINRG-CSRTI collaborative project, February 13, 2015.
- Sarkar PC, Sr. Sc. visited ICAR-CIFT, Mumbai Center, Navi Mumbai and ICAR-CIRCOT, Mumbai for technical discussions pertaining to on-going research projects, February 26-27, 2015.
- Sarkar PC, Sr. Sc. visited Mumbai to attend Asia Coat & Ink Show 2015 & International Conference at Mumbai, February 28, 2015.
- Lohot VD, Sc. and Ghosh J, Sr. Sc. visited Putadag village, Angarah block, Ranchi for selection of *swadi palas* trees for pruning studies, March 13, 2015.
- Bhat SS, Sc. visited ICAR-RCER, RC, Palandu, Ranchi and interacted with scientists regarding integrated farming system and also procured seeds of cow pea, bitter gourd and tomato seedlings for research purpose, March 19, 2015.
- Lohot VD, Sc. visited Dumri and Majhidih village, Giridih (Jharkhand) for collecting flower sample of *palas* variants and identified 3 new *palas* variants, March 07 and also March 20-21, 2015.
- Monobrullah Md, Pr. Sc. visited ICAR-RCER, Patna for monitoring *kusmi* lac cultivation on *Flemingia semialata*, March 21, 2015.
- Sharma SC, Sc. visited ICAR – Central Institute of Agricultural Engineering, Bhopal regarding fabrication of integrated small scale lac processing unit and modifications as per requirement, April 06-18, 2015.
- Ansari MF, Sr. Sc. and Yadav SKS, Sc. visited M/s Chelat labs, Aluva, Cochin regarding technology of gasket shellac cement compound (the firm had taken the technology from ICAR-IINRG, Ranchi), April 09, 2015.
- Sarkar PC, Sr. Sc. and Ansari MF, Sr. Sc. visited ICAR-CIFT, Cochin for discussions on their on-going research projects, April 13, 2015.
- Thombare N, Sc. visited Kolkata to attend shellac safety study meeting with members of The European Shellac Association (TESA) and Jai Research Foundation (JRF), Vapi (Gujarat), April 16, 2015.
- Mohanasundaram A, Sc. visited ICAR-Central Tuber Crops Research Institute-Regional Center, Bhubaneswar, April 23, 2015.
- Yogi RK, Sc. visited Rajasthan area and interacted with the traditional bangle makers in Jaipur, Forest Department, Directorate of Economics and Statistics; Department of Agriculture, Govt. of Rajasthan, NIAM, Jaipur and Ajmer for data collection on NRGs., April 25 – May 09, 2015.
- Yadav SKS, Sc. visited M/s Gupta Brothers (Shellac) Pvt. Ltd. Bundu, Ranchi regarding current scenario in lac industry and isoambrettolide, April 28, 2015.
- Chowdhury AR, Sc. visited Sri Ram Gums and Chemicals and Sunita Hydrocolloids, Jodhpur (Rajasthan) regarding guar gum derivatives and their uses in industry, April 28-30, 2015.
- Yogi RK, Sc. visited Purulia, Dhanbad, Giridih, Bokaro, Ramgarh, Khunti, May 12-13, 2015.
- Thombare N, Sc. visited IARI, New Delhi regarding standardization of gum ghatti derivatization process for GC-MS analysis, May 25-31, 2015.
- Lohot VD, Sc. and Thombare N, Sc. conducted survey in the areas of Himachal Pradesh *viz*., Solan, Chail, Kufri, Kandaghat, Dharampur for lac insect/host plants availability and Dr. YS Parmar University of Horticulture & Forestry, Solan (H.P.) for photographs as also gum and resin tapping trials, May 30-June 05, 2015.

- Sharma SC, Sc. visited ICAR–Central Institute of Agricultural Engineering, Bhopal regarding fabrication of integrated small scale lac processing unit and improvement as per requirement, June 01 – 11, 2015.
- Chowdhury AR, Sc. visited lac processing factory of JHASCOLAMPF, Sidrol, Ranchi regarding its functioning etc., June 04, 2015.
- Kumar Alok, Sr. Sc. visited five locations of Baghia, Rania, Khunti district under monsoon preparedness programme, June 06, 2015.
- Yogi RK, Sc. and Sharma SC, Sc. visited Arki area to identify the site for establishment of SSLPU under Khunti Project, June 25, 2015.
- Yogi RK, Sc. and Patamajhi P, STO visited Assam to organize a workshop jointly with Mising Autonomous Council (MAC) on 'Lac cultivation on *ber* and further management practices' and monitoring the lac cultivation activities in NE region vis-a–vis field demonstration at *ber* plantation at three places of Dhemaji district of Assam, July 02-08, 2015.
- Pandey SK, Sc. visited Renshel Export Pvt. Ltd., Purulia to get familiarized with the process and machineries used in lac industry for DDL preparation, July 03, 2015.
- Kumar Alok, Sr. Sc., Singh AK, Sr. Sc. and Yogi RK, Sc. visited five locations of Hahap, Beradih villages of Ranchi district under '*Mera Goan Mera Gaurav* (MGMG)' programme, July 16, 2015.
- Yogi RK, Sc. visited Torpa, Khunti district with CEO, *Beej* India, IARI, New Delhi for assessment of needs for execution of the seed production project, July 20, 2015.
- Prasad N, Pr. Sc. & Head, PPD Division visited Arki block, Distt. Khunti, Ranchi for participation in inaugural programme of Small Scale Lac Processing Unit, July 21, 2015.
- Sarkar PC, Sr. Sc. visited ICAR-RCER, Patna in connection with ICAR Foundation Day Celebrations, July 24-26, 2015.
- Ghosal S, Pr. Sc. visited Mangubandh and Tati/ Singari for monitoring of inoculation at farmers' field for popularization of technology, July 27 and 30, 2015.
- Singh AK, Sr. Sc. visited Ramnujganj and Ramnagar, Balrampur (Chhattisgarh) for crop evaluation under 'Lac cultivation processing of microenterprise under *Swarn Jayanti Gram Swarojgar* special project', Chhattisgarh Government, July 29, 2015.
- Sarkar PC, Sr. Sc. and Ansari MF, Sr. Sc. visited lac processing unit, Bundu, Ranchi regarding making shellac from seedlac, August 7, 2015.
- Siddiqui MZ, Pr. Sc. visited BIT, Mesra, Ranchi for conducting FT-IR and DSC analysis of research samples, August 11, 2015.
- Sharma SC, Sc. visited Vishakhapatnam and participated in NTFP–EP Phillipines and Cambodia--Experience sharing on gums & resins production, processing and marketing organized by Kovel Foundation, August 15-19, 2015.
- Thombare N, Sc. visited IARI, New Delhi for GC-MS analysis and mass spectrometric characterization of ghatti and jhingan gum and also visited CERA, KAB-1, New Delhi, August 23-27, 2015.
- Ghosal S, Pr. Sc. visited Mangubandh and Tati/ Singari for monitoring of fertilizer application and lac insect settlement at farmers' field for popularization of technology, August 28-29, 2015.
- Monobrullah Md, Pr. Sc. visited SKUAST-Jammu for field visit and monitoring of work being done at Jammu centre under NP-CLIGR project, August 27- 30, 2015.
- Ansari MF, Sr. Sc. visited Tata Steel Jamshedpur regarding utilization of lac in coating applications on steel surfaces, August 29, 2015.
- Yogi RK, Sc., Kumar Alok, Sr. Sc. and Singh AK, Sr. Sc. visited Balrampur, Jagdalpur, Balod, Mahasmund, Kanker and Bilaspur for crop evaluation under 'Lac cultivation processing of microenterprise under *Swarn Jayanti Gram Swarojgar* special project', Chhattisgarh Government and to collect information on NRG and linkages with stakeholders, August 30-31, 2015.
- Sharma SC, Sc. visited Rania block, Khunti and participated in inaugural ceremony of newly established small scale lac processing unit (Capacity – 100 kg/day) under the project No. 2.3.039, August 31, 2015.

- Sharma SC, Sc. visited Kanker (C.G.) and delivered lecture on lac processing on small scale village level entrepreneurship at Lac Development and Extension Centre, Makri, Kanker (C.G.) under MSP scheme, September 22-25, 2015.
- Siddiqui MZ, Pr. Sc. and Chowdhury AR, Sc. visited Jaradih village (Block-Angarah, Distt.-Ranchi) under MGMG programme for interaction and generation of awareness amongst farmers, September 28, 2015.
- Sharma SC, Sc. visited Sarjamdih village, Ranchi and collected information under MGMG programme, September 28, 2015.
- Lohot VD, Sc. and Thombare N, Sc. visited Putadag village, Angarah block, Ranchi under MGMG programme and collected basic information about the village, September 28, 2015.
- Pandey SK, Sc. visited Beradih village, Namkum, Ranchi under MGMG programme for preparing bench mark survey report and list of farmer's for testing their soil samples, September 29, 2015.
- Ghosal S, Pr. Sc. visited Lupungdih and Tangerkela for monitoring of fertilizer application and lac insect settlement at farmers' field, September 30, 2015.
- Kumar Alok, Sr. Sc. and Yogi RK, Sc. visited Bankura for conducting an impact assessment study under 'Sustainable income generation through scientific lac cultivation' 2014-15 project sponsored by *Paschimanchal unnayan Parishad* (PUP), Bankura, West Bengal, September 30, 2015.
- Ghosh J, Sr. Sc. visited Putadag, Angarah block, Ranchi and organized meeting with farmers for *kusmi* lac production on *swadi palas,* October 7, 2015.
- Bhat SS, Sc. visited Pater, Deoghar, Goasaitoli, Kharsidagh, Mangubandh to survey the farmers' fields, October 12, 2015.
- Pandey SK, Sc. visited NASC complex, New Delhi for presentation of Extramural project proposal on 'Storage study of natural resin lac and gums of commercial Importance', October 27, 2015.
- Siddiqui MZ, Pr. Sc. and Chowdhury AR, Sc. visited Tamil Nadu Agricultural University (TNAU)-Forest College and Research Institute, Mettupalayam, Tamil Nadu for attending and presenting progress of the sub-projects in 7th CCM of Network Project on Harvesting Processing & Value Addition of Natural Resins & Gums, October 27-28, 2015.
- Ghosal S, Pr. Sc. visited Mangubandh for monitoring of fertilizer application and lac insect settlement at farmers' field and collected soil samples under MGMG programme, October 28, 2015.
- Siddiqui MZ, Pr. Sc., Yogi RK, Sc. and Chowdhury AR, Sc. visited Jaradih village (Block-Angarah, Distt.-Ranchi) under MGMG programme for collection of soil samples for testing for balanced fertilizer applications, November 3, 2015.
- Ghosh J, Sr. Sc. visited Deoghar under MGMG programme and discussed with farmers about importance of soil health card, November 7, 2015.
- Kumar Alok, Sr. Sc. visited Rosin & Turpentine Factory, Nahan, Sirmour for data collection, December 28, 2015.

Radio/ TV Talks

Expert	Topics of Radio Talk	Date of Broadcast
Dr. J Ghosh, Sr. Sc.	*Semialata par lah ki kheti.*	24.02.2015
Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division	How to save lac crop from high temperature and enemy insects.	25.4.2015
Dr. Md Monobrullah, Pr. Sc.	*Kamjor mansoon ki aasanka ke madhya najar kisanon ke liye sujhao.*	07.7.2015
Dr. J Ghosh, Sr. Sc.	*Ber ped par lah ki kheti.*	30.11.2015

Expert	Topics of Radio Talk	Date of Broadcast
Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division	Precautionary measure for harvesting of *kusmi* lac and marketing of broodlac.	15.12.2015

Expert	Topics of TV Talk	Date of Telecast
Dr. KK Sharma, Pr. Sc. & Head, LP Division	Integrated lac cultivation on *semialata* (Doordarshan Ranchi).	02.4.2015
Dr. Alok Kumar, Sr. Sc.	Lac production in NE region (DY 365 TV), Assam.	04.5.2015
Dr. AK Singh, Sr. Sc.	Plantation raising and lac cultivation on *Flemingia semialata* (ETV).	18.5.2015
Dr. KK Sharma, Pr. Sc. & Head, LP Division	*Lakh ka neunatam samarthan mulya* (Doordarshan Ranchi).	28.5.2015
Dr. Alok Kumar, Sr. Sc.	*Lakh ki Kheti* (Doordarshan Ranchi)	19.6.2015
Dr. S Ghosal, Pr. Sc.	Barsat ke mausam me lakh kit sancharan ke liye savdhania.	18.7.2015
Dr. AK Singh, Sr. Sc.	Plantation raising and lac cultivation on *Flemingia semialata* (ETV).	27.7.2015
Dr. AK Singh, Sr. Sc.	Lac inoculation on *Flemingia semialata* with *kusmi* brood (ETV).	07.8.2015
Dr. KK Sharma, Pr. Sc. & Head, LP Division	*Palas vriksh par lakh keet prabandhan* (Doordarshan Ranchi).	18.8.2015
Dr. AK Singh, Sr. Sc.	Crop care and management of *aghani* lac on *Flemingia semialata* (ETV).	05.10.2015
Dr. KK Sharma, Director (Actg.)	*Kusmi lakh ki labh prad kheti* (Doordarshan Ranchi).	06.10.2015
Dr. RK Yogi, Sc.	Employment generation and livelihood security through lac cultivation (Doordarshan Ranchi).	12.10.2015
Dr. A Mohanasundaram, Sc.	Discovery of lac insect and their host plants at Jawadhu and Yelagiri Hills of Tamil Nadu (Doordarshan Ranchi).	01.11.2015
Dr. Alok Kumar, Sr. Sc.	*Lakh parshikashan karykaram ki samasaye avum samadhan* (Doordarshan Ranchi).	05.11.2015
Dr. Md Monobrullah, Pr. Sc.	*Rangeeni lakh Kheti ki taknik avam labh* (Doordarshan Ranchi).	20.11.2015

Database

- National level database of the NRGs production and EXIM data has been generated and maintained at NRG Information Cell (NIC), TOT Division, ICAR-IINRG, Ranchi.
- A national level database of 1077 lac growers across the country has been prepared and maintained at NRG Information Cell (NIC), TOT Division, ICAR-IINRG, Ranchi.

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

By Director

- Attended Director's Conference, New Delhi, January 22-24, 2015.
- Convened & chaired Farm Management Committee meeting, ICAR-IINRG, Ranchi, April 07, 2015.
- Convened & chaired RFD Committee meeting, as Nodal Officer, RFD, ICAR-IINRG, Ranchi, April 28, 2015.
- Attended Governing Body meeting of Birsa Agricultural University Management Board, BAU, Ranchi, May 02, 2015.
- Attended interactive meeting of VCs and Directors, New Delhi, May 15-16, 2015.
- Convened & chaired Farm Management Committee meeting, ICAR-IINRG, Ranchi, June 29, 2015.
- Attended Mid-Kharif workshop at Dasokhap village (Mandu) organized by CRURRS, Hazaribagh and delivered a lecture on 'Lac cultivation on *ber*', September 07, 2015.
- Participated in discussion on 'Agricultural Policy of Jharkhand State' organized by Agriculture, Animal Husbandry and Cooperative Department, Government of Jharkhand, September 10, 2015.
- Examiner, M.Sc. (Biotechnology) (Practical), Ranchi University, Ranchi, September 22, 2015.
- Convened & chaired Farm Management Committee meeting, ICAR-IINRG, Ranchi, September 29, 2015.
- Chaired 73rd meeting of Institute Joint Staff Council, ICAR-IINRG, Ranchi, September 29, 2015.
- Participated in the selection process of SRF at Department of Pharmaceutical Sciences and Technology, Birla Institute of Technology, Mesra, Ranchi, as an external expert, October 27, 2015.
- Chaired meeting of Sports Contingent, ICAR-IINRG, for Sports Meet at ICAR-IVRI, Izatnagar, Bareilly (U.P.), November 11, 2015.
- Chaired Management Committee Review meeting for ISO:9000-2008 of Quality Evaluation Laboratory, ICAR-IINRG, Ranchi, November 18, 2015.
- Attended Research Advisory Committee meeting of Central Tasar Research and Training Institute, Nagri, Ranchi, as an external member, November 20-21, 2015.
- Attended Golden Jubilee Celebration of Green Revolution organized by National Academy of Agricultural Sciences and Indian Institute of Agricultural Sciences, New Delhi, November 27, 2015.
- Participated in a meeting with Deputy Commissioner, Hazaribagh in connection of land transfer for IARI-Jharkhand, December 03, 2015.
- Attended a meeting chaired by Hon'ble Minister of Agriculture for review of progress, Birsa Agricultural University, Ranchi, December 05, 2015.
- Attended Assessment Meeting under Career Advancement Scheme, ASRB, New Delhi, December 21, 2015.
- Chaired CHD 23 Meeting of Bureau of Indian Standards, New Delhi, December 28, 2015.
- Convened & chaired a number of meetings of all the scientists, ICAR-IINRG, Ranchi in connection with Mera Gaon Mera Gaurav (MGMG) Scheme and Soil Health Cards.

Lectures delivered

- Sharma KK (2015). Delivered a lecture on 'Lac integrated farming system' to M.Sc. (Agri.) students of BHU, Varanasi and Sam Higginsbottom Institute of Agricultural Sciences, Allahabad, June 06, 2015.

- Sharma KK (2015). Delivered a lecture on 'Broodlac farming, effect of climate on lac cultivation and their remedies' to trainee farmers for exposure visit from Purulia district under TERI programme at Institute of Forest Productivity, Ranchi, July 29, 2015.
- Sharma KK (2015). Delivered a lecture on 'Biotechnology and its potential applications with special reference to lac insects' at Biotechnology Department, Ranchi University, Ranchi, September 01, 2015.
- Sharma KK (2015). Delivered a lecture on 'Lac cultivation on *ber*' in Mid-Kharif workshop at Dasokhap village (Mandu) organized by CRURRS, Hazaribagh, Ranchi, September 07, 2015.
- Sharma KK (2015). Delivered a lecture on 'Natural resins and gums' to the participants of the programme on 'Innovative drug discovery approaches and emerging trends in neuropharmacology', Department of Pharmaceutical Sciences and Technology, Birla Institute of Technology, Mesra, Ranchi, December 18, 2015.

By Others

- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division participated in SAC meeting, KVK Saraikela, Kharsawan (Jharkhand), February 7, 2015.
- Dr. Md Monobrullah, Pr. Sc. attended Annual Review meeting, Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR), KFRI, Peechi, Thrissur (Kerala), March 10, 2015.
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division participated in SAC meeting, KVK Kodarma (Jharkhand), March 25, 2015.
- Dr. MZ Siddiqui, Pr. Sc. attended 2nd Indo-German workshop on Supra-molecular Chemistry, Department of Chemistry, University of Delhi, Delhi, March 30, 2015.
- Dr. RK Yogi, Sc. attended a meeting with delegates from Asian Paints for Corporate Social Responsibility (CSR) project to promote the domestic consumption of lac based products and enhancing the livelihood security options through lac cultivation, April 01, 2015.
- Dr. AK Singh, Sr. Sc. attended a meeting with Deputy Commissioner and DPO, Khunti for extension of MOU of Khunti Project- Lac (Culture) Cultivation and Processing Unit Establishment, April 07, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division participated in workshop on Making Engineering Scientists contribution more meaningful to stake holders and the Nation, NASC complex, New Delhi, April 13-14, 2015.
- Dr. N Prasad, Pr. Sc. & Head PPD Division participated in meeting on shellac safety study with members of The European Shellac Association, representatives from ICAR-IINRG, Ranchi and Jai Research Foundation, Kolkata, April 16, 2015.
- Er. SK Pandey, Sc. and Dr. RK Yogi, Sc. attended and showcased the Institute technologies jointly with JASCOLAMPF in the Food Processing Investors Summit on 'Advantage Jharkhand' organized by Department of Industry, Government of Jharkhand, April 22-23, 2015.
- Dr. AK Singh, Sr. Sc. attended Scientific Advisory Committee meeting of Divyayan KVK, Ranchi, May 06, 2015.
- Dr. RK Yogi, Sc. attended a meeting with the Development Commissioner, Ranchi and Secretary Cooperatives, Govt. of Jharkhand for RKVY Project, May 07, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division participated in Director's Conference, NASC complex, New Delhi, May 15-16, 2015.
- Dr. RK Yogi, Sc. participated in the consultation programme on Policy Perspectives and State Response to Agrarian Crisis and Farmers Distress organised by NIRD, Hyderabad, May 21-22, 2015.
- Er. SK Pandey, Sc. participated in 4th Annual Review workshop, NASF (NFBSFARA, NASC complex, New Delhi, May 28-29, 2015.
- Dr. S Ghosal, Pr. Sc. participated in workshop on Agriculture, greening, training, capacity building and income generation programme, Institute of Forest Productivity, Lalgutwa, Ranchi, June 18-19, 2015.

- Dr. AK Jaiswal, Pr. Sc. & Director (Actg.) represented the Institute at launch workshop for introduction of lac cultivation in Goa at Don Bosco Farm, Sulcorna organised by Kadamba Foundation and Ritumbara Environment Society, June 24, 2015.
- Dr. AK Jaiswal, Pr. Sc. & Director (Actg.) attended a meeting in office of *Paschimanchal Unnayan* Affair, Govt. of West Bengal at Kolkata with Secretary in respect of consultancy for impact analysis of on-going project on lac cultivation in Purulia, Bankura and Midnapur districts of West Bengal, June 29, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division; Dr. AK Singh, Sr. Sc.; Er. SK Pandey, Sc. and Dr. SC Sharma, Sc. participated in 87th Foundation Day / Award Ceremony and National Conference, KVK, Patna, July 25-26, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division participated in IMC meeting, IASRI, New Delhi, August 01, 2015.
- Dr. RK Yogi, Sc. participated in workshop of Nodal Officers of ICAR Research Data Repository for Knowledge Management Initiatives held at NASC complex, New Delhi August 04-05, 2015.
- Er. SK Pandey, Sc. participated in ork shop on MSP on lac, Govt. of India programme, JHASCOLAMPF, Ranchi, August 18, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division participated in IMC meeting of NIRJAFT, Kolkata, August 28, 2015.
- Dr. SKS Yadav, Sc. attended Review meeting, Network Project titled, 'High Value Compounds and Phytochemicals' ICAR-Indian Institute of Spices Research, Kozhikode, September 07, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division participated in a meeting in Project Bhawan, Dhurwa relating to Jharkhand Agriculture Policy, September 10, 2015.
- Sri N Thombare, Sc. attended a meeting regarding shellac safety study held in presence of Dr. S Ayyappan, DG, ICAR; Dr. Alagusundaram, DDG (Engg) and Dr. KK Singh, ADG (Engg), ICAR-IARI, New Delhi, October 20, 2015.
- Dr. AK Singh, Sr. Sc. attended a meeting on MGMG and Soil Health Card, chaired by DDG (AE) at ATARI, Kolkata, November 01, 2015.
- Dr. Alok Kumar, Sr. Sc. participated in workshop on Developing strategies for improvement of the technical, extension and demonstration services to the farmers of eastern hill and plateau region jointly organized by ICAR-Agriculture Technology Application Research Institute, Jabalpur (M.P.) and ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar (Odisha), November 23, 2015.
- Dr. Saurabh Swami , Sc. and Sri Mohd Ali, Sc. participated in workshop on 'Polymer & chemical based industries PCBI' organized by Khadi and Village Industries Commission, Ministry of MSME, Govt of India, Ranchi, November 23, 2015.
- Dr. S Ghosal, Pr. Sc. participated in Vigilance Officers' meet, Agartala (Tripura), November 27, 2015.
- Dr. AR Chowdhury, Sc. participated in 3rd International Plant Physiology Congress on Challenges and Strategies in Plant Biology Research (3rd IPPC 2015), New Delhi, December 11-14, 2015.
- Dr. AK Singh, Sr. Sc. participated in one-day workshop on Improving Development Programmes in Tribal Areas organized by Welfare Department, Govt. of Jharkhand & World Bank, BNR Chanakya Hotel, Ranchi, December 18, 2015.
- Dr. Alok Kumar, Sr. Sc. participated in International Conference on Agriculture, Horticulture & Plant Sciences, Shimla (H.P.), December 26-27, 2015.

Human Resource Development

- Dr. PC Sarkar, Sr. Sc. attended training programme for ISO: 9000 Certification, ICAR-IINRG, Ranchi, January 15, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division attended training programme for ISO: 9000

Certification, ICAR-IINRG, Ranchi, May 18-19, 2015.

- Sri Mohd Ali, Sc. completed three month professional attachment training at Department of Organic Chemistry, Indian Institute of Science, Bangalore, June 15 to September 14, 2015.
- Dr. MZ Siddiqui, Pr. Sc. and Dr. AR Chowdhury, Sc. attended 10-day training on Advances in Nanotechnology, ICAR-CAZRI, Jodhpur (Raj.), July 21-30, 2015.
- Dr. SKS Yadav, Sc. attended short course on Smart agro-input delivery approaches based on hydrogels and other polymeric carriers for improved crop health and productivity, Division of Agricultural Chemicals, ICAR-IARI, New Delhi, July 21-30, 2015.
- Dr. PC Sarkar, Sr. Sc. and Dr. Alok Kumar, Sr. Sc. attended training programme on Analysis of experimental data, ICAR-NAARM, Hyderabad, August 17-22, 2015.
- Dr. RK Yogi, Sc. attended training programme on Analysis of experimental data, ICAR-NAARM, Hyderabad, September 06 -14, 2015.
- Sri N Thombre, Sc. successfully completed course work relating to Ph.D. programme at Applied Chemistry Division, BIT, Mesra, Ranchi, September 15, 2014 to March 13, 2015.
- Dr. J Ghosh, Sr. Sc. attended training programme on Quantitative techniques for analysis of breeding experiments, ICAR-NAARM, Hyderabad, November 02–07, 2015.
- Dr. MZ Siddiqui, Pr. Sc. attended 12-day Management Development Programme on Leadership Development (a pre-RMP Programme), ICAR-NAARM, Hyderabad, November 30 to Dec. 11, 2015.
- Dr. S Swami, Sc. completed three month professional attachment training at Organic Chemistry Division, CSIR-National Chemical Laboratory, Pune, December 14, 2015 to March 14, 2016.

Honours, Awards and Recognitions

- Dr. A Mohanasundaram, Sc. was given best poster presentation award for the paper entitled, 'Reproductive isolation between lac insect species, *Kerria lacca* and *K. chinensis*', International Conference on 'Innovative Insect Management Approaches for Sustainable Agro Eco System', Department of Agricultural Entomology, Agricultural College and Research Institute, Madurai, TNAU (Tamil Nadu), January 27-30, 2015.
- Dr. Alok Kumar, Sr. Sc. was conferred Young Scientist Associate Award-2015 by Bioved Research Institute of Agriculture & Technology, Allahabad, February 21-22, 2015.
- Dr. Alok Kumar, Sr. Sc. was conferred Young Scientist Award by Indian Society of Extension Education, New Delhi at Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior (M.P.), February 26-28, 2015.
- Dr. Thamilarasi K, Sc. was given best oral paper presentation award for the paper entitled, 'Identification of the endosymbiotic bacteria from the Indian lac insect, *Kerria lacca* (Kerr.)', International Symposium on 'New Perspectives in Modern Biotechnology', Puducherry, March 23– 25, 2015.
- Dr. MZ Sidiqui, Pr. Sc. continued as Member, Technical Editorial / Advisory Board of 'Krishak Vandana' published from Jabalpur (M.P.), since March, 2012.
- Dr. PC Sarkar, Sr. Sc. chaired one technical session and Dr. SKS Yadav, Sc. chaired two technical sessions during 4th International Conference on 'Natural Polymers, Bio-polymers, Bio-materials and their Composites' MG University, Kottayam (Kerala), April 10–12, 2015.
- Dr. J Ghosh, Sr. Sc. was nominated External Expert Member of Research Advisory Committee for Forest Genetics discipline, FRI University, Dehradun, April 23, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division was Examiner for M. Tech. (Farm Machinery and Power) Project Thesis, Department

of Agricultural and Food Engineering, IIT, Kharagpur and conducted viva-voce examination of eight students, May 02-04, 2015.

- Dr. N Prasad, Pr. Sc. & Head, PPD Division was Examiner for M. Tech. (Agricultural Process Engineering) Project Thesis, College of Agricultural Engineering and Technology, OAUT, Bhubaneshwar and conducted viva-voce examination of four students, May 29-31, 2015.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Editorial Board, Research Journal of Chemistry and Environment, an International Monthly Online NAAS Indexed Journal, since June, 2014.
- Dr. AK Singh, Sr. Sc. was given best oral paper presentation award for his two papers entitled, 'Effect of fortified lac mud application on growth and flower production of rose' and 'Impact of lac cultivation on economic strengthening of tribal women', IJTA 1st International Conference on 'Agriculture and Horticulture Sciences, International Journal of Tropical Agriculture' and Serials Publications Pvt. Ltd., New Delhi, June 6-7, 2015.
- Dr. MZ Siddiqui, Pr. Sc. was awarded First Prize in Antakshari Competition during Rajbhasha Celebrations in the Institute, September 09, 2015
- Er. SK Pandey, Sc. received Distinguished Worker Award-2015, ICAR-IINRG, Ranchi under Scientific Category, September 21, 2015.
- Dr. Alok Kumar, Sr. Sc. was given best paper presentation award for his two papers entitled, 'Impact of special project on lac cultivation & processing in the Mahasamund divisional forest area of Chhattisgarh under Swarnjayanti Gram Swarozgar Yojana (SGSY)' and 'Queries and expectations of lac farmers under one to one programme: An analysis', International Conference on 'Agriculture, Horticulture & Plant Sciences', Shimla (H.P.), December 26-27, 2015.
- Sri SS Bhat, Sc. was awarded Doctorate of Philosophy (Forestry) Forest Genetic Resources by Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), December 31, 2015.
- Dr. A Mohanasundaram, Sc. was conferred Fellow Member of the Entomological Society of India, ICAR-IARI, New Delhi, December 31, 2015.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division was nominated Associate Editor, Journal of Agricultural Engineering, published by Indian Society of Agricultural Engineers, New Delhi.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division was nominated Member, IMC, NIRJAFT, Kolkata; CIAE, Bhopal and IASRI, New Delhi.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division continued as Coordinator of Network Project on 'Harvesting, Processing and Value Addition of Natural Resins and Gums'.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division continued as General Secretary, Society for Advancement of Natural Resins and Gums, ICAR-IINRG, Ranchi.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division was Member, Executive Committee, The Institution of Engineers (India), Jharkhand State Chapter (elected for the period 2014-15 to 2015-16).
- Dr. S. Srivastava, Pr. Sc. was elected as Vice-President, East Zone, Executive Council of Society of Pesticide Science, India for a period of three years.
- Dr. MZ Siddiqui, Pr. Sc., continued as Member, Editorial Board, World Journal of Pharmaceutical Sciences, since 2013.
- Dr. MZ Siddiqui, Pr. Sc. was nominated Reviewer of 'Arid Land Research and Management'; 'Pharmaceutical Biology'; Journal of Essential Oil bearing Plants' and 'Research Journal of Chemistry & Environment' all NAAS indexed International Journals.
- Dr. PC Sarkar, Sr. Sc. continued as Reviewer of Asian Journal of Dairy and Food Research, Karnal.

- Dr. PC Sarkar, Sr. Sc. continued as Reviewer for J. Indian Chemical Society, Kolkata.
- Dr. RK Yogi, Sc. has been nominated Editorial Board Member of two International Journals (International Journal of Agricultural Sciences and Journal of Agricultural Science and Technology).
- Dr. AK Singh, Sr. Sc. continued as Editor-in-Chief of Agrica- An International Journal of Plant Science and Related Industries.
- Dr. MF Ansari, Sc. was appointed as Examiner for conducting viva voce exam of B. Tech. students, BIT, Mesra, Ranchi.
- Dr. MF Ansari, Sc. was nominated Reviewer, International Journal 'Pigment & Resin Technology', UK.

Capacity Building / Lectures / Talk Delivered

- Dr. N Prasad, Pr. Sc. & Head, PPD Division; Dr. S Srivastava, Pr. Sc.; Dr. MZ Siddiqui, Pr. Sc.; Dr. MF Ansari, Sr. Sc.; Dr. SKS Yadav, Sc.; Dr. RK Yogi, Sc.; Dr. SC Sharma, Sc.; Dr. VD Lohot, Sc.; Dr. AR Chowdhury, Sc. and other participated and presented their papers in city level Hindi Sangosthi on 'Medicinal uses of natural resins and gums', ICAR-IINRG, Ranchi, January 09, 2015.
- Er. SK Pandey, Sc. imparted training on aleuritic acid to Sri Roshan Khalkho, Ranchi, January 12-21, 2015.
- Er. SK Pandey, Sc. delivered a lecture on लाख प्रसंस्करण के उन्नत उपकरण and demonstration of small scale lac processing unit, TOT training programme, January 15, 2015.
- Dr. Alok Kumar, Sr. Sc. and Dr. AK Singh, Sr. Sc. organized Research-extension-farmer-interface meeting-cum-workshop on lac cultivation, as Co-conveners, in joint collaboration with SEET, Rourkela at Kuchaita (Rourkela), Sundergarh (Odisha), January 22, 2015**.**
- Dr. Thamilarasi K, Sc. imparted training to B.Tech (Biotech) student on topic, 'Cox1 PCR based identification of lac insect species', February 09, 2015 to April, 24, 2015.
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division and Dr. Alok Kumar, Sr. Sc. organized an attachment programme for IAS officer trainees 2014 batch, ICAR-IINRG, Ranchi, February 12, 2015.
- Er. SK Pandey, Sc. imparted training on aleuritic acid to Mr. Sagar Parekh, M/s Serena Chemicals, Mumbai, February 16-25, 2015.

Following lectures were delivered during one week training programme for the RA/SRFs working at different centers of Network project on 'Conservation of Lac Insect Genetic Resources (NP-CLIGR)', ICAR-IINRG, Ranchi:

- Dr. Md Monobrullah, Pr. Sc. delivered a lecture on Lac insect and its life cycle, February 24, 2015.
- Dr. S Ghosal, Pr. Sc. delivered a lecture on Nutritional management and agronomic practices for lac cultivation, February 25, 2015.
- Dr. J Ghosh, Sr. Sc. delivered a lecture on Lac cultivation on potential host especially *Cajanus cajan*, February 25, 2015.
- Dr. Md Monobrullah, Pr. Sc. delivered a lecture on *Rangeeni* lac cultivation on *palas* and *ber* trees, February 27, 2015.
- Er. SK Pandey, Sc. delivered a lecture on Processing of lac, February 27, 2015.
- Dr. SS Bhat, Sc. delivered lectures on Importance of lac integrated farming system & Raising and management of lac host plantations, February 27, 2015.
- Dr. MF Ansari, Sr. Sc. delivered lecture-cum-demonstration on Diversified uses / applications of lac, February 27, 2015.

Following lectures were delivered to the students of M.Sc. (Forestry) from Guru Ghasidas Central University, Bilaspur (Chhattisgarh) under 'Industrial Training on Natural Resins & Gums' organized by TOT Division, ICAR-IINRG, Ranchi, February 16-28, 2015:

- Dr. Md Monobrullah, Pr. Sc. delivered a lecture on Impact of climate change on lac production, February 20, 2015.

- Dr. SS Bhat, Sc. delivered lectures on Genetic improvement in resin and gum producing trees and Lac integrated farming system, February 20, 2015.
- Dr. S Srivastava, Pr. Sc. delivered lectures on Industrial aspects of quality control for natural resins and gums & Application of guar gum in food and pharmaceutical industry, February 21 & 25, 2015.
- Dr. MF Ansari, Sr. Sc. delivered a lecture on Industrial uses of lac, February 23, 2015.
- Dr. SC Sharma, Sc. delivered a lecture on Processing of lac at small scale –village level entrepreneurship and demonstrated small scale lac processing, February 23, 2015.
- Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of gums and oleo gum-resins, February 25, 2015.
- Dr. AK Singh, Sr. Sc. delivered a lecture on Raising and management of lac host trees, February 25, 2015.
- Dr. SC Sharma, Sc. delivered a lecture on Harvesting and tapping techniques for gums, February 25, 2015.
- Dr. Alok Kumar, Sr. Sc. delivered a lecture on Prospects for scientific lac and resins production in eastern plain at eastern zone. Regional Agriculture Fair, CPRS, Patna, February 19-21, 2015.
- Dr. AK Singh, Sr. Sc. delivered a lecture during *kisan gosthi* on lac cultivation at Johna (Angara), Ranchi, March 03, 2015**.**
- Dr. SC Sharma, Sc. delivered lecture on sustainable harvesting and uses of gums and resins under farmers training programme of livelihood generation through sustainable utilization of NTFPs, Institute of Forest Productivity, Ranchi, March 09-14, 2015.

❋ Dr. Thamilarasi K, Sc. imparted training to M.Sc. (Biotech) student on Molecular cloning and characterization of farnesyl diphosphate synthase (FPPS) gene in Indian lac insect *K. lacca* (Kerr), March 20, 2015 to September 11, 2015.

❋ Er. SK Pandey, Sc. delivered two lectures on लाख प्रसंस्करण के उन्नत उपकरण एवं लाख चौरी उत्पादन की लघु इकाई and demonstration of 'Small scale lac processing unit, TOT training programme, April 08 & 16, 2015.

❋ Er. SK Pandey, Sc. imparted training on lac dye to Sri D Radhakrishnan, M/s Digitex Colour Solution, Salem (Tamil Nadu), April 13-19, 2015.

❋ Er. SK Pandey, Sc. imparted training on aleuritic acid to Sri Vivek Agrawal, M/s Ganga Lac Factory and Sri Anil Kr Saraogi, M/s Jagdamba Lac Udyog, Khunti (Ranchi), April 22 to May, 01, 2015.

Dr. AK Singh, Sr. Sc. organized HRD programme on lac promotion and development for the executives of NEH region, as Co-convener, TOT Division, ICAR-IINRG, April 27-29, 2015 and following lectures were delivered:

- Dr. Alok Kumar, Sr. Sc. and Dr. AK Singh, Sr. Sc. delivered lecture on Lac cultivation on *Flemingia semialata:* Plantation raising and cultivation practices and Contract farming, April 27, 2015.
- Dr. RK Yogi, Sc. delivered a lecture on Economics and marketing aspects of lac cultivation, April 27, 2015.
- Er. SK Pandey, Sc. delivered a lecture on Processing, value addition and entrepreneurship development, April 29, 2015.

❋ Er. SK Pandey, Sc. imparted training on aleuritic acid and lac dye to Sri Krishnendu Dutta, Kalyani, Nadia (West Bengal), June 01-10, 2015.

❋ Dr. AK Singh, Sr. Sc. organized 7th Summer Students workshop on Natural resins and gums, as Co-convener, TOT Division, ICAR-IINRG for students from Banaras Hindu University, Varanasi and Higginbotton Institute of Agriculture, Technology and Sciences, Allahabad (U.P.), June 02-11, 2015.

❋ Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division delivered lecture on storage of sticklac / seedlac, quality evaluation of sticklac and ways to increase productivity of lac, MSP programme, Bilaspur and Kanker (Chhattisgarh), June 02 and 04, 2015.

- Dr. AK Singh, Sr. Sc. delivered lectures on Intensive lac cultivation on bushy lac host (*Flemingia semialata*) & Raising and management of lac host trees in 7th Summer student workshop on Natural resins and gums, June 03, 2015.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on Quality parameters of seedlac/shellac to the lac growers/farmers in MSP workshop, Saraikela-Kharsawa, Ranchi, June 06, 2015.
- Dr. Alok Kumar, Sr. Sc. organized an off campus motivational training cum-monsoon preparedness session in Baghia Village of Rania Block , Khunti, Ranchi, June 06, 2015.
- Er. SK Pandey, Sc. delivered lecture-cum-demonstration on lac dye, bleached lac, aleuritic acid and processing of lac to small scale-village level entrepreneurs, June 08 & 11, 2015.
- Dr. S. Srivastava, Pr. Sc. delivered lecture on Industrial aspects of quality control for natural resins and gums to B.Sc. (Ag) students from Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, June 20, 2015.
- Dr. Alok Kumar, Sr. Sc. delivered a lecture on Formation of lac producers during technical session of workshop on 'Formation of lac producers federation' organized by Ramakrishna Mission Ashrama, Ranchi, June 26, 2015.
- Dr. Alok Kumar, Sr. Sc. organized MGMG programme, ICAR-IINRG, Ranchi, July 16, 2015.
- Dr. S Ghosal, Pr. Sc. delivered a lecture on Lac host management and raising of plants to the trainee farmers for exposure visit from Purulia district, TERI programme, Institute of Forest Productivity, Ranchi, July 29, 2015.
- Dr. RK Yogi, Sc. delivered a lecture on Economic aspects of lac cultivation, processing and value addition, RKMVU, Ranchi, August 19, 2015.
- Dr. AK Singh, Sr. Sc. participated and put up Institute stall in Agricultural Exhibition organized by ICAR at Piprakothi, Motihari, Bihar on the eve of inauguration of a new ICAR Institute (ICAR-National Research Centre on Integrated Farming System), Bihar, August 20-21, 2015.
- Er. SK Pandey, Sc. imparted training on aleuritic acid to Sri Roshan Tirky, Bano, Simdega, Ranchi, August 24 to September 02, 2015.
- Dr. SC Sharma, Sc. delivered lecture on lac processing to small scale village level entrepreneurs, Lac Development and Extension Centre, MSP scheme, Makri, Kanker (Chhattisgarh), September 22-25, 2015.
- Dr. SKS Yadav, Sc. delivered a lecture on Hydrogel amendments to soil for improving water productivity in Winter school, 'Recent advances in enhancing the water productivity in hill and plateau region', ICAR-Research Complex for Eastern Region, Research Centre, Ranchi, September 29, 2015.
- Dr. S Ghosal, Pr. Sc. organized and delivered a lecture-cum-demonstration on soil sample collection and its importance under MGMG programme at Mangubandh, Ranchi, September 30, 2015.
- Dr. A Mohanasundaram, Sc. delivered lecture on Lac insect life cycle, crop cycle and lac related terminology during training course on Advances in lac production, processing, product development and value addition, TOT Division, ICAR-IINRG, Ranchi, October 05, 2015.
- Dr. SC Sharma, Sc. delivered/recorded a talk on Gramin istar per lakh prasanskaran ewam udhymita on October 05, 2015 which was telecast under Krishi Darshan programme, DD National, October 16, 2015.
- Dr. S Ghosal, Pr. Sc. delivered three lectures on Nutritional management and agronomic practices for lac hosts, Lac cultivation on *F. semialata* & *Kusmi* lac cultivation on *kusum* and *ber* trees during Orientation training for newly joined scientist, LP Division, ICAR-IINRG, Ranchi, October 16, 2015.

- Dr. A Mohanasundaram, Sc. delivered lecture on Insects pests of lac and their management and climate change and lac performance during Orientation training for newly joined scientist, LP Division, ICAR-IINRG, Ranchi, October 17, 2015 and October 23, 2015.
- Er. SK Pandey, Sc. imparted training on bleached lac and Dr. SC Sharma, Sc. on lac processing to Sri Akash Gavel, Jangir-Champa (Chhattisgarh), October 28 to November 06, 2015.
- Dr. PC Sarkar, Sr. Sc. delivered a talk on Polymer and chemical based MSME industries in workshop on 'Polymer & chemical based industries PCBI' organized by Khadi and Village Industries Commission, Ministry of MSME, Govt of India, Ranchi, November 23, 2015.
- Dr. AR Chowdhury, Sc. delivered a lecture on Laboratory safety requirements under Good Laboratory Practices during one day Hindi workshop, ICAR-IINRG, Ranchi, November 26, 2015.
- Dr Alok Kumar, Sr. Sc. and Dr. AK Singh Sr. Sc. organized a National workshop on Current trends in lac production on *Flemingia semialata* and sustainable lac production strategies, as Co-conveners, in which 37 participants from Gujarat and Chhattisgarh participated, November 26-27, 2015.
- Dr. SS Bhat, Sc. delivered a lecture on Agronomic practices for raising plantation of *semialata* in the National workshop on 'Current trends in lac production on *Flemingia semialata* and sustainable lac production technologies' November 27, 2015.
- Dr. SS Bhat, Sc. delivered a lecture on Principles and practices of tree improvement in the monthly seminar of Lac Production Division, ICAR-IINRG, Ranchi, November 30, 2015.
- Dr. S Ghosal, Pr. Sc. delivered a lecture on Soil health and nutrient management in Jharkhand on World Soil Day, ICAR-IINRG, Ranchi, December 05, 2015.
- Dr. Alok Kumar, Sr. Sc. facilitated to generate and distributed a total of 251 Soil Health Cards (SHC) to the farmers of Khunti district on the occasion of World Soil Day, December 05, 2015.

Events - 2015

4th Technology Fortnight-2015

ICAR-IINRG Ranchi celebrated 4th Technology Fortnight on 'Advanced Technologies on Natural Resins and Gums' during January 19 to February 2, 2015. During the fortnight, two master training programmes were conducted for the farmers of Jharkhand. Also, demonstration on scientific tapping of *Karaya* Gum at Asni village, Gumla was done. Research-Extension-Farmer-Interface Meeting-cum-Workshop on lac cultivation was organized at Kuchaita, Sundergarh in Odisha. Product demonstration training on Aleuritic acid, Field Day, Farmers Workshop and *Kisan Gosthi* were also organized during the programme. An awareness–cum-educational programme for the graduate students of St. Joseph College, Torpa, Khunti was organized.

During this programme about 2065 stakeholders including farmers, master trainers, government officials, NGO personnel, industrialists, processors, traders, exporters, graduate and school students got benefited. Sri Ram Kumar Pahan, MLA, Khijri, Ranchi was the Chief Guest of the dosing ceremony held on February 2, 2015. The details of the different activities conducted during fortnight are as under:

Sri Ram Kumar Pahan addressing the gathering

Sl. No.	Programme	Sponsor/Collaborator	Duration	Place	No. of Participants
1.	Master Trainer's Training (One-week; 2 No.)	Tribal Welfare Dept. Ranchi	January 19-24, 2015; January 27-31	IINRG, Ranchi	71
2.	Kisan Mela-cum-Exhibition	IINRG, Ranchi	January 29, 2015	IINRG, Ranchi	900
3.	NEH Lac Promotion Activity	AIE Valley Producer & Allied Agro Marketing Co-op Society Ltd	January 22-25, 2015	IINRG, Ranchi	8
4.	Lac Cultivation tools/ kits Distribution Flagship Programme	ICAR, New Delhi	January 24, 2015	IINRG, Ranchi	8
5.	Field Day	Mahila Vikas Kendra Torpa , (Khunti)	January 31, 2015	Torpa (Khunti)	50
6.	Demonstration of Scientific tapping and collection of natural gums	Villagers from Asni, Gumla	January 31, 2015	Asni, Gumla	20
7.	Training on Aleuritic Acid	Shri Roshan Khalkho, Ashokpuram, Ranchi	January 12-21, 2015	IINRG, Ranchi	1
8.	Research-Extension-Farmer-Interface Meeting-cum Workshop on lac cultivation	SEET, Rourkela, Odisha	January 22, 2015	Kuchaita, Sundergarh	102

Sl. No.	Programme	Sponsor/Collaborator	Duration	Place	No. of Participants
9.	Field Visit-cum- Interaction (TSP Activity)	SEET, Sundergarh, Odisha	January 23, 2015	Hathihuda, Kendughat, Sargigarh, Kuchauta, Sundergarh	50
10.	Farmer's Workshop	Torpa Rural Development Society for Women, Torpa (Khunti)	January 23, 2015	Torpa (Khunti)	155
11.	Kishan Goshthi	Goonj Parivar, Silli, Ranchi	January 31, 2015	Silli, ranchi	300
12.	Educational Programme for Students	St Joseph College, Torpa (Khunti)	January 31, 2015	Torpa (Khunti)	400

Exhibition-cum-*Kisan mela* Organised in the Institute

Annual Exhibition-cum-*Kisan Mela* 2015 was organised in the Institute on January 29, 2015. Sri Ram Tahal Choudhary, Hon'ble MP, Ranchi was the Chief Guest and Dr Jitu Charan Ram, Hon'ble MLA, Kanke was the Guest of Honour on the occasion. Dr. N Krisnamurthy, Chairman, RAC, ICAR-IINRG Ranchi and Smt Arti Kujur, Member, Zila Parishad were the prominent persons who attended the *Mela* besides several dignitaries from the state, lac industrialists and entrepreneurs. Around 750 farmers from different states mainly Jharkhand, Chhattisgarh, Madhya Pradesh and West Bengal participated in the programme.

Addressing the mela Chief Guest Sri Ram Tahal Choudhary complimented the contribution of IINRG and appreciated the role of farmers in the development of country. He also highlighted the importance of *Mahila* society and SHGs to boost the lac production in the states. In his speech, the Guest of Honour, Dr. Jitu Charan Ram stressed upon the increase of lac production and said that it is good alternative for enhancing the income of the farmers of Jharkhand. In his welcome address, Dr. R Ramani, Director, ICAR-IINRG highlighted the progress and activities of the Institute and said that Jharkhand is leading state in the country in the lac production and this position should be maintained. Dr. N Krisnamurthy and Smt Arti Kujur also addressed the gathering. Around 30 stalls were put up by the various govt. and non-government organizations and progressive farmers. The farmers also visited Institute museum and Institute Research Farm and *Kisan gosthi* was also organized for redressal of problem of farmers. On this occasion seven farmers, entrepreneurs and executives were felicitated for their remarkable contribution in lac sectors which are as under.

Sri Ram Tahal Choudhary visiting the stall

Sri Ram Tahal Choudhary addressing the gathering

Award Categories	Awardees
Excellent Lac Farmer Award	Sri Mahetar Das, Sarguja (Chhattisgarh). Sri Dhan Singh Temare, Seoni (MP). Sri Namjan Topno, Khunti (Jharkhand).
Excellent Lac Production Entrepreneurship Award	Sri Alok Kumar Mahto, Purulia (WB). Sri Subodh Prasad, Ranchi (Jharkhand).
Excellent Lac Promotion Executive Award	Sr. Daphne Sequeira, Director, Torpa Rural Development Society for Women, Torpa, Khunti (Jharkhand).
Excellent Lac Industrialist Award	M/s National Enterprises, Ranchi (Jharkhand).

The inaugural programme was conducted by Dr. Anjesh Kumar, STO and concluded with vote of thanks given by Dr. AK Jaiswal, Convener & Head, Transfer of Technology Division. Dr. Alok Kumar & Dr. A.K. Singh were the Co-Conveners of the programme.

HRD Programme on Integrated Pest Management in Lac Cultivation

ICAR-Indian Institute of Natural Resins and Gums, Ranchi organized 1st HRD programme on Integrated Pest Management in lac cultivation on February 16, 2015 in collaboration with the Bayer Crop Science Ltd. for the input dealers of the State of Jharkhand. All the participants got an introduction of the lac cultivation, processing and value addition during orientation session. They also visited the Institute Research Farm, Lac Museum and Processing & Product Development Division. The experts addressed the various issues of recommendation and application of pesticides for lac cultivation in the state. Dr. AK Jaiswal, Head & Convener of the programme pointed out that there is great scope for convergence with the service providers to execute the pest management practices in right time with or optimum quantity/dose of the formulation. Dr. RK Yogi, Sc. & Co-convener took the feedback from the stakeholders and also discussed the present utilization of the pesticides in Jharkhand state. Experts from Bayer Crop Science Ltd emphasized that service providers are important role player in the optimum application of pesticides as they may provide in hand and fresh information to the farmers about various aspect of pesticide use. A total of 25 stakeholders including service providers, officials from Bayer Crop Science Ltd and farmers from Ranchi, Khunti, Lohardaga and Saraikela-Kharsawan districts of Jharkhand were benefited.

3rd Winter Student Workshop on Natural Resins and Gums Organized at ICAR-IINRG, Ranchi

Students observing the lac-insect-stages

3rd Winter Student Workshop on Natural Resins and Gums was organized during February 16-28, 2015. The workshop was inaugurated by Dr. R Ramani, Director, ICAR-IINRG, Ranchi. Eleven postgraduate students of Forestry from Guru Ghasidas Central University, Bilaspur, Chhattisgarh whith the theme of Industrial training on natural resins and gums. Training was imparted on processing of natural resins like lac, resin, oleo-resins and their industrial applications. Students were also made aware about seed gums and exudates gums: harvesting, tapping, collection, processing, quality control and their industrial uses. Students were exposed to horticulture, tasar culture, forestry and allied activities.

Trainees visiting industrial plant of lac

Dr. R Ramani, Director of the institute interacted with the students to get their feedback for improvement

in the future programmes. Dr. AK Jaiswal, Principal Scientist, Head TOT Division & convener proposed to continue this activity every year so that students are exposed to this sector also, as agriculture stream do not touch such areas. Dr. SKS Yadav and Dr. RK Yogi were Co-convener of the workshop.

NP-CLIGR Organizes Training for Network Cooperating Centres

A one-week training on Collection and Conservation of Lac-Insect and Host-Plant Biodiversity was organized under Network Project on 'Conservation of Lac Insect Genetic Resources (NP-CLIGR) during February 23-28, 2015 at IINRG, Ranchi. 18 Co-PIs / Research Associates / Senior Research Fellows from seven Network Cooperating Centers (AAU, Jorhat; CAU, Imphal; MPUAT, Udaipur; SFRI, Jabalpur; KFRI, Thrissur; PAU, Ludhiana; SKUAST, Jammu and the Lead Center (IINRG, Ranchi) participated in the training.

The programme was inaugurated by Dr. R Ramani, Director. Dr. KK Sharma, Project Coordinator & Head LPD presented a brief overview about the training. Dr. Md Monobrullah, PS & Convener briefed about the importance and necessity of organizing the training Dr. VD Lohot, Scientist and Dr. A Mohanasundaram, Scientist were co-conveners for the programme.

During the week long training, major focus was given to practical aspects of lac insect / host plants conservation. The participants were taken to the IRF, the Institute Museum and the Field Gene Banks of NATLIGEC for practical exposure. Hand-on-training was provided on identification of host-plants and lac associated insect fauna and forecast of larval emergence. A field visit was also arranged for exposure to *in-situ* conservation of lac insect.

NP-CLIGR participants at Ranchi

National Science Day

National Science Day was observed in the Institute on February 28, 2015 with the theme 'Science for Nation Building' by arranging a Group Discussion Contest amongst the young scientists from ICAR-IINRG, ICAR-IIAB and students from Ranchi University and BIT, Mesra, Ranchi. The winners of the contest were awarded with certificates and prizes in the form of books authored by Dr. APJ Abdul Kalam, former President of India, along with decent diaries. All the participants were given away certificate of appreciation.

1st Annual Progress Review Meeting of NP-CLIGR

First Annual Progress Review Meeting of the Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) was organized at Kerala Forest Research Institute, Peechi, Thrissur (Kerala) on March 10, 2015. PIs / Co-PIs of six Network Cooperating Centers (AAU, Jorhat; ANGRAU, Hyderabad; KFRI, Thrissur; MPUAT, Udaipur; PAU, Ludhiana and SKUAST, Jammu) presented their up-to-date progress report. Progress report of CAU, Imphal and SFRI, Jabalpur was presented in absentia as PIs / Co-PIs of these two Centers could not attend the meeting due to administrative and technical reasons.

Participant of the meeting

Women's Day Celebration

Women's Day was observed in the Institute on March 11, 2015 with the theme Women Equality: Present & Way forward. Dr. Mahua Maji, Chairperson, Jharkhand State Women Commission, Ranchi was the Guest Speaker on the occasion. It was attended by HODs, Scientists, TOs, Sectional Incharges, RAs, SRFs, of the Institute, Scientists from ICAR-IIAB, Ranchi and women scientists from ICAR-RCER, Plandu, Ranchi.

3rd National Workshop Organized at ICAR-IINRG, Ranchi

ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi organized a three day HRD Programme on Lac Promotion and Development for the Executives of NEH Region on April 27-30, 2015.

Trainee students of 7th Summer Students Workshop on Natural Resins and Gums with the experts of ICAR-IINRG, Ranchi

Dr. R Ramani, Director in his welcome address outlined the achievements of institute in the field of production and value addition in lac sector. He also apprised 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 will be started in PESA states under the jurisdiction of TRIFED as nodal agency. Dr. AK Jaiswal, Head & Convener of this function briefed about the various activities organized and coordinated under the NEH project. He also informed the delegates for further dissemination of the technical know–how and given stress that there is good potential of lac cultivation on *ber* (*Ziziphus mauritiana*) in north-east states of India. Mr NC Dalai, Managing Director, TRIFED, Ranchi opined that regular training programme at this institute is the best module to promote the scientific lac cultivation activities in traditional areas and orientation in newer areas. Dr. JS Singh, Deputy Commissioner, (Commercial Tax), Department of Commercial Taxes, Government of Jharkhand was the Chief Guest in valedictory session of this event on April 29, 2015. Dr. Singh in his address told about the importance of the continuum of knowledge, training and experience. This process of learning and doing things impart the experience and based on the field condition different innovations emerge out. Dr. Alok Kumar, Sr. Scientist & Co-convener presented the report on the various technical sessions. Representative from the different identified NGOs from Assam, Arunachal Pradesh and Tripura also shared their view and said that they have been benefitted during various technical sessions for production, marketing and value addition through field and industrial visits during three days of workshop. On this occasion a total of 50 participants including 27 delegates from NEH region, 3 state government officers, 20 scientists and staff of IINRG and IIAB, Ranchi attended the function. During technical sessions four topics in lac cultivation, production, pest management, processing, quality evaluation, prospects of lac development & livelihood opportunity in NEH region were presented by experts and discussed with the delegates. Dr. AK Singh, Sr. Scientist & Co-convener of the function proposed vote of thanks.

7th Summer Students Workshop on Natural Resins and Gums Organized at ICAR-IINRG, Ranchi

7th Summer Students Workshop on Natural Resins and Gums was organized during June 02-11, 2015. The workshop commenced with the interaction of the students with Dr. R Ramani, Director and experts on June 02, 2015. The workshop was specially organized for 38 undergraduate students of Agriculture and Forestry from Banaras Hindu University (BHU), Varanasi and Sam Higginbottom Institute of Agriculture, Technology & Sciences (SHIATS), Allahabad. The theme of the Workshop was Educational training on lac production tapping, processing and applications of natural resins and gums'.

Students were educated about processing of natural resins like lac, rosin, oleo-resins and their industrial applications. Training was 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.

Students interacting with the expert about lac cultivation

Exposure-cum-educational visit to Central Tasar Research and Training Institute, Nagari and Institute of Forest Productivity, Lalgutwa, Ranchi was organized to acquaint them with tasar culture and forest management, biodiversity conservation and ecological security. 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 M/s Gupta Brothers (Shellac) Pvt. Ltd., Bundu, Ranchi.

The valedictory function of the summer student's workshop was organized on June 11, 2015 in *Kusmi* Conference Hall of the institute. The Chief Guest of the function was Smt. Aradhana Patnaik, Secretary, Human Resource Development. Department, Government of Jharkhand. She stressed the students to create awareness in the people to use natural products prepared from natural resins and gums.

Dr. R Ramani, Director discussed various issues related to workshop with the students and apprised them about the relevance of natural product in life. Dr. AK Jaiswal, Head TOT Division and convener of programme informed that the institute is strengthening the extension activities in southern part of the country like Karnataka and also in North Eastern states through NEH Plan and he was hopeful that students will play a vital role in creating awareness in public about natural resins and gums. Dr. AK Singh and Dr. SKS Yadav, Scientists of TOT Division were Co-convener of the workshop.

A student receiving the certificate from the Chief Guest Smt. Aradhana Patnaik, Secretary, HRD, Govt. of Jharkhand during the Valedictory Funtion on June 11, 2015

An Industry Meet on Minimum Support Price and Procurement of Lac Organized at ICAR-IINRG, Ranchi

Institute organized an industry meet on Minimum Support Price and Procurement of Lac on June 18, 2015. Shri DB Singh, Deputy Development Commissioner, Khunti, Shri SK Jaiswal, President, Lac Processors Association and representatives group of all the lac processing units interacted during discussion on various issues related to the processing charges of sticklac, by-product processing facility, drying loss and quality standards of lac based products. In his welcome address Dr. AK Jaiswal, Director (Actg.) apprised about the role of the Institute in technical matters related to the procurement and processing of sticklac under MSP procurement Scheme. He emphasized upon the efficient mechanism for marketing of Minor Forest Produce through Minimum Support Price and development of Value Chain for MFPs including lac and gum *karaya*. Speaking on the occasion Shri DB Singh, Deputy Development

Dr. AK Jaiswal, Director (Actg.) convening the meeting with DDC, Khunti

Commissioner, Khunti said about the importance of the scheme for farmers as well as processors. Shri Singh told that the financial support by the central government may be helpful to enhance the sticklac production and further development of the sector. He appealed to the industry partners to involve and support the scheme by processing of sticklac actively. Shri Sanjeet Kumar, a representative from the Jharkhand State Co-operative Lac Marketing & Procurement Federation Ltd., Govt. of Jharkhand informed about the procurement of sticklac at Minimum Support Price from Khunti district. He told that memorandum of understanding has been signed with Torpa Rural Development Society, Torpa for processing of procured sticklac. During the session, agenda note on various issues were prepared for representation to the Ministry of Tribal Affairs (MOTA), Government of India. Around 20 participants including processors, state government officers and scientists of ICAR-IINRG attended the session.

Participants (lac industrialist) with Govt. Officials in the meeting

Inauguration of *Mera Goan Mera Gaurav* Programme at ICAR-IINRG

Mera Goan Mera Gaurav programme was inaugurated at the Institute to commemorate 87th ICAR foundation day on July 16, 2015. Chief Guest Shri Ram Kumar Pahan (Member of Legislative Assembly, Khijri) and guests of honour Smt. Sundri Tirki (Chairperson, *Zila Parishad)* and Smt. Arati Kujur (Member, *Zila Parishad*, Ranchi) were welcomed by the Director, IINRG, Ranchi. On this occasion from teams of experts were flagged off to visit adopted villages namely Hahap, Beradih, Guttidih and Jardih.

Teams flagged off by the Cheif Guest

The Chief Guest Shri Pahan in his address told about the need of dissemination of the important information and technologies to the farmers. He appreciated the initiative of *Mera Goan Mera Gaurav* programme**.** Further he added that adopted village should be an example in the locality so that adjoining villages may be benefitted by the interaction of expert/scientists from this institute.

Dr. AK Jaiswal, Acting Director informed that under this programme each scientist of the institute will adopt a village. Experts will visit the village and discuss with villagers and local representatives to know constraints. Dr. Alok Kumar, Convener of the function outlined about the activities under this programme.

Experts visited all the four adopted villages and interacted with the local representatives and farmers regarding agricultural practices which include lac cultivation, crops, dairy, goatary, poultry, fisheries, *etc*. They also discussed the issues related to education, water sanitation, health service and energy supply including LPG, electricity, solar power *etc*. Extension literature was distributed to the farmers. Around 100 persons including scientists, officials and staff members of three ICAR institutes(ICAR-IINRG, ICAR-IIAB, ICAR-RCER RC) and about 200 stakeholders including local representatives, officials and farmers participated in the field visit.

Selection of broodlac for new *Aghani* lac crop

92nd Foundation Day Celebration

IINRG celebrated its 92nd Foundation day on September 21, 2015. Padmashri Shri Ashok Bhagat, Secretary, Vikas Bharti, Bisunpur, Gumla was the Chief Guest of the function and Dr. NK Yadav, Vice-Chancellor, Central University, Jharkhand graced the occasion as Guest of Honour. Speaking about the utility of varied natural resources, Shri Bhagat said that natural resource management is lagging behind in the state. The state government needs to conserve it, as large section of people depend upon it for their livelihood. Welcoming the guests, Dr. KK Sharma, Director of the Institute explained about the current activities and briefly highlighted the achievements of Institute. Congratulating the staff members Dr. Sharma expressed hope that Institute will continue to play an important role for the farmers and all the stakeholders in future.

To commemorate the occasion, 5th Ms Dorothy Norris Memorial Lecture was organized in memory of the founder Director of the Institute. The lecture entitled An ecological approach for economic development through Natural resins and gums was delivered by Dr. Bangali Baboo, Former National Director, NAIP, ICAR, New Delhi and Former Director, ICAR-IINRG Ranchi. Dr. Baboo emphasized upon the role of natural resins and gums in national economy & livelihood support, in climate moderation and in pharmaceutical / neutraceutical applications. He said that India is endowed with rich forest cover and trees outside forest areas, stands to gain by sustained use of these valuable natural resources to augment the income in disadvantaged areas, where most of these trees grow. Their processing and value addition further augments their income and forms a potential intervention.

All the staffmembers of the Institute and ICAR-IIAB Ranchi participated in the programme. Apart from other dignitories, Dr. R Ramani, former Director ICAR-IINRG and Officer on Special Duty, Indian Agricultural Research Institute, Jharkhand also graced the occasion. Distinguished worker award 2015 was conferred upon to the employees from scientific, technical, administrative and supporting categories on the occasion. Institute observed Open days on September 22 and 23 for public, in which more than 1000 students from different schools visited the Institute.

7th Coordination Committee Meeting of Network Project on HPVA of NRG

The 7th Coordination Committee Meeting of Network Project on Harvesting, Processing & Value Addition of Natural Resins and Gums was held at the TNAU-Forest College and Research Institute, Mettupalayam, Tamil Nadu during October 27-28, 2015. Before inauguration, Dignitaries, PIs and Co-PIs planted different germplasm of Tamarind in the farm of TNAU-Forest College and Research Institute. The inaugural session of the meeting was chaired by Dr. CR Anandha Kumar, Vice-Chancellor (Acting), TNAU, Coimbatore and attended by Dr. M Maheswaran, Director of Research, TNAU, Coimbatore; Dr. KK Suresh, Dean (Forestry), FC & RI, Mettupalayam; Dr. R Ramani, PS & Officer on Special duty (OSD) IARI, Jharkhand; Project Coordinator of Network Project on HPVA of NRG; PIs, Co-PIs and RAs of Project Centres. Dr. CR Anandha Kumar in his opening remark said that emphasis should be given on the secondary plant products like NRGs. He also mentioned that export and import of NRGs should be strengthened and technology awareness may be introduced between commerce and sustainability of NRGs production. He emphasized that multi-locational trials of newer gums and resins producing species should be taken up and stressed upon to explore the medicinal properties of gums and resins to boost the basic research on NRGs. The technical session of the meeting was chaired by Dr. R Ramani, Pr. Sc. & OSD, IARI, Jharkhand and Co-chaired by Dr. N Prasad, Project Coordinator, IINRG, Ranchi, in which PIs of Network Project Centres presented their progress for the year 2014-15 and Technical Programme for 2015-16. Concluding session of the meeting was organized on October 28, 2015, which was chaired by Dr. R Ramani, in which final recommendations were presented followed by vote of thanks by Dr. A Balasubramanian, PI, TNAU-FC & RI.

Inauguration of 7th CCM, TNAU-FC & RI

Visit of farmers' group at IRF Unit, PD Unit and certificate distribution

Institute Celebrates World Soil Health Day

World Soil Health Day was observed at the Institute on December 05, 2015. Shri Ram Kumar Pahan, Hon'ble Member of Legislative Assembly, Khijri was the chief guest of the occasion and Mrs Arti Kujur, member Zila Parishad, Ranchi was the guest of honour on the occasion. Main attraction of the function was the distribution of soil health cards to the beneficiary farmers. A total number of 251 Soil Health Cards were distributed by the Chief Guest and the guest of honour. A lecture on Soil Health and Nutrient Management in Jharkhand was delivered by Dr. S Ghosal, Pr. Sc. Farmers, dignitaries, staff members of the Institute attended the programme.

Celebration of *Jai Kisan Jai Vigyan* Week

Indian Institute of Natural Resins and Gums celebrated '*The Jai Kisan Jai Vigyan*' week at during December 23-29, 2015. On first day, a group of 40 farmers from West Bengal visited PD Unit with experts. Technical knowhow and new tools and technologies were shown to them. Recent technological advances were demonstrated at the Institute Research Farm and Institute Museum during the visit. A video documentary on scientific lac cultivation, processing and value addition was show to them. In his concluding remark, Dr. KK Sharma, Director (Actg.) informed about more than ten schemes of the central government for the development of farming community. He briefed about Soil Health Card, Per Drop More Crop, Lab to Land, *Mera Goan Mera Gaurav*, National Agricultural Market, Digital Agriculture, *Paramparagat Krishi Vikas Yojna*, National *Gokul* Mission, Neem Coated Urea, Blue Revolution and Mission for Integrated Development of Horticulture. Dr. RK Yogi, Scientist & Convener of the programme told about the contribution of two former Prime Ministers Shri Atal Bihari Vajpayee and Late Shri Chaudhary Charan Singh. Subsequently, during the week, One to One Prgoramme (OTOP) on Lac cultivation, Pest management and Market intelligence were designed for interaction with stakeholders during first half of the office. Experts interacted with farmers on various issues related to lac cultivation on *kusum, siris, palas, semialata* and *ber;* pest management, availability of broodlac; *etc.* Farmers also shared various constraints in lac cultivation mainly poor market linkages, spray schedule and dose of pesticides.

A total of six experts interacted with 100 lac growers during the week. An interaction meeting with local farmers was also conducted at Krishi Vigyan Kendra (KVK), Khunti. About 150 farmers of Jharia and Jaradih villages were benefitted during on-farm-training. On December 29 , 2015, a batch of 50 farmers also visited the IRF and museum. Dr. S Srivastava, Processing and Product Development Division and Dr. Alok Kumar, TOT Division, ICAR-IINRG, Ranchi briefed about the divisional activities. During Farmers-Scientist Interaction Meeting, farmers asked questions which were responded in local language by Dr. S Ghosal, Pr. Sc.

On this occasion about 350 farmers from the various states interacted with the Institute experts. Dr. SKS Yadav, Scientist and Rapporteur of the function, proposed vote of thanks.

Concluding remark by the Director (Actg.)

Meetings of Important Committees

Institute Research Committee (IRC)

During the period under report, two IRC meetings were held. First on April 04, 2015 under the Chairmanship of Dr. R Ramani, Director and second during July 07-08, 2015 under the Chairmanship of Dr. AK Jaiswal, Director (Acting), ICAR-IINRG, Ranchi. During both the meetings, 46 research projects were discussed which included 26 Institutional Projects under different core programmes, 6 Externally Funded Projects, 3 Exploratory Studies, 2 Network Projects and 9 New Research Proposals .

The following points were emerged out during the meeting for guidance and compliance:

- Chairman made emphasis on the issue of number of projects to be taken by each scientist. As per Council's instructions each scientist should devote at least 25% time for one project.
- The house was also informed that following the directives from SMD regarding reduction in number of Institute funded projects by 25%, eight Institute projects were merged into four projects, after having thorough discussions in two metings with HODs, I/c PME Cell and I/c IRIS Cell under Chairmanship of Director.
- It was decided that the date of start of the merged project will be the starting date of that project which started earlier and date of completion will be the date of that project ending later.
- RPP-II and RPP-III of the final merged projects will be submitted in combined form only.
- Chairman stressed upon for the improvement with respect to publications in high impact Journals. Necessary initiatives may be taken by all concerned on the suggestions given.
- He also pointed out that every staff should ensure that ICAR is incorporated in the first part of the Institute name like ICAR-IINRG.

Research Advisory Committee (RAC)

The XXII RAC meeting was held on January 27-28, 2015 under the Chairmanship of Dr. N Krishnamurti in *Kusmi* Conference Hall. The other members present were:

- Dr. N Krishnamurti -- Chairman
- Dr. Kanchan K Singh, ADG (Farm Engg), ICAR, New Delhi -- Member
- Dr. Vineet Kumar, Scientist E, FRI, Dehradun -- Member
- Dr. R Ramani, Director, ICAR-IINRG, Ranchi -- Member
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division, ICAR-IINRG, Ranchi -- Member-Secretary

Invited Members

- Dr. KK Sharma, Pr. Sc. & Head, LP Division
- Dr. N Prasad, Pr. Sc. & Head, PPD Division
- Dr. Md Monobrullah, Pr. Sc. & I/c PME Cell

At the outset, Dr. AK Jaiswal, Pr. Sc. & Member-Secretary, welcomed Chairman and all the members present.

Dr. R Ramani, Director, ICAR-IINRG too welcomed the Chairman and other members of RAC. He apprised the committee about the overall progress of the Institute including information about NRGs. He provided basic information on the section of SFC of Institute and allocation of fund for NEH, TSP, Network Projects; shellac safety study; National Entomologists' Meet; strengthening of natural resins/ gums production in Jharkhand with support of JHAMCOFED; initiative or clean India mission; minimum support prices for NRGs; NEH and TSP programmes; creation of IRIS Cell at the Institute level; KVK khunti establishment; support and establishment of ICAR-IIAB and preparation of Jharkhand Agri Development Vision Document for its release by Hon'ble Union Agricultural Minister. He also acknowledged the outgoing Chairman and other members of the RAC for their keen interests and contributions as this being the last year of the tenure.

In his opening remarks the Chairman appreciated efforts of the Institute for good research work. He desired that developed products/technologies should go to industry.

Dr. Md Monobrullah, Pr. Sc. & I/c PME Cell presented the list of all on-going institutional and externally funded projects of the Institute. Dr. AK Jaiswal, Pr. Sc. & Member-Secretary presented the ATR of last RAC. Few clarifications sought by the Chairman were suitably addressed. After presentation of the division's progress by its respective HODs, six new research proposals were presented and discussed in detail.

XXII Research Advisory Committee meeting at ICAR-IINRG

During interaction with the scientists of the Institute, Dr. KK Singh, ADG ((Farm Engg), ICAR, New Delhi & Member, RAC advised that all the research projects should start preferably from April and conclude in March and output of the projects should be beneficial to the society. Dr. Singh complimented the scientists for their hard work and good publications and emphasized that the same zeal and spirit be maintained in future also.

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

- A long term (around 25 years) trend analysis of important natural resins and gums productions in the past and projection of future development, based on current and emerging scenario should be taken up as a sub-project.
- Identification of new lac hosts for better stress tolerance and enhanced productivity, which can be integrated with agriculture, should be taken up.
- The institute has made good progress in development of technologies for industry. But, technology commercialization is challenging and needs emphasis so that about two process/product technologies are transferred for commercial exploitation, every year.

In the last, Dr. AK Jaiswal, Pr. Sc. & Member-Secretary extended sincere thanks to the Chairman and other members of RAC for their valuable scientific inputs to improve upon the research programme of the Institute.

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. The following is a list of distinguished visitors:

- Hon'ble Radha Mohan Singh, Union Minister, Agriculture and Farmers Welfare, Govt. of India.
- Sri Anthony Russel, Soulier Bernard, France.
- Sri Sofia Lluch, Barcelona, Spain.
- Sri Robert Millis, Seatle, USA.
- Dr. Satish Sinha, IICM, Ranchi (Jharkhand).
- Sri Jai Shankar Singh, DCCT, West Circle, Ranchi (Jharkhand).
- Sri Rajendra Shreshtha, KTM, Nepal.
- Sri Bimal Agarwal, KTM, Nepal.
- Sri Madan Maharajan, KTM, Nepal.
- Sri Jyothi Thakur, Forest Department, Chhattisgarh.
- Sri Gaurav Tiwari, Forest Department, Chhattisgarh.
- Prof. Prabhat Ranjan, Executive Director, TIFAC, New Delhi.
- Sri Pritam Singh, DSP, Ranchi (Jharkhand).
- Sri Ram Surat Prasad, RFO, Chaibasa (Jharkhand).
- Dr. HP Paul, SDO, MIE, Shillong.
- Sri Mouisha Khatri, IAS, Mussoorie.
- Dr. Satyendra Singh, NIA, Jaipur (Rajasthan).
- Sri Dhornendre, MD, Bangalore.
- Sri NC Dalai, Regional Manager, TRIFED, Ranchi (Jharkhand).
- Sri Marc Laugasque, Soulier Bernard, France.
- Sri Malhice Abondaron, Firmenich Company, France.
- Ms Aradhana Patnaik, Secretary, Govt. of Jharkhand (Jharkhand).
- Dr. Amitabh Kumar, NIFT, Ranchi (Jharkhand).
- Md. Saleem Ansari, NIFT, Ranchi (Jharkhand).
- Sri George Kutty, Navjeevan Hospital, Palamu (Jharkhand).
- Sri Preetam Singh, DSP, Ranchi (Jharkhand).
- Sri Manoj Varghere, IIMC, Delhi.
- Ms Archana Anokhe, ICAR-IARI, New Delhi.
- Ms Priyakshi Bnagohaim, AAU, Jorhat (Assam).
- Dr. SN Chattopadhyay, Pr. Sc., ICAR- NIRJAFT, Kolkata (West Bengal).
- Dr. Muneshwar Singh, PC, ICAR-IISC, Bhopal (Madhya Pradesh).
- Dr. Dipak De, Professor, Agri. Sci., BHU, Varanasi (Uttar Pradesh).
- Col. Kamal Kishore, Adm. Commandant, Ranchi (Jharkhand).
- Col. Sanjeev Kumar Sharma, Ranchi (Jharkhand).
- Sri KPS Nirankush, Chairman, Jharkhand Hindi Sahitya Sanskriti Manch, Ranchi (Jharkhand).
- Sri AN Jain, Head of Department (Zoology), Dalmia College, Sundergarh (Odisha).

Support Services

Institute Research Farm

Resource generation

Broodlac / Sticklac (Rs.)	Other Farm Produce (Rs.)	Fuel Wood (Rs.)	Water Fuel (Deisel) Charge (Rs.)	Total (Rs.)
1,82,326	1,45,318	11,035	24,125	3,62,804

Infra-structure development

- Renovation of *pucca* water reservoir with RCC.
- Replacement of 400 metre three phase electric cable.
- 2000 m x 3 m road was reshaped and end straightened.
- Establishment of sprinkler system for irrigation purposes.
- Renovation of mist chamber.

Nursery management

- The seedlings of different lac hosts were raised for gap filling and sale in large number.
- *F. Semialata*–50,000 Nos., *Ber*–4156, *Kusum*-118, *Khair*-301, *Galwang*-94 and *Palas*-02.
- 2500 seedlings of *F. semialata* was transplanted for gapfilling.

Lac culture & seed production

- 4364.7 Kg *kusum* broodlac of Simdega, Kulajanga, Gumla, Nawadih, Bandgaon & *ber* stock was inoculated on *ber* & *kusum* trees for *aghani* & *jethwi* crops.
- 743 kg *kusumi* broodlac was sold.
- The seeds of *F. semialata*- 09 Kg, *kusum*-5 Kg, *galwang*-10 Kg, *khair*-2 Kg, *ber*-35 Kg, *F. macrophylla*-4 Kg were collected for nursery and sale purposes.

Soil amendment

50 Kg *Dhaincha* and 50 Kg *Sanai* was shown for green manuring in *ber* (Plot NO. 48-51) and *kusum* (Plot No. 40-46).

Maintenance

Weeding, cleaning and lime pasting with chloropyriphos TC of 1700 *kusum*, 2500 *ber*, 2500 *palas*, 950 *galwang*, 90 *ghont*, 750 *khair*, 18 *Sandan* and 1000 other trees.

Quality Evaluation Laboratory

During the period under report a total No. of 72 customer's letter (47 outside and 25 internal), 243 samples (80 outside and 163 internal) of lac, lac-based products and natural gums have been received from Govt. organization / private industries / various Divisions of the Institute and total 955 (154 outside and 801 internal) tests have been carried out and a sum of Rs. 44361/- only has been earned form external source. The total revenue generated from the testing of internal as well as external samples was Rs. 2,29,374/- and realized as testing charges.

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 the Director of the Institute for assigning research project.
- Maintaining a database on all publications.
- Coordination for publication of Institute.

- Coordination for HRD programmes of scientists and other staff members of the Institute.
- Processing of research papers for publication in Journals.
- Maintenance of research project files, both Institutional as well as externally funded projects.
- Coordination for participation of scientists in conference, seminar, symposium / workshop and training etc.
- Coordination for conduction of SOC meeting, IRC meeting, RAC meeting.
- To coordinate and synthesize the recommendations of meetings *viz*. RAC, IRC, Director's Conference, Regional Committee.
- Processing of papers for Honours / Awards of Institute staff.
- Processing of requests under Right to Information (RTI) Act.
- Providing LAN and internet connectivity to the divisions and sections of the Institute.
- Maintenance of web based database for Personnel Management Information Systems (PERMISNET), ICAR-Enterprise Resource Planning (ERP), Project Information Management System (PIMS-ICAR) and Half-Yearly Progress Monitoring (HYPM) System of scientists.
- Hosting of websites for ICAR-IINRG, ICAR-IIAB, SANRAG and two Network Projects. Regular updating of these websites (general information, events, tenders, walk in interviews etc.) from time to time.
- The projection system in the *Kusmi* Conference Hall has been upgraded.

The PME cell presently maintains three servers namely, Proxy server for providing internet connectivity to various divisions / sections, Mail server for providing e-mail facilities and Apache web server for hosting website.

Library and Documentation Centre

The library of the Institute plays an important role in meeting the information- needs of its users. Library of the Institute is a repository of scientific and technical information on natural resins and gums. Besides catering to the needs of Institute scientists, it also renders 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. This library also supplies photocopies of rare research articles to NISCAIR, New Delhi from 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. 14,703.00/- was generated, as revenue, from the sale of publications and reprographic services during the year. The library also continue 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
- C.D. 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) 04
- Indian Periodicals (Subscribed) 11
- Indian Periodicals (Gratis/exchange) 13

Library holdings (as on 31/12/2015)

Documents	Additions	Total Holdings
Books	41	7953
Bound Journals	38	21661
Annual Report	91	5208

CD- Rom	-	123
IS-Specification	-	184
Maps	-	37
Patents (Foreign)	-	327
Patents (Indian)	-	15
Thesis	-	13

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 the Institute premises. The work is being outsourced and is monitored by the Estate Management Committee so as to ensure that the work is done satisfactorily as per the scope of work.

Registration of jobs

Jobs registered in the various job registers during the period under report are:

- Electrical works – 760
- Civil & water supply - 436 (this includes plumbing & other civil works)
- Carpentry works – 359
- Turners works – 503
- Welders works – 65

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

Work taken up through C.P.W.D

- Renovation of quarters Type IV (3 to 10) and Type III (18 to 29).
- Roof treatment of quarters Type IV (5 & 6).
- Extension of PPD & LPD Divisions.
- Renovation of transformer room.
- Renovation of IRF building (civil and electrical).
- Renovation of water supply pipe line.
- Internal repair and miscellaneous civil work in TOT Division.
- Renovation of Director's office.
- Renovation of water reservoir at IRF.

Major works carried out departmentally

- Installation and painting of net fence in front of Bungalow No. 2.
- Applying distemper, painting of doors & windows and weather coat in quarters Type V (3 & 4), Type IV (2), Type III (1, 2, 13, 17 & 14 to 16) and Type II (15 to 24).
- Distempering and painting of doors & windows in the office rooms of the factory building at PDU campus.
- Plinth protection & construction of PCC approach road for quarters Type V (3 & 4).
- Renovation of courtyards of quarters Type III (8 & 13) and Type II (15 to 24) by removing the old PCC.
- Providing weather coat at vehicle shed near main gate of the Main campus and renovation of old office building at PDU campus.
- Applying distemper, re-plastering wherever required, painting of doors & windows and weather coat in Samaj Sadan.
- Extension of roof top of vehicle sheds located near main gate of the Main campus, Type V new quarters and Type IV new quarters by plastic coated GI sheet.
- Providing drinking water facilities to the occupants of Main campus directly through submersible pump located in front of the guest house.
- Installation of mono block pumps in the main campus and PDU campus.

- Restraining of overhead electric connection from electric pole No. 12 to 18 which was destroyed due to heavy rainfall and storm on 28th April 2015.
- Electrical wiring for air conditioners installed in the *Kusmi* Conference Hall.
- Installed 10 Nos. of street lights in the Main campus of the Institute.
- Concealed wiring of old Administrative II office room.
- Maintenance of street lights in serviceable condition throughout the year.
- Maintenance of electrical installation of residential quarters and Division/ Section in operational condition throughout the year.
- Maintenance of genset and associated panels, transformer, overhead LT lines in operational condition throughout the year.
- Renovation of conference table of the *Kusmi* Conference Hall.
- Replacement of windows of quarters Type V (2) and Type III (9 & 10).
- Manufacturing of mega cage for LP Division for research purpose.
- Number plates in all the residential quarters located in the Main campus and PDU campus.

Commitments for the Year 2016

- Renovation of Main gate complex along with waiting lounge, reception counter, security office and sale counter.
- Enhancement of capacity of existing transformer of 2 Nos. of 320 KV transformer 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 PDU building.
- Renovation of old guest house & Kisan hostel.

Health Services

The Institute had a functional dispensary in the campus, which was renamed as Health Center w.e.f. November 5, 2015. Dr. (Mrs.) Reema K. Khalkho and Dr. Ashok Kumar have been functioning as a part time Medical Officers on contractual basis on alternate days. Most of the medical cases were handled in the health center itself and complicated cases referred to authorized hospitals and pathology clinics in the city for expert diagnosis and treatment. The health center remained equipped with routine instruments to handle general/minor dressing, first aid, physical examination of patients, measure B.P., pulse, height, weight, blood sugar etc. In the year 2015, 6842 patients were registered and treated in the health center. Around 193 patients were monitored for blood sugar by test strips method in the center itself as per the advice of AMAs. The health center has computerized inventory system, facilitating retrieval of records like issue of medicine, date of receiving, unregistered patient etc. along with the near date of expiry of medicine, short supply by the supplier (stock) etc. This ultimately helps the AMA in taking better decision while prescribing medicines. OPD medical booklets were also issued to chronic patients with unique Identification code for maintaining patients' case history. 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 labourers on humanitarian grounds.

During the year under report, doctor's chambers were provided with hydraulic door closer, AC, intercom and Digital Queue Management System + UPS. New signages were provided and patient handling was streamlined.

IPR / ITMU

- Participation of ITMU and demonstration of Institute technologies during Annual Kisan Mela, ICAR- IINRG, Ranchi, 29.01.2015.
- Filing of examination (FER) of Patent application 580/KOL/2011 in February, 2015 through Seenergi, IPR, Kolkata.
- Participation of ITMU and demonstration of Institute technologies in Hindustan Trade Fair at Morabadi Maidan, Ranchi, February 28-March 03, 2015.

- Questionnaire for data collection, technology evaluation for technology transfer of aleuritic acid to Chinese firm required by Agroinnovate India (AGIN) was prepared and sent to AGIN for further necessary actions by them.
- Filing of examination (FER) of two Patent applications 1330/KOL/2013 and 1435/KOL/2013 in March, 2015 through Seenergi, IPR, Kolkata.
- Meeting of PPD and TOT Division scientists with the officials of Asian paints, Mumbai was organised in the Institute on 01.4.2015 regarding use of lac in paints and varnishes etc. followed by another meeting on 10.4.2015 for ATR.
- Visited M/s Tajna Shellac Khunti, Ranchi along with paint officials for discussion on bleached lac on 01.4.2015.
- Proposal for patent filing of polycosonol from lac wax submitted by Dr. S Srivastava, Pr. Sc., PPD Division was processed through M/s Anjan Sen & Associates, Kolkata.
- Proposal for commercialization of fruit coating formulation for kinnow through NRDC examined under ITMU for incorporating necessary suggestions.
- Proposal for patent filling of moringa based hydrogel submitted by Dr. SKS Yadav, Sc., TOT Division was processed through M/s Anjan Sen & Associates, Kolkata.

Agro-meteorology Unit

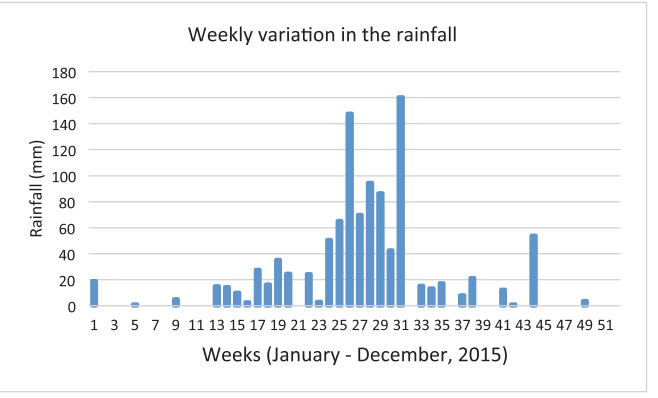
Agro-meteorology unit of the institute is situated at 23^0 23' N latitude, 85^0 23' E longitude at 650 m altitude. During the year 2015, different weather parameters were recorded and updated daily as well as weekly at the Institute website. Daily SRRG sheets as also rainfall data for the year were sent to Indian Meteorological Department, Kolkata. The monthly mean relative humidity (RH %), mean temperature (^{0}C) and total rainfall (mm) is detailed in the Table . Weekly analysis of rainfall has been presented in Fig. Analysis of the data for these parameters revealed significant variations in the months.

Relative humidity was the maximum (90.03 %) in August while it was minimum (59.54 %) in the month of February. Maximum temperature for the year was recorded on 25th May (41 ^{0}C) while minimum temperature on 19th January and 1st February (3 ^{0}C). Hottest and coldest months of the year were May and January with mean monthly temperature 36.69 ^{0}C and 7.42 ^{0}C, respectively.

On 12th June, onset of monsoon was observed and the total annual rainfall was 1064.10 mm. It is pertinent to say here that 29thJune received maximum rainfall (120 mm). Maximum monthly rainfall was observed in July (303.70 mm), while no rainfall occurred in February and November of the Calendar Year 2015.

Table: Meteorological data recorded at the Agro-meteorology unit of the Institute during 2015

Month, 2015	Mean Relative Humidity (%)		Mean Temperature (^{0}C)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
January	88.26	67.52	21.96	7.42	20.30
February	77.46	59.54	27.10	9.11	0.00
March	72.32	63.55	29.81	13.96	20.40
April	77.37	65.97	33.05	17.89	54.50
May	71.68	68.16	36.69	21.00	101.00
June	80.67	73.96	33.27	22.47	264.70
July	88.68	84.19	28.81	21.53	303.70
August	90.03	82.29	29.71	21.44	197.00
September	86.43	76.10	30.65	20.22	31.70
October	81.52	73.90	29.72	17.05	67.20
November	77.93	65.19	27.80	11.13	0.00
December	83.48	66.26	23.17	8.44	3.60
Total Annual Rainfall (mm)					1064.10



Weekly distribution of rainfall for the year, 2015

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 तकनीकी सहायक (अगस्त 2015 तक), 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 रुप में शामिल हैं तथा वरिष्ठ तकनीकी अधिकारी (रा.भा.) सदस्य सचिव हैं।

संस्थान 'क' क्षेत्र में है, इसे राजभाषा अधिनियम की धारा 10(4) के अर्न्तगत केन्द्रीय गजट में अधिसूचित किया जा चुका है। संस्थान के पॉच 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, 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, नामपट्ट के निर्माण में 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 2015 में संस्थान राजभाषा कार्यान्वयन समिति की चारो 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 13.02.2015

  (ख) दिनांक 23.5.2015

(ग) दिनांक 13.8.2015 एवं

(घ) दिनांक 30.11.2015

बैठकों में 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 2014-15 एवं 2015-16 के प्रस्ताव पर चर्चा ।
- वार्षिक पत्रिका लाक्षा-2015 का प्रकाशन ।
  - वर्ष 2015-16 के लिए नकद पुरस्कार योजना लागू करना एवं वर्ष 2014-15 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 2014 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 उपलब्धियॉ-2015

- दिनांक-09.01.2015 को ''प्राकृतिक राल एवं गोंद के औषधीय उपयोग'' विषय पर एक दिवसीय नगर स्तरीय हिन्दी संगोष्ठी/कार्यशाला का आयोजन किया गया।
- "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-2015 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-2014 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 07 अधिकारियों/कर्मचारियों को पुरस्कार प्रदान किए गए।

कार्यक्रम

प्राकृतिक राल एवं गोंद के औषधीय उपयोग विषय पर नगर स्तरीय एक दिवसीय हिन्दी संगोष्ठी सह कार्यशाला

भाकृअनुप-भारतीय प्राकृतिक राल एवं गोन्द संस्थान, नामकुम, रांची में प्राकृतिक राल एवं गोंद के औषधीय उपयोग विषय पर 09 जनवरी, 2015 को नगर स्तरीय एक दिवसीय हिन्दी संगोष्ठी सह कार्यशाला का आयोजन किया गया, जिसमें संस्थान के 46 वैज्ञानिकों/अधिकारियों/ अनुसंधानकर्मियों के अतिरिक्त राँची स्थित केन्द्र सरकार के 23 कार्यालयों के 43 अधिकारियों/कर्मचारियों ने भाग लिया। संगोष्ठी में प्राकृतिक राल एवं गोंद के औषधीय उपयोग के विभिन्न पहलूओं पर चर्चा की गई। संगोष्ठी में संस्थान के वैज्ञानिकों की प्रस्तुति के अतिरिक्त बी.आई.टी., मेसरा, रांची के फार्मास्यूटिकल विभाग के अध्यक्ष डॉ बी एन सिन्हा तथा राँची विश्वविद्यालय, रांची के रसायन शास्त्र विभाग के पूर्व प्राध्यापक डॉ जी डी मिश्रा ने मुख्य भाषण दिया।

अपने व्याख्यान में डॉ सिन्हा ने कहा कि लाख का प्रयोग औषधियों में प्राचीन काल से होता आ रहा है। लाख में पाए जाने वाले लैकाइक एसिड का उपयोग कैंसर व एड्स जैसी बीमारियों के उपचार में किया जा सकता है। इन दिनों इस विषय पर अध्ययन किया जा रहा है, वहीं बैक्टीरिया व फफूंद से होने वाले कई प्रकार के संक्रमण में यह एसिड कारगर साबित हुआ है। दवाओं के निर्माण के साथ-साथ फलों व टॉफी आदि पर इसकी परत लगाने से न सिर्फ उनकी खुबसूरती बढ़ती है, बल्कि यह अधिक दिनों तक सुरक्षित भी रहते हैं।

संगोष्ठी सह कार्यशाला के दूसरे सत्र में बोलते हुए डॉ जी डी मिश्रा ने प्राकृतिक राल लाख एवं गोंद के विभिन्न औषधीय उपयोग पर प्रकाश डालते हुए बताया कि कृत्रिम औषधियों की तुलना में प्राकृतिक राल एवं गोंद निर्मित औषधियों का मानव के स्वास्थ्य पर सकारात्मक प्रभाव पड़ता है। साथ ही इन औषधीयों के प्रयोग से मनुष्य पर कोई हानिकारक प्रभाव नहीं पड़ता है।

संगोष्ठी सह कार्यशाला में संस्थान के 7 वैज्ञानिकों ने प्राकृतिक राल एवं गोंद के विभिन्न औषधियों में उपयोग से जुड़े विषयों पर अपने आलेख प्रस्तुत किए।

संस्थान के निदेशक डॉ रंगनातन रमणि ने कार्यक्रम के उद्देश्यों पर प्रकाश डाला। अपने संबोधन में डॉ रमणि ने कहा कि प्राचीन काल से ही लाख का उपयोग औषधि के रुप में किया जा रहा है। अर्थववेद के एक पूरे अध्याय में इसका विवरण मिलता है। आज कृत्रिम औषधियों के प्रयोग से होने वाले दुःपरिणामों के कारण प्राकृतिक औषधियों की ओर लोगों का रुझान बढ़ा है, आवश्यकता है, प्राकृतिक राल एवं गोंद के विभिन्न औषधीय गुणों के अनुसंधान एवं प्रचार-प्रसार करने की।

डॉ निरंजन प्रसाद, विभागाध्यक्ष एवं प्रधान वैज्ञानिक ने कार्यक्रम का संयोजन किया तथा उद्घाटन सत्र में कार्यक्रम के वारे में विस्तृत जानकारी दी। तकनीकी सत्रों का निर्धारण, समीक्षा व धन्यवाद ज्ञापन कार्यक्रम की सह-संयोजक एवं प्रधान वैज्ञानिक डॉ एम जेड सिद्दीकी ने तथा संगोष्ठी का संचालन डॉ अंजेश कुमार, वरिष्ठ तकनीकी अधिकारी ने किया।

हिन्दी चेतना मास/हिन्दी दिवस समारोह-2015

भारतीय प्राकृतिक राल एवं गोंद संस्थान में राजभाषा अधिनियम के अनुपालन एवं कार्यालय कार्य में राजभाषा हिन्दी के प्रयोग में उत्तरोत्तर वृद्धि के लिए संस्थान में दिनांक-01.9.2015 से 30.09.2015 तक हिन्दी चेतना मास का पालन किया गया तथा इसके अन्तर्गत दिनांक-29.09.2015 को अपराह्न 02.30 बजे हिन्दी दिवस समारोह का आयोजन किया गया।

हिन्दी दिवस समारोह के अवसर पर मुख्य अतिथि हिन्दी साहित्यकार श्री प्रशांत करण, भारतीय पुलिस सेवा, पुलिस अधीक्षक, राज्य अपराध अभिलेख ब्यूरो, राँची ने संबोधित करते हुए कहा कि वर्त्तमान समय में हिन्दी की स्थिति में काफी सुधार हुआ है। लोग हिन्दी को अपना रहे हैं और न केवल भारत में बल्कि पूरे विश्व में लोग हिन्दी के प्रति आकर्षित हो रहे हैं, यह सुखद बात है। हिन्दी का अधिकाधिक इस्तेमाल करने का प्रयास करें, तभी हिन्दी दिवस मनाने का सही अर्थ पूरा होगा, साथ ही उन्होंने कहा कि हिन्दी हमारी राष्ट्रभाषा है और राष्ट्रभाषा हिन्दी का सम्मान सभी को करना चाहिए।

इस अवसर पर विशिष्ट अतिथि के रुप में श्री कामेश्वर प्रसाद श्रीवास्तव निरंकुश, प्रसिद्ध कवि एवं अध्यक्ष, झारखंड हिन्दी साहित्य संस्कृति मंच, राँची ने बोलते हुए कहा कि भूमंडलीकरण के दौर में सबसे अधिक खतरा भाषा, संस्कृति व साहित्य को हैं एवं हिन्दी की यह अनोखी विशेषता है कि वह अपने में प्रायः सभी प्रादेशिक भाषाओं के शब्दों को समाहित कर सकती है। उन्होंने कहा की हिन्दी जितनी सरल होगी, वह उतनी ज्यादा लोगों में प्रचलित होगी एवं हिन्दी के प्रति सबको लगाव होना चाहिए। हिन्दी देश को आजाद करने वाली एवं मनोबल ऊंचा उठाने वाली भाषा है।

संस्थान के निदेशक, डॉ. केवल कृष्ण शर्मा ने अपने स्वागत भाषण में कहा कि हिन्दी चेतना मास के अन्तर्गत 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।

हमारा पुस्तकालय वैज्ञानिक साहित्य की दृष्टि से बहुत समृद्ध है, साथ ही यहाँ प्रचूर संख्या में हिन्दी की पुस्तक/पुस्तिकाएं उपलब्ध हैं।

इस अवसर पर संस्थान की पत्रिका लाक्षा-2015 का लोकार्पण अतिथियों के द्वारा किया गया, साथ ही हिन्दी चेतना मास की अवधि में दिनांक-08-09 सितम्बर 2015 को आयोजित हिन्दी टिप्पण, प्रारूप लेखन, निबंध, अंताक्षरी, पर्याय, व्याख्यान, पर्यायवाची शब्द एवं विपरीतार्थक शब्द प्रतियोगिता के विजेताओं को पुरस्कार प्रदान किया गया। इस अवसर पर लाक्षा-2014 में उत्कृष्ट आलेख का पुरस्कार डॉ निरंजन प्रसाद, डॉ. आलोक नाथ को प्रदान किया गया। डॉ. एम एफ अंसारी, श्री प्रहलाद सिंह, श्री बिनोद कुमार, श्री अनिल कुमार सिन्हा, श्री कृष्ण मुरारी कुमार, श्री रघुनाथ महतो, श्री शरत चन्द्र लाल, श्री अश्विनी कुमार, श्री विनय कुमार मिश्रा, श्री बैजनाथ महतो, श्री चैतु कच्छप इत्यादि को पुरस्कार प्रदान किया गया। समारोह में गत वर्ष में हुए राजभाषा कायों की प्रगति प्रतिवेदन भी प्रस्तुत किया गया।

कार्यक्रम का संचालन डॉ अंजेश कुमार, व.त.अ. एवं धन्यवाद ज्ञापन डॉ आलोक कुमार, व.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, अक्तूबर 2014 - सितम्बर 2015, अंको की संख्या- 04 पृष्ठों की संख्या-32 (द्विभाषी)
- झारखंड कृषि विकास विजन, पुस्तिका, पृष्ठों की संख्या-74 (द्विभाषी)
- पलास वृक्ष एवं लाख की खेती, पुस्तिका, पृष्ठों की संख्या 58- (हिन्दी)
- कुसुम वृक्ष एवं लाख की खेती, पुस्तिका, पृष्ठों की संख्या 58- (हिन्दी)
- बेर वृक्ष एवं लाख की खेती, पुस्तिका, पृष्ठों की संख्या 46- (हिन्दी)
- ईयर प्लानर-सह-प्रचार पत्रक 2015, पृष्ठों की संख्या 28 (द्विभाषी)
- लाक्षा-2015, पृष्ठों की संख्या-86

अन्य गतिविधियां

- दिनांक-24.7.2015 को मंडल रेल प्रबंधक कार्यालय, हटिया में आयोजित नगर राजभाषा कार्यान्वयन समिति की बैठक में संस्थान का प्रतिनिधित्व किया, सचिव, नराकास के आग्रह पर डॉ. अंजेश कुमार, व.त.अ. ने कार्यक्रम का संचालन व कार्यालयों के बीच समन्वय कार्य किया तथा हिन्दी की प्रगति का विवरण प्रस्तुत किया। नराकास की इस बैठक में डॉ अंजेश कुमार ने संस्थान की गतिविधियों से संबंधित विस्तृत विवरण की पावर प्वाईंट प्रस्तुति दी। अध्यक्ष महोदय ने बेहतर प्रस्तुति के लिए डॉ कुमार को रू. तीन हजार का नकद पुरस्कार प्रदान किया।
- भारतीय विमानपत्तन प्राधिकरण, राँची में दिनांक - 18.3.2015 को आयोजित कार्यशाला में आमंत्रित व्याख्याता के रूप में डॉ. अंजेश कुमार, व.त.अ. ने कार्यशाला को संबोधित किया।
- क्षेत्र प्रचार निदेशालय, सूचना एवं प्रसारण मंत्रालय के हीनू, रॉची स्थित कार्यालय में दिनांक-24.3.2015 को आयोजित कार्यशाला में आमंत्रित व्याख्याता के रूप में डॉ. अंजेश कुमार, व.त.अ. ने कार्यशाला को संबोधित किया।
- केन्द्रीय विश्वविद्यालय, ब्रॉम्बे, राँची में दिनांक-27.3.2015 को आयोजित नाट्य महोत्सव में अतिथि के रूप में डॉ. अंजेश कुमार, व.त.अ. एवं श्री मदन मोहन, तकनीकी सहायक ने संस्थान का प्रतिनिधित्व किया।
- पावर ग्रीड कॉरपोरेशन, अशोक नगर, राँची में दिनांक-30.3.2015 को आयोजित कार्यशाला में आमंत्रित व्याख्याता के रूप में डॉ. अंजेश कुमार, व.त.अ. ने कार्यशाला को संबोधित किया।

Budget

Budget allocation and utilization during 2015-16 (Rs. in Lakhs)

	Name of the Head	Non Plan		Plan	
		R.E. 2015-16	Expenditure during 2015-16	R.E. 2015-16	Expenditure during 2015-16
1	2	3	7	9	13
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	**0.00**	0.00	**106.35**	106.35
	ii. Residential Building	**0.00**	0.00	**0.00**	0.00
	iii. Minor Works	**0.00**	0.00	**0.00**	0.00
2	Equipments	**6.00**	5.87	**50.00**	49.97
3	Information Technology	**0.00**	0.00	**24.00**	24.00
4	Library Books & Journals	**0.00**	0.00	**6.20**	6.19
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	**1.00**	0.99	**2.00**	1.95
8	Others	**0.00**	0.00	**0.00**	0.00
	Total Capital(Grants for creation of capital assets)	**7.00**	**6.85**	**188.55**	**188.45**
GRANT IN AID SALARIES (REVENUE)					
1	Establishment Expenses				
	(A) Salaries				
	i. Establishment charges	**986.80**	983.57	**0.00**	0.00
	ii. Wages	**0.00**	0.00	**0.00**	0.00
	iii. Over Time Allowance	**0.30**	0.19	**0.00**	0.00
	Total Estt. Expenses (grant in aid salaries)	**987.10**	**983.76**	**0.00**	**0.00**
GRANT IN AID GENERAL (REVENUE)					
1	Pension & other Retirement Benefits	**200.20**	200.19	**0.00**	0.00
2	Travelling Allowances				
	(A) Domestic TA/ Transfer TA	**7.00**	6.52	**12.00**	11.99
	(B) Foreign TA	**0.00**	0.00	**0.00**	0.00
	Total Travelling Expenses	**7.00**	**6.52**	**12.00**	**11.99**
3	Research & Operational Expenses				
	(A) Research Expenses	**14.00**	10.93	**35.00**	34.87
	(B) Operational Expenses	**9.00**	1.72	**34.00**	33.39
	Total Res. & Operational Expenses	**23.00**	**12.66**	**69.00**	**68.26**
4	Administrative Expenses				
	(A) Infrastructure	**31.73**	31.73	**20.00**	19.90
	(B) Communication	**2.00**	1.80	**0.00**	0.00

	Name of the Head	Non Plan		Plan	
		R.E. 2015-16	Expenditure during 2015-16	R.E. 2015-16	Expenditure during 2015-16
1	2	3	7	9	13
	(C) Repairs & Maintenance				
	i. Equipments, Vehicle & Others	**13.35**	13.35	**10.00**	9.99
	ii. Office Building	**19.61**	19.61	**0.00**	0.00
	iii. Residential Building	9.40	9.36	0.00	0.00
	iv. Minor Works	0.00	0.00	0.00	0.00
	(D) Others Admin. Expenses	47.98	47.93	45.00	44.96
	Total Administrative Expenses 0.00	**124.07**	**123.78**	**75.00**	**74.84**
5	Miscellaneous Expenses				
	(A) HRD	0.00	0.00	3.00	2.27
	(B) Other Items (Fellowship/ Scholarship etc.	0.00	0.00	0.00	0.00
	(C) Publicity & Exhibitions	1.00	0.98	3.50	3.48
	(D) Guest House Maintenance	1.00	1.00	0.00	0.00
	(E) Other Miscellaneous	4.36	4.35	2.50	2.48
	Total Misc. Expenses	**6.36**	**6.32**	**9.00**	**8.24**
	Total Grant in Aid General	**360.63**	**349.46**	**165.00**	**163.33**
	Total Rev. (Grant in aid gen. + salaries)	**1347.73**	**1333.22**	**165.00**	**163.33**
	TOTAL (Capital + Revenue)	**1354.73**	**1340.07**	**353.55**	**351.78**
	Tribal Sub Plan Expenditure			**0.00**	**0.00**
	NEH Expenditure			**5.00**	**2.66**
	GRAND TOTAL	**1354.73**	**1340.07**	**358.55**	**354.45**
	Loans & Advances	***10.00***	***8.13***		
	Revenue Generation Target				
	Financial Year	Target for the Financial Year		Revenue Generated	
	2015-16	42.29		41.17	

Plan Schemes

Head of Expenditure	Other than NEH & TSP		NEH		Total	
	Approved RE	Expenditure	Approved RE	Expenditure	Approved RE	Expenditure
NWP on H & PHP & VANR& G						
Grant-in-aid Capital	35.00	34.60	0.00	0.00	35.00	34.60
Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
Grant-in-aid General	85.00	84.66	0.00	0.00	85.00	84.66
Total	**120.00**	**119.26**	**0.00**	**0.00**	**120.00**	**119.26**
NWP on CLIGR						
Grant-in-aid Capital	35.75	35.75	0.00	0.00	35.75	35.75
Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
Grant-in-aid-General	104.25	104.13	0.00	0.00	104.25	104.13
Total	**140.00**	**139.88**	**0.00**	**0.00**	**140.00**	**139.88**

Personnel

Details of scientific, technical, administrative and supporting staff as on December 31, 2015:

Scientific	Sanctioned Strength*
RMP	01
Principal Scientist	06
Senior Scientist	15
Scientist	26
Total	**48**

*including KVK

Technical	
Category-I	43
Category-II	23
Category-III	06
Total	**72**

Administrative	
Sr. AO	01
F & AO	01
AAO	02
AD(OL)	0
PS	01
Security Officer	01
PA	02
Assistant	11
Sr. Clerk	05
Jr. Clerk	06
Steno Gr. III	02
JAO	01
Total	**33**

Skilled Support Staff	
SSS	84

Cadre	Sanctioned	In-Position
Scientific	48*	30*
Technical	72	42
Administrative	33	24
Supporting	84	52
Total	237	148

* including RMP and KVK

PERSONNEL

Dr. KK Sharma	Director (Actg.)

Lac Production Division

Dr. KK Sharma, Head	Agril Entomology
Dr. AK Singh	Plant Pathology
Dr. Md Monobrullah, Pr. Sc.	Agril Entomology
Dr. S Ghosal, Pr. Sc.	Agronomy
Dr. Jyotirmoy Gosh, Sr. Sc.	Gen Plant Breeding
Dr. Vaibhav D Lohot, Sc.	Plant Physiology
Sri Anees K, Sc.	Plant Biochemistry
Dr. (Mrs.) Thamilarasi K, Sc.	Agril Biotechnology
Sri SC Meena, Sc. (on study Leave)	Agril Entomology
Dr. A Mohanasundaram, Sc.	Agril Entomology
Dr. SS Bhatt, Sc.	Agro-Forestry
Sri Ashish Kr Raut, Sc.	Agril Entomology
Sri PA Ansari, TO	F/F Tech
Sri Binod Kumar, TO	F/F Tech
Sri SK Tripathi, TA	F/F Tech
Sri Bhupal Kumar, TA	F/F Tech

Processing and Product Development Division

Dr. N Prasad, Pr. Sc. & Head	AS & PE
Dr. Sanjay Srivastava, Pr. Sc.	Agril Chemical
Dr. (Ms) MZ Siddiqui, Pr. Sc.	Agril Chemical
Dr. PC Sarkar, Sr. Sc.	Agril Chemical
Dr. Md Fahim Ansari, Sr. Sc.	Agril Chemical
Er. SK Pandey, Sc.	Mech Engg
Dr. SC Sharma, Sc.	FM & Power
Dr. Arnab Roy Chowdhury, Sc.	Agril Chemical
Sri Nandkishore Thombare, Sc.	Agril Chemical
Sri CJ Mate, Sc.	Agril Chemical
Sri Md Ali, Sc.	Agril Chemical
Dr. Saurabh Swami, Sc.	Agril Chemical
Sri KK Prasad, CTO	Lab Tech
Sri SK Tirkey, TA	Lab Tech
Sri Ajay Kumar, TA	Lab Tech
Sri RK Rai, TA	Lab Tech
Sri Anup Kumr, TA	Lab Tech
Sri Binod Kumar, TA	Lab Tech

Transfer of Technology Division

Dr. AK Jaiswal, Pr. Sc. & Head (Actg.)	Agril Entomology
Dr. Alok Kumar, Sr. Sc.	Agril Extension
Dr. AK Singh, Sr. Sc.	Agronomy
Dr. RK Yogi, Sc.	Agril Economics
Dr. SKS Yadav, Sc.	Agril Chemical
Sri P Patamajhi, STO	F/F Tech
Sri RP Srivastava, TO	Photography Staff
Sri DK Singh, STO	F/F Tech
Sri AK Sinha, STO	F/F Tech
Sri SB Azad, TO	F/F Tech
Sri Madan Mohan, TA	F/F Tech

PME & IRIS Cell

Dr. Md Monobrullah, Pr. Sc.	I/c PME Cell
Dr. AK Singh, Pr. Sc.	I/c IRIS Cell
Sri D Ganguly, ACTO	Lab Tech
Sri Sunil Kumar, STO	Lab Tech

Quality Evaluation Lab (Under PPD Division)

Dr. Sanjay Srivastava, Pr. Sc.	I/c QEL
Sri BK Singh, TA	Lab Tech

Institute Research Farm (Under LP Division)

Sri Binod Kumar, TO	I/c, Farm
Sri Satish Kumar, STO	F/F Tech
Sri SK Mukherjee, TA	F/F Tech
Sri Jhirga Oraon, Tech	W & Engg

Library

Sri VK Singh, CTO	Lib. Inf. & Documentation
Sri Binod Kumar, STO	Lib. Inf. & Documentation

Estate Section

Sri AK Yadav, Security Officer	I/c Estate
Sri HL Bhakta, TO	W & Engg
Sri Binoy Kumar, Sr. TA	W & Engg
Sri Arjun Sharma, TA	W & Engg
Sri RK Ravi, TA	W & Engg
Sri K Tirkey, TA	W & Engg
Sri BS Choudhary, TA	W & Engg
Sri PVD Tirkey, TA	W & Engg
Sri Rama Kant Singh, Sr. Tech	W & Engg
Sri Anil Kr Sharma, Sr. Tech	W & Engg
Sri Mahavir Mahto, Tech	W & Engg
Sri Sukra Oraon, Tech	W & Engg

Hindi Cell

Dr. Anjesh Kumar, STO	Press & Editorial

Dispensary

Dr. PC Sarkar, Sr. Sc.	Chairman
Dr. Ashok Kumar	PT Medical Doctor
Dr. (Ms) RK Khalkho	PT Medical Doctor
Sri CK Singh, Sr. TA	Medical & Paramedical Pharmacist

Administration

Sri Sujit Kumar Singh	Sr. AO

Admin I Section

Sri Thibu Minz	Assistant
Sri SC Lal	Assistant
Sri RN Mahto	Assistant
Sri Krishna Murari Kumar	Sr. Clerk
Sri Bandhu Mahto	Jr. Clerk

Admin II Section

Sri Amrendra Kishore, AAO	DDO
Sri Anant Pandey	Assistant
Sri Arjun Gope	Assistant
Sri RK Toppo	Assistant
Sri Samal Kumar	Sr. Clerk (Cashier)

Admin III Section

Sri Prahlad Singh	AAO
Sri Ravishanker	Assistant
Sri Arun Kumar Tripathi	Assistant
Sri KK Deonath	Sr. Clerk

Audit & Accounts Section

Sri GC Joshi	F & AO
Sri Ashwini Kumar	JAO
Sri K Oraon	Assistant
Sri Bihari Sahu	Assistant
Sri KP Kashi	Sr. Clerk

Steno Pool

Sri SK Yadav	Private Secretary
Sri Hari Vilas	Stenographer Gr. III

Vehicle Pool

Sri Arbind Kumar, Sr. TA	Driver
Sri J Tewari, TA	Driver
Sri Mandeshwer Singh, TA	Driver
Sri RK Yadav, TA	Driver
Sri Bandi Oraon, Tech	Driver

A. Promotion

Technical

- Sri Dilip Kr Singh, TO (F/F Technician Group) promoted to the post of Sr. Technical Officer (F/F Technician Group) w.e.f. 01.01.2015.
- Sri AK Sinha, TO (F/F Technician Group) promoted to the post of Sr. Technical Officer (F/F Technician Group) w.e.f. 01.01.2015.
- Sri Binod Kumar (Library Information & Documentation Group) promoted to the post of Sr. Technical Officer (Library Information & Documentation Group) w.e.f. 27.4.2014.
- Sri BS Choudhury, TA (Workshop & Engg Group) promoted to the post of Sr. Technical Assistant (Workshop & Engg Group) w.e.f. 01.7.2014.
- Sri Rajesh Kr Yadav, TA (Workshop & Engg Group) promoted to the post of Sr. Technical Assistant (Workshop & Engg Group) w.e.f. 22.6.2014.
- Sri Mandeshwer Singh, TA (Workshop & Engg Group) promoted to the post of Sr. Technical Assistant (Workshop & Engg Group) w.e.f. 19.6.2014.

B. Transfer

- Sri KU Tribhuvan, Sc. transferred from ICAR-IINRG, Ranchi to ICAR-IIAB, Ranchi on 03.4.2015.
- Dr. Vibha Singhal, Sr. Sc. transferred from ICAR-IINRG, Namkum, Ranchi to ICAR-CHWR, Dehra Dun on 06.5.2015.
- Smt. PR Ghatak, ACTO transferred from ICAR-IINRG, Namkum, Ranchi to ICAR-CRIJAF, Kolkatta on 19.9.2015.

C. Joining

- Sri Md Ali, Sc. (Agril Chemical) has joined the Institute on 09.4.2015.
- Dr. Saurabh Swami (Agril Chemical) has joined the Institute on 09.10.2015.
- Sri Asish Kr. Rout (Agril Entomology) has joined the Institute on 12.10.2015.

D. Clearance of Probation Period

- Dr. RK Yogi, Sc. (Agril Economics) has completed probation on 31.8.2012 and confirmed from 01.9.2012.
- Sri Nandkishore Thombare, Sc. (Agril Chemical) has completed probation on 14.9.2013 and confirmed from 15.9.2013.

E. Retirement

- Sri TK Saha, ACTO retired on 28.02.2015.
- Sri Dukuma Oraon, SSS retired on 31.3.2015.
- Sri Jagarnath Hans, SSS retired on 31.3.2015.
- Sri Bhola Gope, SSS, retired on 31.3.2015.
- Sri Bhola Ram, TO retired on 31.4.2015.
- Sri LCCN Shahdeo, CTO retired on 30.9.2015.

Results-Framework Document (RFD)
for
ICAR - Indian Institute of Natural Resins and Gums
2014-2015

Section - 1 Vision, Mission, Objectives and Functions

Vision

Harnessing natural resins and gums for livelihood support to resource constrained farmers and promoting a healthier world, interlacing ecological development.

Mission

Accomplishing the vision through R&D and technology diffusion for sustainable lac production, processing, value addition, quality management and application / product development of natural resins and gums.

Objectives

- Development of sustainable lac production technologies.
- Development of processing techniques, value addition and novel applications for natural resins and gums.
- Capacity building and technology dissemination on natural resins and gums.

Functions

- To carry out research on all aspects of lac production, processing and application development of natural resins and gums.
- To conduct research on harvest, post-harvest management and value addition of natural resins and gums.
- Conservation of lac insect genetic resources in network mode.
- Information dissemination and technology transfer to stakeholders.

Section – 2 *Inter se* Priorities among Key Objectives, Success Indicators and Targets

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1.	Development of sustainable lac production technologies	28	To develop and modify lac production technologies for enhanced yield to overcome the adverse impact of climate change	Factors affecting lac productivity identified / managed through locational trials	Number	8	24	20	16	12	8
				LIFS models developed / evaluated / lac production trials conducted	Number	7	11	9	7	5	3
			To conserve and improve lac insect / host plant genetic resources for sustainable use	Lac insects and host plants characterized and evaluated	Number	7	26	22	18	14	10
				Lac insect and host plant biodiversity conserved in the Field Gene Banks of NATLIGEC	Number	6	194	162	130	98	66
2.	Development of processing techniques, value addition and novel applications for natural resins and gums	27	To develop / refine processing techniques / equipments	Process/ equipment for lac / gum processing designed / developed / evaluation trials conducted	Number	11	14	12	10	8	6
			To develop / refine value added products	NRG applications developed	Number	9	6	5	4	3	2
			Quality management	Quality parameters of NRGs determined and testing protocols developed	Number	7	13	11	9	7	5
3.	Capacity building and technology dissemination on natural resins and gums	25	To conduct training programmes on NRGs	Farmers / students / extension workers / entrepreneurs trained	Number	15	4920	4100	3280	2460	1640
			To demonstrate lac production, processing and product technologies	Demonstrations conducted / know-how transferred	Number	10	16	15	14	13	12
*	Publication / Documentation	5	Publication of the research articles in the Journals having NAAS rating of 6.0 and above	Research articles published	Number	3	5	4	3	2	1
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	June 30, 2014	July 02, 2014	July 04, 2014	July 07, 2014	July 09, 2014
*	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
*	Efficient functioning of the RFD system	3	Timely submission of Draft RFD for 2014-2015 for approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014
			Timely submission of Results for 2013-2014	On-time submission	Date	1	May 01, 2014	May 02, 2014	May 05, 2014	May 06, 2014	May 07, 2014
*	Enhanced transparency / Improved service delivery of Ministry / Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80
*	Administrative reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov. 01, 2014	Nov. 02, 2014	Nov. 03, 2014	Nov. 04, 2014	Nov. 05, 2014
			Implementation of agreed milestones of approved Mitigating Strategies for reduction of potential risk of Corruption (MSC)	% Implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for ISO : 9001	% implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% implementation	%	2	100	90	80	70	60

Section – 3 Trend Values of the Success Indicators

S. No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 12-13	Actual Value for FY 13-14	Target Value for FY 14-15	Projected Value for FY 15-16	Projected Value for FY 16-17
1.	Development of sustainable lac production technologies	To develop and modify lac production technologies for enhanced yield to overcome the adverse impact of climate change	Factors affecting lac productivity identified / managed through locational trials	Number	16	20	20	21	22
			LIFS models developed / evaluated / lac production trials conducted	Number	7	9	9	10	11
		To conserve and improve lac insect / host plant genetic resources for sustainable use	Lac insects and host plants characterized and evaluated	Number	10	20	22	23	24
			Lac insect and host plant biodiversity conserved in the Field Gene Banks of NATLIGEC	Number	160	161	162	162	163
2.	Development of processing techniques, value addition and novel applications for natural resins and gums	To develop / refine processing techniques / equipments	Process/ equipment for lac / gum processing designed / developed / evaluation trials conducted	Number	9	11	12	12	12
		To develop / refine value added products	NRG applications developed	Number	3	5	5	5	5
		Quality management	Quality parameters of NRGs determined and testing protocols developed	Number	8	10	11	11	12
3.	Capacity building and technology dissemination on natural resins and gums	To conduct training programmes on NRGs	Farmers / students / extension workers / entrepreneurs trained	Number	4076	2652	4100	4150	4200
		To demonstrate lac production, processing and product technologies	Demonstrations conducted / know-how transferred	Number	32	33	15	15	16

*	Publication / Documentation	Publication of the research articles in the Journals having NAAS rating of 6.0 and above	Research articles published	Number	4	6	4	6	7
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date			July 02, 2014		
*	Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	99.78	99.58	96	99.60	99.70
*	Efficient functioning of the RFD system	Timely submission of draft RFD for 2014-2015 for approval	On-time submission	Date			May 16, 2014		
		Timely submission of results for 2013-2014	On-time submission	Date			May 02, 2014		
*	Enhanced transparency/ Improved service delivery of Ministry/ Department	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%			95		
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%			95		
*	Administrative reforms	Update organizational strategy to align with revised priorities	Date	Date			Nov. 02, 2014		
		Implementation of agreed milestones of approved Mitigating Strategies for reduction of potential risk of Corruption (MSC)	% Implementation	%			90		
		Implementation of agreed milestones for ISO : 9001	% implementation	%			95		
		Implementation of milestones of approved Innovation Action Plans (IAPs)	% implementation	%			90		

Section -4(a) Acronyms

Sl. No.	Acronym	Description
1.	CCN	Community Coordination Network
2.	GOs	Government Organizations
3.	JASCOLAMPF	The Jharkhand State Co-operative Lac Marketing & Procurement Federation Ltd.
4.	LIFS	Lac Integrated Farming System
5.	NARS	National Agricultural Research System
6.	NATLIGEC	National Lac Insect Germplasm Bank
7.	IPR	Intellectual Property Right
8.	NRGs	Natural Resins and Gums
9.	R&D	Research and Development
10.	SAUs	State Agricultural Universities
11.	TRIFED	The Tribal Cooperative Marketing Development Federation of India Ltd.

Section – 4(b) Descriptions and Definition of Success Indicators and Proposed Measurement Methodology

Sl. No.	Success Indicator	Description	Definition	Measurement	General Comments
1	Factors affecting lac productivity identified / managed through locational trials	Large scale pre-summer mortality especially in *rangeeni* strain of lac insect has been observed due to various reasons affecting adversely the lac production base.	Modification of lac production system to devise the appropriate response to mortality.	Study of lac culture samples grown on different host plants from various locations to identify mortality factors. Measures taken to manage the mortality.	-
2	LIFS models developed / evaluated / lac production trials conducted	New lac integrated farming system models for land use diversification and enhanced returns.	Integration of lac culture with other cropping systems like horticulture, forestry and general agriculture.	Number of LIFS models developed and field trials conducted at farmers' field.	-
3	Lac insects and host plants characterized and evaluated	Source material to be evaluated for development of improved breeds / combinations.	Material generated from the basic germplasm.	Number of lac insect stocks/ host plants characterized / evaluated.	-

Sl. No.	Success Indicator	Description	Definition	Measurement	General Comments
4	Lac insect and host plant biodiversity conserved in the Field Gene Banks of NATLIGEC	*Ex-situ* conservation of lac insects and host plants. Diverse germplasm is a source for genetic variability and is basic requirement to select / develop new improved varieties / lac insect - host plant combinations.	Basic genetic resource for lac insect and host plant improvement.	Number of germplasm samples/ accessions collected / conserved live.	-
5	Process / equipment for lac/ gum processing designed / developed / evaluation trials conducted	NRGs need processing to remove impurities for their value addition, application and end use.	Developing improved methods of processing and machines for different processing operations to reduce drudgery, cost and improve quality and yield.	Number of trials conducted for development of improved processing / units.	-
6	NRG applications developed	NRGs are low volume, high value products and find application in various industries. Development of novel applications for NRGs in food, cosmetics and pharmaceutical industry for higher domestic consumption and fetching better price in export markets.	Developing newer application areas for utilization of NRGs in domestic as well as for export markets.	Number of modifications/ evaluations /trials conducted for development of application areas.	-
7	Quality parameters of NRGs determined and testing protocols developed	Exploring unknown and known physico-chemical properties for quality determination, improvement and development of testing methods.	Determining quality parameters of NRGs to study their variability.	Number of quality parameters of NRGs studied.	-
8	Farmers / students / extension workers / entrepreneurs trained	Most of the farmers/stakeholders of the region are illiterate and economically backward. They cultivate natural resins and gums by practising traditional system resulting in poor yield. Therefore, popularization and field demonstration of potential production technologies related to natural resins and gums would help in increasing the productivity.	Technology diffusion on production and utilization would be achieved through capacity building.	Number of beneficiaries.	Targets for number of trainees given in Section 2 and their respective trend values in Section 3 may vary, depending upon the number of participants sponsored
9	Demonstrations conducted / know-how transferred	There is big yield and communication gap hampering technology application.	Speedy and grassroot level efforts to be made through demonstration, exhibition publicity, education etc.	Number of events like demonstrations (locations covered), Kisan mela, Exhibition, Field day, Technology fortnight, Number of published material (folder, pamphlet/booklet and advisory services to institutions.	-

Section - 5 Specific Performance Requirements from other Departments (critical for delivering agreed results)

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this organization	What happens if your requirement is not met
State Govt.	Lac growing states *viz.* Chhattisgarh, Jharkhand, Madhya Pradesh, West Bengal, Andhra Pradesh and Gujarat	GOs / NARS / NGOs	Forest Departments/ SAUs / Lac Industry	Farmers / students / extension workers / entrepreneurs trained	Sponsorship of beneficiaries	To structure training programmes as per participants' requirement	Type of trainees *i.e.* farmers/ students / entrepreneurs	Less or more number of training programmes / trainees

Section - 6 Outcome / Impact of Activities of Department / Ministry

S. No.	Outcome / Impact	Jointly responsible for influencing this outcome / impact with the following Organization (s) / Department (s) / Ministry (ies)	Success Indicator (s)	Units	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1.	Increase in area under systematic lac host plantation	State Forest Departments of Chhattisgarh, Jharkhand, Madhya Pradesh, West Bengal, Andhra Pradesh and Gujarat / JHASCOLAMPF / NGOs-Udyogini, Pradan, CCN Sahyog etc.	Area brought under lac cultivation	% increase	10	10	5	5	5
2.	Improvement in processing and value addition of natural resins and gums	Inter-Institutional collaboration / SAUs / NRG Industries / Entrepreneurs / Network partner	Export of NRG based processed and value added products (quantity)	% increase	1	1	1	1	1
3.	Capacity building in terms of trained lac growers / Entrepreneurs	State Forest departments of Chhattisgarh, Jharkhand, Madhya Pradesh, West Bengal and Andhra Pradesh / NGOs / JHASCOLAMPF / TRIFED	Beneficiaries trained in production, processing and product development technologies on natural resins and gums	% increase	5	5	4	3	2

Target Setting

S. No.	Success indicator(s)	Past Achievements of the Success Indicators								Mean of the Achievements	Projected value of the success indicator for 2014-15 as per the approved RFD 2013-14
		VIII	VII	VI	V	IV	III	II	I		
		2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14		
1.	Factors affecting lac productivity identified / managed through locational trials	-	11	10	12	11	12	26*	20*	11.20	20
2.	LIFS models developed / evaluated / lac production trials conducted	-	5	5	4	4	3	9*	9*	4.20	10
3.	Lac insects and host plants characterized and evaluated	-	19*	13	19*	15	14	14	20*	14.00	22
4.	Lac insect and host plant biodiversity conserved in the Field Gene Banks of NATLIGEC	-	131*	144	147	152	155	160	161	153.17	162
5.	Process / equipment for lac / gum processing designed / developed / evaluation trials conducted	4	3	5	4	5	7	9*	11*	4.67	12
6.	NRG applications developed	3	5	3	3	3	2	3	5	3.38	5
7.	Quality parameters of NRGs determined and testing protocols developed	6	8	7	6	5	6	8	10*	6.57	11
8.	Farmers / students / extension workers / entrepreneurs trained	-	5277*	1813	1242	5282*	5632*	4076*	2652	1902.33	4100
9.	Demonstrations conducted / know-how transferred	-	16	04*	13	06*	26*	13	33*	14.00	15

* Outliers not taken in to account

Classification of the Success Indicator According to its Category

S. No.	Success Indicators	Input	Activity	Internal Output	External Output	Outcome	Measures Qualitative Aspects
1.	Factors affecting lac productivity identified / managed through locational trials	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
2.	LIFS models developed / evaluated / lac production trials conducted	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
3.	Lac insects and host plants characterized and evaluated	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
4.	Lac insect and host plant biodiversity conserved in the Field Gene Banks of NATLIGEC	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
5.	Process / equipment for lac / gum processing designed / developed / evaluation trials conducted	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
6.	NRG applications developed	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
7.	Quality parameters of NRGs determined and testing protocols developed	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
8.	Farmers / students / extension workers / entrepreneurs trained	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
9.	Demonstrations conducted / know-how transferred	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report of RFD of RSCs i.e. Institutions for the year 2014-2015

Name of the Division : Agricultural Engineering
Name of the Institution : ICAR-Indian Institute of Natural Resins and Gums
RFD Nodal Officer : Dr. KK Sharma, Head, Lac Production Division

Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
						Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score		
						100%	90%	80%	70%	60%					
Development of sustainable lac production technologies	28	To develop and modify lac production technologies for enhanced yield to overcome the adverse impact of climate change	Identification / management of factors affecting lac productivity through locational trials	Number	8	24	20	16	12	08	21	92.5	7.40	105.0	
			Development / evaluation trials of lac production / LIFS models	Number	7	11	9	7	5	3	10	95.0	6.65	111.1	
		To conserve and improve lac insect / host plant genetic resources for sustainable use	Characterization and evaluation of lac insects and host plants	Number	7	26	22	18	14	10	26	100.00	7.00	118.2	
			Conservation of lac-insect and host plant biodiversity in the Field Gene Banks of NATLIGEC	Number	6	194	162	130	98	66	163	90.03	5.40	100.6	
Development of processing techniques, value addition and novel applications for natural resins and gums	27	To develop / refine processing techniques / equipments	Design / development / evaluation trials for process / equipment for lac / gum processing	Number	11	14	12	10	8	6	12	90.00	9.90	100.0	
		To develop / refine value added products	Application development of NRGs	Number	9	6	5	4	3	2	5	90.00	8.10	100.0	
		Quality management	Determination of quality parameters of NRGs and testing protocol development	Number	7	13	11	9	7	5	12	95.00	6.65	109.1	


Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
						Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score		
						100%	90%	80%	70%	60%					
Capacity building and technology dissemination on natural resins and gums	25	To conduct training programmes on NRGs	Farmers / students / extension workers / entrepreneurs trained	Number	15	4920	4100	3280	2460	1640	4155	90.07	13.51	101.3	
		To demonstrate lac production, processing and product technologies	Demonstrations conducted / transfer of know-how	Number	10	16	15	14	13	12	20	100.00	10.00	133.3	
Publication / Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	5	4	3	2	1	5	100.00	3.00	125.0	
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	Jun. 30, 2014	Jul. 02, 2014	Jul. 04, 2014	Jul. 07, 2014	Jul. 09, 2014	May 31, 2014	100.00	2.00	-	
Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	99.37	100.00	2.00	-	
Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	May. 15, 2014	May. 16, 2014	May. 19, 2014	May. 20, 2014	May. 21, 2014	May.14, 2014	100.00	2.00	-	
		Timely submission of Results for 2013-2014	On-time submission	Date	1	May. 01, 2014	May. 02, 2014	May. 05, 2014	May. 06, 2014	May. 07, 2014	Apr. 30, 2014	100.00	1.00	-	
Enhanced Transparency / Improved Service delivery of Ministry / Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	100	100.00	2.00	-	
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100.00	1.00	-	

Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
						Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score		
						100%	90%	80%	70%	60%					
Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov. 01, 2014	Nov. 02, 2014	Nov. 03, 2014	Nov. 04, 2014	Nov. 05, 2014	Oct.25, 2014	100.00	2.00	-	
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC).	% Implementation	%	1	100	90	80	70	60	100	100.00	1.00	-	
		Implementation of agreed milestones for ISO 9001	% implementation	%	2	100	95	90	85	80	0	0.00	0.00	-	
		Implementation of milestones of approved Innovation Action Plans (IAPs).	% implementation	%	2	100	90	80	70	60	100	100.00	2.00	-	
Total Composite Score														92.61	
Rating														Very Good	

ANNEXURE-I

Actual Scientific Staff in position in the Institute and their research articles published in International and National Journals having NAAS rating 6.00 or more during April 1, 2014--March 31, 2015

Name of the Division : AGRICULTURAL ENGINEERING
Name of the Institute : ICAR-Indian Institute of Natural Resins and Gums

S. No.	Category of Scientific Staff	Actual Scientific Staff in Position (Nos.)	Research Articles/ Publications as First /Corresponding Author (Nos.)	Publication productivity (Number of research articles /publications divided by number of Scientists)
1.	Principal Scientist	08	05	0.63
2.	Senior Scientist	06	01	0.17
3.	Scientist	16	00	0.00
Total		30	06	0.20

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.	Mising Autonomous Council	Assam	01.01.15 to 06.01.15	22	04	26
	2.	AIE Valley Producer & Allied Agro Marketing Co-operative Society Ltd.	Assam	22.01.15 to 25.01.15	08	-	08
	3.	ICAR-IINRG, Ranchi under tribal sub-plan (TSP), Rourkela	Odisha	27.01.15 to 31.01.15	19	-	19
March	4.	ICAR-IINRG, Ranchi under tribal sub-plan (TSP), Sundargarh	Odisha	16.3.15 to 21.3.15	19	03	22
		Private, Ranchi	Jharkhand	16.3.15 to 21.3.15	01	-	01
May	5.	Watershed Organisation Trust (WOTR), Murhu, Khunti	Jharkhand	18.5.15 to 22.5.15	44	-	44
July	6.	DAO & KVK, Khunti	Jharkhand	30.6.15 to 04.7.15	15	-	15
August	7.	DRDA Chirang, Assam (NEH sub-plan)	Assam	10.8.15 to 14.8.15	12	-	12
November	8.	Mahila Arthik Vikas Mahamandal, Gondia	Maharashtra	02.11.15 to 06.11.15	03	23	26
		AROUSE, Gumla	Jharkhand	03.11.15 to 07.11.15	09	-	09
		Private, Ranchi	Jharkhand	03.11.15 to 07.11.15	01	-	01
December	9.	Chhotanagpur Vikas Nidhi, Hira Nagar, Salgutu, Kamdara, Gumla	Jharkhand	14.12.15 to 18.12.15	22	02	24
				Total	175	32	207
Master trainers' training programme on scientific lac production, processing and uses							
January	1.	TRIFED-North East Naga Traders Pvt. Ltd. (TSP)	Nagaland	06.01.15 to 09.01.15	03	01	04
		Jhalda Lac Growers Association, Purulia	West Bengal	06.01.15 to 09.01.15	47	01	48
	2.	Tribal Welfare Department, (TWC), Simdega	Jharkhand	12.01.15 to 17.01.15	42	10	52
		Adivasi Mahila Samaj Seva Kendra, Gumla	Jharkhand	12.01.15 to 17.01.15	11	-	11
	3.	Tribal Welfare Department, (TWC), Simdega	Jharkhand	19.01.15 to 24.01.15	34	14	48
	4.	Odisha Livelihood Mission, DRDA, Mayurbhanj	Odisha	27.01.15 to 31.01.15	24	-	24

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
February	5.	Tribal Welfare Department, (TWC), Jharkhand through Integrated Tribal Development Society, Goilkera, W. Singhbhum	Jharkhand	02.02.15 to 07.02.15	27	-	27
		Tribal Welfare Department, (TWC), Jharkhand through SBMS, Chaibasa	Jharkhand	02.02.15 to 07.02.15	15	-	15
		Private, Ranchi	Jharkhand	02.02.15 to 07.02.15	02	-	02
	6.	Jhalda Lac Growers Association, Purulia	West Bengal	09.02.15 to 13.02.15	16	-	16
		Forest Department, Godda and Giridih	Jharkhand	09.02.15 to 13.02.15	22	-	22
	7.	Tribal Welfare Department, (TWC), W. Singhbhum	Jharkhand	23.02.15 to 28.02.15	25	-	25
March	8.	Jhalda Lac Growers Association, Purulia	West Bengal	02.3.15 to 05.3.15	55	-	55
	9.	South Forest Division, Chatra	Jharkhand	09.3.15 to 13.3.15	13	-	13
		Forest Department, Khunti	Jharkhand	09.3.15 to 13.3.15	13	-	13
		Forest Department, West Hazaribagh	Jharkhand	09.3.15 to 13.3.15	13	-	13
		Forest Department, Chaibasa	Jharkhand	09.3.15 to 13.3.15	10	-	10
		Private, Bano, Simdega	Jharkhand	09.3.15 to 13.3.15	01	-	01
	10.	Forest Department, Hazaribagh	Jharkhand	16.3.15 to 21.3.15	11	-	11
	11.	ATMA, Deoghar	Jharkhand	23.3.15 to 27.3.15	24	-	24
		Forest Department, Deoghar	Jharkhand	23.3.15 to 27.3.15	22	-	22
		Forest Department, Simdega	Jharkhand	23.3.15 to 27.3.15	08	-	08
April	12.	Forest Department, Dhanbad	Jharkhand	06.4.15 to 10.4.15	10	-	10
		Forest Department, W. Singhbhum	Jharkhand	06.4.15 to 10.4.15	25	-	25
		Forest Department, Ramgarh	Jharkhand	06.4.15 to 10.4.15	07	-	07

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
	13.	Tribal Welfare Department (TWC), Ramgarh	Jharkhand	13.4.15 to 18.4.15	12	-	12
		Tribal Welfare Department (TWC), Simdega	Jharkhand	15.4.15 to 18.4.15	11	02	13
		Private, Ranchi	Jharkhand	15.4.15 to 18.4.15	02	-	02
		Jhalda Lac Growers Association, Purulia	West Bengal	15.4.15 to 18.4.15	26	-	26
	14.	Tribal Welfare Department (TWC), Palkot, Gumla	Jharkhand	20.4.15 to 25.4.15	18	-	18
		Tribal Welfare Department, (TWC), Lapung, Ranchi	Jharkhand	20.4.15 to 25.4.15	06	-	06
		Private, Purulia	West Bengal	20.4.15 to 25.4.15	01	-	01
May	15.	Jhalda Lac Growers Association, Purulia	West Bengal	05.5.15 to 08.5.15	13	05	18
		Chhotanagpur Vikas Nidhi, Lachragarh (Trainees from Gumla)	Jharkhand	05.5.15 to 08.5.15	10	-	10
		ATMA, Khunti	Jharkhand	06.5.15 to 08.5.15	04	02	06
	16.	Tribal Welfare Department, Ranchi	Jharkhand	11.5.15 to 16.5.15	09	-	09
		Tribal Welfare Department, Ranchi	Jharkhand	12.5.15 to 16.5.15	07	-	07
	17.	Forest Department, East Singhbhum	Jharkhand	18.5.15 to 22.5.15	06		06
	18.	Forest Department, Bastar	Chhattisgarh	25.5.15 to 30.5.15	19	-	19
		Forest Department, Simdega	Jharkhand	27.5.15 to 30.5.15	07	-	07
June	19.	Tribal Welfare Department, Ranchi, Jharkhand (TWC)	Jharkhand	17.6.15 to 20.6.15	15	-	15
August	20.	Forest Development Corporation, Purulia	West Bengal	03.8.15 to 07.8.15	20	-	20
	21.	DRDA Chirang, Assam (NEH sub- Plan)	Assam	10.8.15 to 14.8.15	03	-	03
September	22.	BAIF/SPESD, Betul	Madhya Pradesh	07.9.15 to 11.9.15	06	01	07
		BAIF-MITTRA, Gadchiroli	Maharashtra	07.9.15 to 11.9.15	11	-	11
		AROUSE, Gumla	Jharkhand	07.9.15 to 11.9.15	12	05	17
		Private, Gumla	Jharkhand	07.9.15 to 11.9.15	01	-	01
December	23.	Jhalda Lac Growers Association, Purulia	West Bengal	21.12.15 to 24.12.15	33	05	38
				Total	**732**	**46**	**778**

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
Educational programme on production, processing and uses of natural resins and gums							
January	1.	Guru Ghasidas University, Bilaspur (M.Sc. Forestry Students) under Industrial Training on Natural Resins and Gums	Chhattisgarh	16.02.15 to 28.02.15	01	10	11
June	2.	Institute of Agriculture, BHU, Varanasi	Uttar Pradesh	02.6.15 to 11.6.15	08	06	14
		Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHIATS), Allahabad	Uttar Pradesh	02.6.15 to 11.6.15	14	11	25
				Total	23	27	50
Vocational training for skill development on lac processing							
July	1	JASCOLAMPF, Ranchi	Jharkhand	24.7.15 to 25.7.15	25	-	25
				Total	25	-	25
National workshop on current trends in lac production on F. semialata & sustainable lac production technologies							
November	1	ICAR-IINRG, Namkum, Ranchi	Chhattisgarh	26.11.15 to 27.11.15	10	-	10
		ICAR-IINRG, Namkum, Ranchi	Gujarat	26.11.15 to 28.11.15	27	-	27
				Total	**37**	**-**	**37**

Appendix – II On-farm training programme on scientific lac cultivation

Camp No.	District –State	Sponsoring/ Nominating Agency	Venue	Date	M	F	No. of Participants
1.	Khunti, Jharkhand	Forest Department	Kisan Bhavan, Rania	05.01.15	101	14	115
2.	Khunti, Jharkhand	Forest Department	RFO Office, Karra	06.01.15	180	10	190
3.	W. Singhbhum, Jharkhand	Forest Department	Forest Training Hall, Chaibasa	11.02.15	59	-	59
4.	Latehar, Jharkhand	Forest Department	Chandwa Range Office, Chandwa	16.02.15	130	01	131
5.	Latehar, Jharkhand	Forest Department	Training Hall, Latehar	17.02.15	55	01	56
6.	Latehar, Jharkhand	Forest Department	Training Hall, Manika	17.02.15	29	-	29
7.	Giridih, Jharkhand	Forest Department	Pirtand Nursery Campus	19.02.15	140	10	150
8.	Garhwa, Jharkhand	Forest Department	Range Office, Nagar	25.02.15	70	-	70
9.	Garhwa, Jharkhand	Forest Department	Range Office, Bhawanathpur	25.02.15	60	-	60
10.	Latehar, Jharkhand	JASCOLAMPF, Ranchi	Darudih, Lesliganj, Latehar	12.3.15	80	10	90

Camp No.	District –State	Sponsoring/ Nominating Agency	Venue	Date	M	F	No. of Participants
11.	Latehar, Jharkhand	JASCOLAMPF, Ranchi	Lamps Office, Ranka	12.3.15	60	10	70
12.	Garhwa, Jharkhand	Forest Department	Forest Guest House, Dhurki	19.3.15	30	22	52
13.	Ramgarh, Jharkhand	Forest Department	Kulhi, Sikideri, Ramgarh	18.4.15	40	31	71
14.	Simdega, Jharkhand	Forest Department	Beat Office Campus, Thataitangar	10.6.15	49	17	66
15.	Simdega, Jharkhand	Forest Department	Van Nigam Campus, Kurdeg	10.6.15	25	85	110
16.	Palamu, Jharkhand	Nav Jeevan Hospital, Satbarwa	Teacher Training Hall, Satbarwa	24.6.15	31	15	46
17.	Latehar, Jharkhand	Adivashi Mahila Vikas Sammittee, Gumla	Primary School, Balumath	25.6.15	70	02	72
18.	Chatra, Jharkhand	Forest Department	Range Office, Simaria, Chatra	03.10.15	320	05	325
19.	Ramgarh, Jharkhand	Forest Department	DFO Office Campus, Maner	15.10.15	45	150	195
20.	Ramgarh, Jharkhand	Forest Department	Kulhi High School, Campus	16.10.15	90	100	190
21.	Ramgarh, Jharkhand	Forest Department	Barlanga High School, Gola	18.10.15	190	25	215
22.	Raigarh, Chhattisgarh	Forest Department	Poriya, Dharamjaigarh	08.12.15	40	15	55
23.	Korba, Chhattisgarh	Forest Department	Karumahna, Korba	09.12.15	55	-	55
24.	Raigarh, Chhattisgarh	Forest Department	Chindmar, Kathghora	09.12.15	45	-	45
25.	Khunti, Jharkhand	Forest Department	Arki Block Compound	22.12.15	90	05	95
26.	Khunti, Jharkhand	Forest Department	Range Office, Bundu	23.12.15	135	04	139
				Total	**2219**	**532**	**2751**
On-farm motivational / supplementary training programme on lac cultivation							
1.	Khunti, Jharkhand	TRDS, Torpa	Panchayat Bhawan, Bertoli, Banabira, Torpa	31.01.15	20	40	60
2.	Ranchi, Jharkhand	Gram Jan Jagriti Munch	Primary School, Tutihara, Namkum	01.7.15	30	03	33
3.	Khunti, Jharkhand	Forest Department	Agriculture office, Khunti	22.7.15	50	-	50
4.	Gumla, Jharkhand	AROUSE, Gumla	Community Hall, Gumla	28.9.15	07	34	41
5.	Khunti, Jharkhand	Forest Department	Range Office, Karra	16.12.15	55	05	60
				Total	**162**	**82**	**244**

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

Camp No.	District –State	Nominating Agency	Date	M	F	No. of Participants
1.	Bokaro, Jharkhand	JOR, Peterwar, Bokaro	09.01.2015	23	27	50
2.	Khunti, Jharkhand	ATMA, Simdega	12.01.2015	08	07	15
3.	Gumla, Jharkhand	Mahila Mandal, Gumla	16.01.2015	-	39	39
4.	W. Singhbhum, Jharkhand	ITDS, Goilkera	21.01.2015	12	-	12
5.	Bokaro, Jharkhand	JOR, Peterwar, Bokaro	09.01.2015	23	27	50
6.	Khunti, Jharkhand	ATMA, Simdega	12.01.2015	08	07	15
7.	Gumla, Jharkhand	Mahila Mandal, Gumla	16.01.2015	-	39	39
8.	W. Singhbhum, Jharkhand	ITDS, Goilkera	21.01.2015	12	-	12
9.	Bokaro, Jharkhand	JOR, Peterwar, Bokaro	29.01.2015	27	23	50
10.	Meghalaya, Shillong	Meghalaya Institute of Entrepreneurship, Shillong	04.02.2015	12	10	22
11.	Meghalaya, Shillong	Meghalaya Institute of Entrepreneurship, Shillong	04.02.2015	16	22	38
12.	Jashpur, Chhattisgarh	RCADS, Jashpur	05.02.2015	62	-	62
13.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	10.02.2015	160	02	162
14.	Ranchi, Jharkhand	IFP, Lalgutwa, Ranchi	12.02.2015	26	04	30
15.	Ranchi, Jharkhand	Bayer Crop Science, Ranchi	16.02.2015	20	-	20
16.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	20.02.2015	87	07	94
17.	Imphal, Manipur	CAU, Imphal	23.02.2015	11	07	18
18.	Ranchi, Jharkhand	Firayalal Public School, Ranchi	25.02.2015	40	28	68
19.	Ranchi, Jharkhand	RK Mission Vivekananda University, Ranchi	25.02.2015	22	01	23
20.	Ranchi, Jharkhand	RCADS, Jashpur	25.02.2015	39	01	40
21.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	25.02.2015	38	10	48
22.	Ranchi, Jharkhand	Udyogini, Ranchi	25.02.2015	05	100	105
23.	Khunti, Jharkhand	Royni Self Help Group, Simdega	28.02.2015	06	15	21
24.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	11.3.2015	45	-	45
25.	Simdega, Jharkhand	JASCOLAMPF, Ranchi	11.3.2015	28	07	35
26.	Latehar, Jharkhand	Progressive farmers	16.3.2015	14	38	52
27.	Ranchi, Jharkhand	UDYOGNI, Ranchi	16.3.2015	-	60	60
28.	Ranchi, Jharkhand	DAV, Pundag, Ranchi	19.3.2015	33	-	33
29.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	19.3.2015	82	-	82
30.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	19.3.2015	40	-	40
31.	Ranchi, Jharkhand	MUDRIKA, Ranchi	20.3.2015	40	-	40
32.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	23.3.2015	43	02	45
33.	Narayanpur, Chhattisgarh	RK Mission, Narayanpur, Chhattisgarh	25.3.2015	50	-	50
34.	Ranchi, Jharkhand	BAU, Kanke, Ranchi	27.3.2015	27	03	30
35.	Ranchi, Jharkhand	RK Mission, Ranchi	30.3.2015	63	-	63
36.	Ranchi, Jharkhand	JASCOLAMPF, Ranchi	31.3.2015	60	40	100

Camp No.	District –State	Nominating Agency	Date	M	F	No. of Participants
37.	Ranchi, Jharkhand	IICM, Ranchi	16.4.2015	20	10	30
38.	Ranchi, Jharkhand	GEL Church, Zadakudar	16.4.2015	11	-	11
39.	Ranchi, Jharkhand	Progressive farmers, Silli	02.5.2015	14	17	31
40.	Ranchi, Jharkhand	RUDSETI, Silli	12.5.2015	18	13	31
41.	Ranchi, Jharkhand	JASCOLAMPF	16.5.2015	100	-	100
42.	Ranchi, Jharkhand	RUDSETI, Silli	21.5.2015	20	03	23
43.	Ranchi, Jharkhand	JASCOLAMPF	21.5.2015	65	-	65
44.	Ramgarh, Jharkhand	SUPPORT	20.6.2015	04	25	29
45.	Latehar, Jharkhand	MESSO, Balumath	26.6.2015	50	-	50
46.	Ranchi, Jharkhand	Progressive farmers	02.7.2015	25	02	27
47.	Ranchi, Jharkhand	CJJM, Chene, Namkum	02.7.2015	18	04	22
48.	Baruihat, Assam	Forest Department	13.7.2015	28	11	39
49.	Ranchi, Jharkhand	JASCOLAMPF	24.7.2015	28	03	31
50.	Ranchi, Jharkhand	RK Mission	11.8.2015	16	01	17
51.	Latehar, Jharkhand	JSLPS	11.9.2015	11	23	34
52.	Ranchi, Jharkhand	XISS	16.9.2015	35	37	72
53.	Ranchi, Jharkhand	Guru Nanak School	22.9.2015	-	-	216
54.	Ranchi, Jharkhand	St. Francis School, Namkum	22.9.2015	-	-	86
55.	Ranchi, Jharkhand	Manan Vidya, Dumardaga	22.9.2015	-	50	184
56.	Ranchi, Jharkhand	Central School, Namkum	22.9.2015	-	-	129
57.	Ranchi, Jharkhand	Manan Vidya, Dumardaga	22.9.2015	-	-	167
58.	Ranchi, Jharkhand	Bishop Westcott Boys School	22.9.2015	-	-	93
59.	Ranchi, Jharkhand	Govt. Buniyadi Middle School	22.9.2015	-	-	124
60.	Ranchi, Jharkhand	Model School	22.9.2015	-	-	23
61.	Ranchi, Jharkhand	Bishop Westcott Girls School	23.9.2015	-	96	96
62.	Ranchi, Jharkhand	Bishop Westcott Girls School	23.9.2015	-	92	92
63.	Ranchi, Jharkhand	Sacred Pioneer Public School	23.9.2015	-	-	140
64.	Ranchi, Jharkhand	Sachidanand Gyan Bharti Model School	23.9.2015	-	-	72
65.	Ranchi, Jharkhand	Sachidanand Gyan Bharti Model School	23.9.2015	-	-	52
66.	Ranchi, Jharkhand	Kasturba Gandhi Balika Vidyalaya	23.9.2015	1	109	110
67.	Ranchi, Jharkhand	Bishop Westcott Girls School	23.9.2015	-	200	200
68.	Ranchi, Jharkhand	Progressive farmers	26.9.2015	04	10	14
69.	Ranchi, Jharkhand	CTRI, Nagri, Ranchi	07.10.2015	14	14	28
70.	Ranchi, Jharkhand	ROUTSET, Shilli	08.10.2015	-	45	45
71.	Ranchi, Jharkhand	BAU, Kanke	14.10.2015	17	06	23
72.	Ranchi, Jharkhand	BAU, Kanke	27.10.2015	16	14	30
73.	Purulia, W.B.	Progressive farmers	29.10.2015	30	-	30
74.	Ranchi, Jharkhand	JASCOLAMPF	07.11.2015	60	02	62

Camp No.	District –State	Nominating Agency	Date	M	F	No. of Participants
75.	Ranchi, Jharkhand	RK Mission	07.11.2015	40	-	40
76.	Sundargarh, Odisha	Dalmia College, Rajgangpur	18.11.2015	05	23	28
77.	Ranchi, Jharkhand	JASCOLAMPF	30.11.2015	48	-	48
78.	Ranchi, Jharkhand	SBM Sr. Sec. School, Kamre	09.12.2015	54	52	106
79.	Ranchi, Jharkhand	RK Mission	09.12.2015	33	-	33
80.	Ranchi, Jharkhand	Kairali School, Dhurwa	17.12.2015	130	127	257
81.	Lohardaga, Jharkhand	BOI RSETI	26.12.2015	16	10	26
			Total	**3349**	**1525**	**4874**

Appendix – IV Workshop/ FIG /Educational programme on lac cultivation

Camp No.	District –State	Nominating Agency	Venue (Village, Block)	Date	No. of Participants	Name of Programme
1.	Sundergarh, Odisha	SEET, Rourkela	Kuchaita (Sarrgigarh), Rourkela	22.01.15	102	Workshop
2.	Khunti, Jharkhand	Torpa Rural Development Society (TRDS), Torpa	KVK, Khunti	23.01.15	155	*Kisan Gosthi*
3.	Ranchi, Jharkhand	Gunj Parivar	Lagam, Silli, Ranchi	31.01.15	300	*Kisan Gosthi*
4.	Khunti, Jharkhand	TRDS, Torpa	TRDS,Torpa	31.01.15	60	Workshop
5.	Ranchi, Jharkhand	RK Mission, Ranchi	RK Mission Farm, Getalsud, Angara	13.02.15	600	*Kisan Gosthi*
6.	Khunti, Jharkhand	JASCOLAMPF, Ranchi	Kisan Bhawan, Rania	09.3.15	120	*Kisan Gosthi*
7.	Khunti, Jharkhand	JASCOLAMPF, Ranchi	Kisan Bhawan, Arki	10.3.15	105	*Kisan Gosthi*
8.	Gumla, Jharkhand	JASCOLAMPF, Ranchi	Lamps Campus, Palkot	11.3.15	105	*Kisan Gosthi*
9.	Palamu, Jharkhand	JASCOLAMPF, Ranchi	Lamps Campus, Chainpur	13.3.15	70	*Kisan Gosthi*
10.	Gumla, Jharkhand	JASCOLAMPF, Ranchi	Lamps Campus, Sesai	14.3.15	60	*Kisan Gosthi*
11.	W. Singhbhum, Jharkhand	JASCOLAMPF, Ranchi	Lamps Campus, Anandpur	18.3.15	105	*Kisan Gosthi*
12.	Simdega, Jharkhand	JASCOLAMPF, Ranchi	Panchayat Bhwan, Barka Duiel, Bano	20.3.15	70	*Kisan Gosthi*
13.	Gumla, Jharkhand	JASCOLAMPF, Ranchi	Lamps Campus, Bharno	24.3.15	57	*Kisan Gosthi*
14.	Sundargarh, Odisha	SEET, Rourkela	Hatioda, Gurundia,	18.4.15	45	FIG Meeting
15.	Khunti, Jharkhand	TRDS, Torpa	TRDS, Torpa	22.5.15	100	FIG Meeting
16.	Khunti, Jharkhand	TRDS, Torpa	Baghia, Rania	06.6.15	37	*Kisan Gosthi*
17.	Khunti, Jharkhand	TRDS, Torpa	Farmers' Building, Arki	15.7.15	250	Farmer-Interface Meeting

Camp No.	District –State	Nominating Agency	Venue (Village, Block)	Date	No. of Participants	Name of Programme
18.	Khunti, Jharkhand	TRDS, Torpa	Farmers' Building, Arki	21.7.15	300	Farmer-Interface Meeting
19.	Khunti, Jharkhand	TRDS, Torpa	Farmers' Building, Arki	19.9.15	195	Farmer-Interface Meeting
				Total	**2836**	

Appendix – V Activities of NIC and MOTAS under one to one programme (OTOP)

S. No.	State	Organization/District/Place	Category	Number
1.	Assam	Dhemaji	GOs	04
2.	Chhattisgarh	Raigarh	Exporter	01
		Janjgir champa	Entrepreneurs	01
		Korea	GO	01
		Ambikapur	Processor	01
3.	Delhi	New Delhi	Researcher/Scholars	03
4.	Jharkhand	Gumla	Farmer	01
		Khunti	Processors	01
		Ramgarh	Farmer	01
		Ranchi	Entrepreneurs	02
			Farmer	09
			Traders	01
			GOs	01
			Researcher/Scholars	03
		Simdega	Entrepreneurs	01
		Saraikela Kharsawan	GOs	01
		West Singhbhum	Farmer	02
			Traders	03
5.	Karnataka	Uttara Kannada	Entrepreneurs	01
		Bangalore	Processors/exporters	01
6.	Odisha	Kalahandi	Entrepreneurs	01
			Processors	01
7.	Madhya Pradesh	Balaghat	Farmer	01
8.	Maharashtra	Mumbai	Processors	01
			Manufactures	01
			Exporters	01
9.	Andhra Pradesh	Vishakhapatnam	Entrepreneurs	03
10.	Telangana	Hyderabad	Researcher	01
11.	West Bengal	Purulia	Farmer	01
12.	Nepal	Kathmandu	Trader/Processors	03
			Total	**53**

Appendix – VI Lac crop surveillance conducted

S. No.	Village (Block)	District (State)	Date	Crop	Observation
1.	Guyanala, Amadova, Jalari, Ghorabari (Khatra)	Bankura (W.B.)	17.01.15	*Rangeeni* lac on *B. monosperma* and *Z. mauritiana*	Average to good settlement of lac insect was observed.
2.	Jilmili (Raniband)	Bankura (W.B.)	03.3.15	*Rangeeni* lac on *B. monosperma* and *Z. mauritiana*	Very good settlement. Male emergence was under progress.
3.	Pochapani (Bispur II)	West Midnapur (W.B.)	03.3.15	*Rangeeni* lac on *B. monosperma* and *Z. mauritiana*	Very good settlement. Male emergence was under progress.
4.	Paraspani, Barsoti (Dhurki)	Garhwa (J.H.)	19.3.15	*Rangeeni* lac on *B. monosperma*	Good settlement and survival of lac insect.
5.	Kudlang, Babujur, Kenddih, Dungrical, Khedadih, Mangaddih (Barabazar)	Purulia (W.B.)	30.3.15	*Rangeeni* lac on *B. monosperma* and *Z. mauritiana*	Crop was in excellent condition.
6.	Baredih, Hathinada, Ranga (Baghmundi)	Purulia (W.B.)	07.4.15	*Kusmi* lac on *S. oleosa*	Crop was in excellent condition with one spray of fipronil.
7.	Paisagara (Manbazar), Rituguda, Kodagada, Dhodungri, Basaburu(Bandwan)	Purulia (W.B.)	15.4.15	*Rangeeni* lac on *B. monosperma* and *Z. mauritiana*	Healthy crop. Two sprays of fipronil and carbendazim were carried out.
8.	Chitrapur, Tigra, Harbha, Cheyadih, Bagandih, Saparambeda, Chatni, Bandgutu, Ranga, Ichakota, Lebugara, Bhuigara (Jhalda II, Baghmundi, Jhalda-I)	Purulia (W.B.)	01.5.15	*Kusmi* lac on *S. oleosa*	Healthy crop. Two sprays of fipronil and carbendazim were carried out.
9.	Chandai, Navadih, Mahuatand and Kenduadih (Jhalda- I)	Purulia (W.B.)	24.4.15	*Kusmi* lac on *S. oleosa*	Healthy crop. Two sprays of fipronil and carbendazim were carried out.
10.	Kangod (Sidlapur)	Uttar Kannada (Karnataka)	25.5.15	*Kusmi* lac on *F. semialata*	Two hectare plantation was Inoculated with 50 kg broodlac.
11.	Bidarkhan (Sidlapur)	Uttar Kannada (Karnataka)	25.5.15	*Kusmi* lac on *F. semialata, S. oleosa* and *Calliandra spp*	Utilised 300 kg broodlac for inoculation of trees.
12.	Bidarkhan Forest Area (Sidlapur)	Uttar Kannada (Karnataka)	25.5.15	*Kusmi* lac on *S. oleosa*	Thirty trees were inoculated with broodlac. Very good crop condition.
13.	Gadgiri (Sugavi- Gadgiri, Sirsi)	Uttar Kannada (Karnataka)	25.5.16	No lac crop	Four hectare plantation of *F. semialata* was raised along with ginger.
14.	Gendalahusur (Sorba)	Uttar Kannada (Karnataka)	25.5.16	*Kusmi* lac on *S. oleosa*	Eighteen trees were inoculated with 350 kg broodlac. Crop was in excellent condition.

S. No.	Village (Block)	District (State)	Date	Crop	Observation
15.	Targod (Sirsi)	Uttar Kannada (Karnataka)	26.5.15	*Kusmi* lac on *S. oleosa*	Crop was in good condition. 50 kg broodlac was inoculated on 5 trees.
16.	Balaru (Sirsi)	Uttar Kannada (Karnataka)	26.5.15	*Kusmi* lac on 1000 *F. semialata*	Highly infected with fungus.
17.	Semiamane (Kumta)	Uttar Kannada (Karnataka)	26.5.15	*Kusmi* lac on *S. oleosa*	Crop was in excellent condition. 20 kg broodlac was inoculated on two trees.
18.	Mattli (Kumta)	Uttar Kannada (Karnataka)	26.5.15	*Kusmi* lac on *S. oleosa*	Crop was in good condition.
19.	Hebbail (Kumta)	Uttar Kannada (Karnataka)	26.5.15	*Kusmi* lac on *S. oleosa*	Fifteen kg broodlac was inoculated and crop was good.
20.	Gotagodikoppa (Mundgud)	Uttar Kannada (Karnataka)	27.5.15	*Kusmi* lac on *S. oleosa*	Excellent crop on 5 trees inoculated with 45 kg broodlac. New plantation of 5000 *F. semialata* plantation was raised.
21.	Indur (Indur)	Uttar Kannada (Karnataka)	27.5.15	*Kusmi* lac on *S. oleosa*	Crop was in a very good condition. 50 kg broodlac was inocualted on 18 trees.
22.	Pundalik (Mangalwara)	Uttar Kannada (Karnataka)	27.5.15	*Kusmi* lac on 1000 *F. semialata*	Intercrop of *F. semialata* and chilli was done, 50 kg broodlac was inoculated, moderate crop.
23.	Dharwad Agriculture University Campus	Uttar Kannada (Karnataka)	27.5.15	*Kusmi* lac crop on *Calliandra, Z. mauritaiana, Prosopis* and *Ficus spp*	Good survival of lac insect on all tree species was observed.
24.	Belatoli (Thethaitangar)	Simdega (J.H.)	10.6.16	*Kusmi* lac on *S. oleosa*	Crop was in good condition.
25.	Sifore, Salgram (Jeypore)	Purulia, (W.B.)	22.6.15	*Kusmi* lac on *S. oleosa*	Crop was in good condition. One spray each of fipronil and carbendazim was done.
26.	Bagandih (Arsha)	Purulia, (W.B.)	22.6.15	*Kusmi* lac on *S. oleosa*	Crop was in good condition. One spray each of fipronil and carbendazim was done.
27.	Mechakitangani (Sisibargaon)	Dhemaji, Assam	03.7.15	*Kusmi* crop on *Z. mauritiana*	Crop was average to good.
28.	Jonai (Murkongselek)	Dhemaji, Assam	04.7.16	*Kusmi* crop on *Z. mauritiana*	Crop was average to good.
29.	Basantpur (Manbazar)	Purulia (W.B.)	09.12.15	*Rangeeni* crop on *B. monosperma* and *Z. mauritiana*	Very healthy crop.

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