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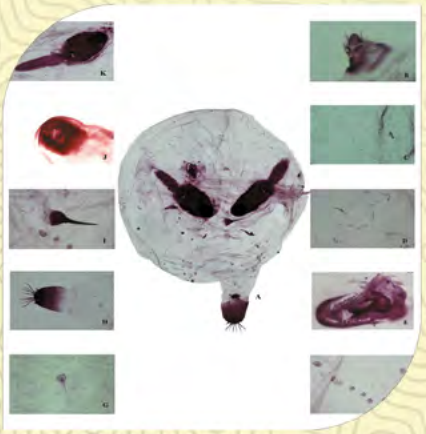
भाकृअनुप
ICAR

ANNUAL REPORT
2020-21







ICAR-Indian Institute of Natural Resins and Gums
भाकृअनुप - भारतीय प्राकृतिक राल एवं गोंद संस्थान
Namkum, Ranchi - 834010 (Jharkhand)
नामकुम , राँची - 834010 (झारखण्ड)

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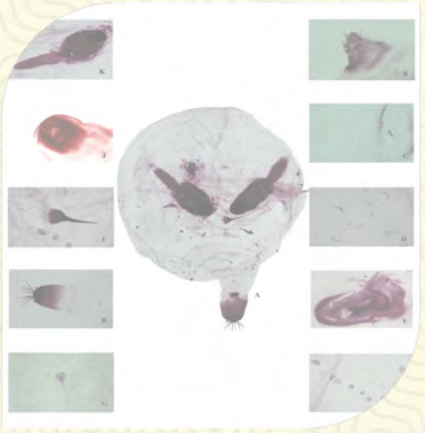





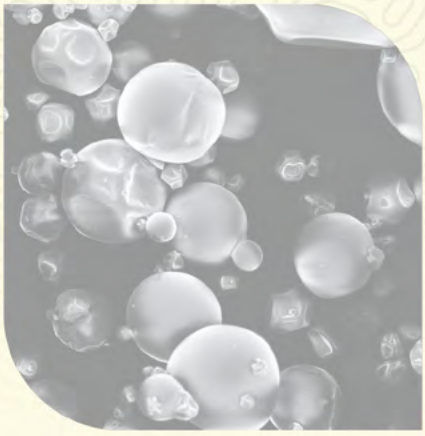

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Dr. Thamilarasi K

Compiled, Edited and Produced by
Dr. Thamilarasi K
Dr. SC Sharma
Dr. Nandkishore Thombare
Dr. Achintya Pramanik
Mr. Tariq Zaman

Administrative Assistance
Sri SK Yadav

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Front Page (Top to bottom)

First row

- Spray dried dietary fibre encapsulated ascorbic acid
- Microscopic images for morphological characterization of *Kerria chinensis* (Mahdihassan)

Second row

- Sticky insect trap with lac-based glue in the field
- Lac Integrated Agro forestry Model at farmer's field, Silda, Khunti district
- Lac insect settlement on *Conocarpus lancifolius*

Third row

- Planting of *kusum* seedling at IRF
- Morphology of spray dried gum ghatti by FESEM

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ICAR-IINRG, Director's Office

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Preface

Biodiversity conservation and value addition of natural resins and gums are two of the most important aspects for maintaining a healthy ecosystem and providing a sustainable livelihood to the farmers. National Lac Insect Germplasm Center of the Institute collects and evaluates the lac insect germplasm resources of our country and maintains the world's largest live collection of lac insects. Taxonomical characterization of populations of lac insect in the Lac Insect Field Gene Bank revealed presence of *Kerria pusana* in the conserved stocks. Full length coding sequence of N-acetyl transferase, demethylase and Crimson N Acetyl transferase were cloned from lac insects. qPCR of these insects and HPLC analysis of the body pigments indicated a putative role for this acyl carrier protein in lac pigment biosynthesis.

Lac integrated cropping models developed by the institute and tested at farmers' fields have not only helped in land use diversification but also increasing the income of the cultivators. Another model being developed involving intercropping of *F. semialata* and okra has performed better in terms of yield, total biomass production and total carbon stock of crop in rainy season. Relative abundance and emergence profile of parasitoids and predators associated with lac insect during summer season (*baisakhi*) and rainy season (*katki*) crops revealed that the three parasitoids (*Aprostocetus purpureus, Tachardiaephagus tachardiae* and *Tyndarichus clavicornis*) and one predator *Eublemma amabilis* were the most abundant during these crop seasons.

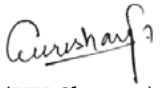
Under Network Project on Conservation of Lac Insect Genetic Resources, lac insect collected from Madurai, Tamil Nadu on rain tree, *Samanea saman* was identified as a new lac insect species *Kerria canalis.* The whitefly sample observed for the first time on the lac host plant, *Flemingia semialata* was found to be *Aleurodicus dispersus.* Lac was observed for the first time on *Conocarpus lancifolius* in Chittoor, Nellore and Guntur district of Andhra Pradesh. Similarly, lac insect was found infesting Champak, *Magnolia champaca* for the first time in Imphal West district. Two entomopathogenic fungi (EPFs), *Isaria fumosorosea* and *Isaria javanica* earlier isolated and identified against lac predator *Eublemma amabilis* were found to be safe for lac insects. Among the pigeon pea varieties, AL 201 was found to be promising for cultivation of *rangeeni* strain (*katki* crop) of lac insect providing additional benefits as compared to sole crop under Punjab conditions.

During processing the lac, drying of seedlac especially during rainy season is the major impediment reported by the industry. To tackle this problem, the institute undertook study on drying kinetics of seedlac using infrared, infrared assisted convective drying and hot air drying. Infrared assisted convective drying was found the best as it required least drying time and energy while maintaining the quality of seedlac. Natural resins and gums find place of eminence in food industry. Encapsulation of ascorbic acid was achieved by dietary fibre from guar gum using spray drying technique. Bioavailability study of the encapsulated product in fish model indicated encouraging results to use it as functional feed.

Nano-composite films reinforced with piyar-AgNPs have been developed through solution casting method for diversified applications under Network Project on Harvesting, Processing and Value Addition of NRGs. Detoxified guar meal when incorporated in cookies at 3% acceptable concentration caused significant increase in fibre and minerals. Dhoop sticks were prepared from black dammar powder and a manual type agarbatti making machine was designed by the network Cooperating Center at Thrissur. 6465 trees of *Acacia Senegal* treated by CAZRI gum inducer, resulted in production of 2.90 tons of gum Arabic in 48 villages of Rajasthan leading to revenue generation of Rs. 23.20 lakhs to the farmers.

During the year, COVID-19 took a heavy toll and affected normal agricultural activities. The institute undertook effective steps to outreach to the stakeholders. It organized a Webinar on "Agricultural Marketing to strengthen the efforts of Government during COVID period without breaking the lockdown guidelines" in association with Chaudhary Charan Singh National Institute of Agricultural Marketing, Jaipur (Rajasthan). Extension initiatives like ICT enabled One to One Programme (OTOP), Market Oriented Technical Advisory Services (MOTAS), Diagnostic Crop Monitoring and industrial visits benefited stakeholders including entrepreneurs, farmers, policy makers, NGOs and FPOs across the country. Social media WhatsApp group Laksha Updates initiative has boosted linkages with stakeholders and proved to be an effective platform for interaction and feedback.

With passage of time we encounter various challenges; some expected some unexpected. The pandemic has taught us the lesson that we have to be ever ready to face these challenges. The institute was not found wanting!



(KK Sharma)
Director

December, 2021
Namkum, Ranchi

Introduction

Mandate

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

Historical Perspectives

India is one of the largest producers of natural resins, gums and gum-resins (NRGs) along with China, Indonesia, Russia and Brazil. Our country is the world leader in production of guar, karaya and psyllium gums as well as lac. Total production of NRGs has decreased from 8,43,178 tons in 2015-16 to 5,31,721 tons in 2017-18. Total production of lac was observed around 13.06 per cent lower than the previous year and 13.2 per cent decrease in lac production was recorded in Jharkhand. The world trade aggregation of lac, natural gums, resins, gumresins, balsams and other natural oleo-resins (HS code:1301) revealed that out of 117 exporting countries in the world, India ranks 4th in export with a share of 9.0% in the total world export value. Similarly, out of 175 importing countries of the world, India ranks 6th in import with a share of 19.3% in the total world import value.

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

Realizing the strategic importance of this commodity, the then Imperial Government of India constituted the Lindsay-Harlow Committee in 1920 to look into all aspects of the country's lac trade and its development. On the suggestions of this committee, lac merchants organized themselves into the Indian Lac Association for Research, under the aegis of which, the foundation stone of the Indian Lac Research Institute (ILRI) was laid on September 20, 1924 at Ranchi. Subsequently, on the recommendations of the Royal Commission on Agriculture, the Indian Lac Cess Committee (ILCC) was constituted, which took over the reins of the ILRI in 1931. As a result of reorganization of agricultural research and education in the country after independence, the ICAR took over the administrative control of the ILRI in April 1966. This Institute is thus, one of the oldest institutions within the ICAR system, having completed more than 96 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^{o} 23" N latitude and 85^{o} 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

ICAR-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 was 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 Bank. 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 31scientific including RMP, 39 technical, 14 administrative and 31supporting posts with a total of 115 staff are in position as on December 31, 2020.

Infrastructure

Manned by a team of dedicated scientists from various disciplines including Agricultural Entomology, Plant Sciences, Agricultural Chemicals, Engineering, Biotechnology etc., the Institute has about 115 staff in scientific, technical, administrative and supporting categories. The Institute has a number of prestigious labs, like Biotechnology, Bio-control Laboratory, Instrumentation Laboratory, Quality Evaluation Laboratory etc. The Institute shoulders the responsibility of collection and maintenance of germplasm of lac insect lines as well as lac host trees (NATLIGEC). Similarly, the Lac Host Plant Field Gene Bank of the Institute has 89 collections of 55 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 and 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* (*Flemingia macrophylla*) under protected 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 and others.

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: https://iinrg.icar.gov.in is a valuable source of information in the Institute.

Executive Summary

Characterization and Conservation of Lac Insects and Host Plants

- Surveys were conducted to document lac insect biodiversity in different agro-climatic regions. Natural population of lac insects was observed on wild host *Calliandra surinamensis* at Ghaziabad, Uttar Pradesh. 1290 cultures of 56 lac insect lines are being conserved on *Flemingia macrophylla* in Lac Insect Field Gene Bank and 89 collections of 55 species of lac host plants in Lac Host Field Gene Bank of National Lac Insect Germplasm Centre (NATLIGEC).
- LIK0007, LIK0031 and LIK 0001 populations of lac insect from Lac Insect Field Gene Bank, NATLIGEC were processed and permanent slide mounts were prepared for taxonomic characterization. The populations were identified as *Kerria sharda, Kerria chinensis* and *Kerria pusana*, respectively.
- Full length CDS (coding sequence) of N-acetyl transferase (*nat*), demethylase (*dm3a*) and Crimson N Acetyl transferase (*cnt*) were cloned from lac insects. Acyl carrier protein knock down mutant of lac insects have been developed using RNAi technique. qPCR of these insects and HPLC analysis of the body pigments indicated a putative role for this acyl carrier protein in lac pigment biosynthesis.
- Out of nine plant growth regulators tested, treatment of NAA (100 ppm) to host plant *Flemingia semialata* yielded the highest broodlac (592.20 g/plant) followed by NAA-50 ppm (587.40 g/plant) as compared to control (543.80 g/plant). Kinetin (100 ppm) showed the highest scrapped lac per plant (103.90 g) followed by NAA-50 ppm (100.70 g) as compared to control (72.70 g).
- Seed storage behavior and seasonal variation in early growth performances of *kusum* seeds collected from Namkum (Ranchi), Peterwar (Bokaro) and Murhu (Khunti) were stored under airtight plastic jar, HDPE and cotton bag, respectively. It was observed that seeds maintained higher vigour in the month of September and October when stored under airtight plastic jar and HDPE bag. Seed viability decreased with the storage duration. Furthermore, seeds of *kusum* treated with chitosan and imidacloprid 17.8 SL @ 0.04% before storage observed an increase in potential seed longevity, vigour and viability.
- Seed germination percent in *kusum* increased significantly due to heat treatment. Treated seed recorded 28 percent germination, while untreated lot recorded 14 percent germination only. Germination of treated seeds initiated at 44 days after sowing and that of untreated seeds at 58 days after sowing.

Pest Behaviour and Management

- Relative abundance and emergence profile of parasitoids and predators associated with lac insect during summer season (*baisakhi*-2020) and rainy season (*katki*-2020) crops revealed that the three parasitoids (*Aprostocetus purpureus, Tachardiaephagus tachardiae* and *Tyndarichus clavicornis*) and one predator *Eublemma amabilis* were the most abundant during these crop seasons.
- Emergence profile of lac associated fauna was compared between different caging methods *viz. in-situ* caging and laboratory caging during *baisakhi*-2020 and *katki*-2020. Higher numbers of *A. purpureus* (except in *palas*), *T. tachardiae, T. clavicornis* and *E. amabilis* were recorded in *in-situ* caging method (12, 74, 3 and 3) and (221, 44, 13 and 8) compared to laboratory caging (0, 39, 1 and 1) and (3, 97, 2 and 5) on *ber* and *palas,* respectively during *baisakhi* crop. In *katki* crop, higher numbers of *A. purpureus, T. tachardiae, T. clavicornis* and *E. amabilis* were recorded in *in-situ* caging (149, 172, 8 and 6) and (66, 24, 6 and 13) compared to laboratory caging (56, 1, 2 and 5) and (42, 2, 1 and 13) on *ber* and *palas,* respectively.
- Maximum temperature and relative humidity (evening) have significant positive correlation on the population of *A. purpureus* on *palas* based on four week and five week lag weather parameters (83 and 86 per cent, respectively). The impact of weather factors on the population of *A. purpureus* on *ber* showed that the relative humidity (evening) and rainfall significantly and positively contributed and also played major role (75 per cent) based on four week lag weather parameters.

- During the year 2018-19 derived models: Y= - 94.55 + 0.93 (Max temp) + 1.20 (Eve RH) from *palas* (five Week Lag) and Y= - 25.64 + 0.47 (Eve RH) + 0.16 (RF) from *ber* (4 Week Lag) can be used for predicting population of *A. purpureus* during *baisakhi* crop.

Good Cultivation Practices

- Fertilizer application along with liming proved to be the best for attaining desirable host plant attributes in *palas*. NPK + liming increased number of rejected shoots to the tune of 100% over control. However, double dose of NPK+ liming produced 50% increase in number of new shoots per unit branch thickness. More rest (19 months) could increase average shoot diameter by 28.5percent and shoot length by 35 percent over seven months rest. Parasitoid count in the month of April was influenced significantly due to topography of land.
- The intercropping of *F. semialata* + okra performed better than other treatment combinations in terms of yield, total biomass production and total carbon stock of crop in rainy season. Results showed that the plant height of intercrop okra was significantly higher ($p<0.05$) than sole okra. Fresh fusiform tap root length was observed significantly higher in the intercrop radish than sole radish.

Application and Product Development

- Sixteen trials were carried out for Decoloured Dewaxed Lac (DDL) preparation from *kusmi* seedlac in lac: solvent (2-Propanol) ratio of 1:6. In these trials, yield of DDL was 62 to 82% by weight of seedlac with an average yield of 72.75%. Reduction in colour value of lac (seedlac colour value 12) in DDL varied between 0.6 and 5. Flow and life of DDL samples prepared in these trials were comparable with shellac. Wax, impurity content and acid value of DDL samples were found better and within acceptable limit for most of the trials.
- Lac samples (sticklac, seedlac and shellac), buried directly in the soil for biodegradability study, were drawn after interval of one year and studied for weight loss and other properties. Weight losses were found 40-60%, 42% and 21-28% from sticklac, seedlac and shellac samples respectively. Physico-chemical properties such as flow, life under heat, colour index and cold alcohol insoluble percentage of the samples were studied along with control samples and recorded improvement in the properties of the samples to a great extent as compared to those of control samples, owing to conversion into shellac and removal of insoluble portion from the samples.
- Drying kinetics of seedlac dried under infrared (near and far), infrared (near and far) assisted convective drying and hot air drying was studied. It was observed that drying of seedlac takes place in falling rate period and Page model was found best to describe the drying behavior of seedlac in all the drying methods studied. Infrared assisted convective drying was found best as it required least drying time and energy while maintaining the quality of seedlac. The optimized drying conditions for drying of seedlac under infrared assisted convective drying were infrared power 500 W, loading density 3 kg/m^2, air velocity 1 m/s and distance between lamp and product surface 15 cm.
- Encapsulation of ascorbic acid (vitamin C) was achieved by dietary fibre from guar gum using spray drying technique. Characterization of the encapsulated product revealed the presence of ascorbic acid as sustained release formulation. Bioavailability study of the encapsulated product in fish model also indicated encouraging results to be used as a functional feed.
- Lac based glue formulations were further modified to improve their tack and thread forming ability which is crucial in trapping and holding flying insects. Fortification of dewaxed decolorized lac to the synthesized hydrolyzed lac resulted in improved adhesion without darkening the color. To increase spreading ability on polythene sheet, some vegetable oil fillers were added to the lac based non-drying adhesive. Field trial experiments were conducted for the lac based glue and commercial glue for sticky traps in semialata, pigeon pea and mustard crops. All lac glue formulations showed fairly good insect trapping efficiency which was about 80% as compared to commercial formulation (Chipku®).
- Hydrogels were synthesized from guar gum by varying cross-linker concentration using ceric ammonium nitrate as a free radical initiator. Characterization of hydrogel was done using scanning electron microscopy, FTIR, thermogravimetic and elemental analysis.

Capacity Building and Training

- Five Farmers' training programmes on 'Scientific Lac Cultivation, Processing and Utilization' were organized for 160 farmers from four States *viz*., Assam, Jharkhand, Chhattisgarh and Uttar Pradesh.
- One off-campus training programme of 25 days duration on 'Lac Based Handicraft Making Training under Skill Development and Women Empowerment' organized for 20 women at Hesla, Patratu (district Ramgarh) Jharkhand. The programme was sponsored by Patratu Vidyut Utpadan Nigam Limited (PVUNL), Patratu, Ramgarh.
- Livestock, farm tool-kit, sprayer and vermi bed were distributed under Development Action Plan for Schedule Caste (DAPSC) among 1588 farmers in 17 programmes organized at different KVKs of Jharkhand.
- Two on-farm motivational training programmes were organized for 99 stakeholders of Jharkhand.
- Twenty three On-campus, one-day Orientation Programme on 'Natural Resins and Gums' were organized in collaboration with GOs and NGOs of Jharkhand and West Bengal states. 563 farmers, school children, college students and executives visited the institute under these programmes.
- Twenty two Front Line Demonstration (FLD) were organized by the institute. Institute also participated in one exhibition *i.e.* Block Level *Kisan Mela* cum Exhibition-2020, organized at Torpa Block Ground, Torpa, Khunti. A total of 431 farmers visited the stall.

Field Demonstration, Technical Advisory and Extension Activities

- An ICT enabled One to One Programme (OTOP), Market Oriented Technical Advisory Services (MOTAS), Diagnostic Crop Monitoring and industrial visits benefited 43 stakeholders including six entrepreneurs, seven processors/ manufactures, nine farmers, six government organizations/ policy makers, two researchers/research scholars, two traders, nine NGOs and FPOs from India. Social media WhatsApp group *Laksha Updates* initiative boosted the linkages with stakeholders.
- A sum of Rs. 3.03 lakh was generated through training charges during the period.

Technology Adoption, Impact Assessment and Market Research Activities

- Twelve per cent decrease in the production of NRGs was recorded during 2019-20 in comparison to 2018-19. This was mainly because of decline in production of *guar* gum (13%). Consequently, total production of NRGs decreased from 6,05,771 tons in 2018-19 to 5,28,194 tons in 2019-20. Total production of lac in India was observed to be higher than the previous year. Production of other resins and gums like gum *karaya, dhawda* and pine resins also increased slightly in 2019-20.
- Export quantity (2.46 lakh tons) and export value (Rs. 3146 Crores) of NRGs from India declined in 2019-20 and import scenario looked relatively stable over the period. ITC calculations based on UN COMTRADE statistics, the world trade aggregation of all commodities during 2018 revealed that out of 130 exporting countries in the world, India ranks 19th in export with a share of 1.74% in the total world export value and ranks 9th in import with a share of 2.71% in the total world import value.

Network Project on Harvesting, Processing and Value Addition of NRGs

- During 2020, 6465 trees of *Acacia senegal* were treated by CAZRI gum inducer, resulting in production of approximately 2.90 tons of gum Arabic in 48 villages of Rajasthan. Farmers earned revenue of Rs. 23.20 lakhs from sale of gum and CAZRI, Jodhpur generated resource of Rs. 6.46 lakhs from sale of gum inducer.
- Use of ethephon was significantly effective in gum tapping in Chironji (*Buchanania lanzan*) and Rohini (*Soymida febrifuga*) during April to June as compared to mechanical and traditional method of gum tapping.
- Detoxified guar meal when incorporated in cookies at 3% concentration found to be overall acceptable which caused significant increase in fibre and minerals.
- The ethephon injection method in *Ailanthus* tree was studied and found to be the best method as it yielded maximum resin than that in brush method. It was also observed that the post monsoon period is the best season for resin extraction.

- Dhoop sticks were prepared from black dammar powder using different molds and training was given at different tribal settlements of Kerala for 120 trainees.
- A manual type *agarbatti* making machine was designed with the support of Agricultural engineering college, Thavanoor, KAU. The machine is designed for the tribals who are residing in the settlements where in electricity connection is a major issue.
- Resin tapping from *Pinus kesiya* trees of three different diameter classes from Meghalaya revealed effect of season on resin yield. Among the 30-35 cm diameter class trees, mean total resin yield varied from 89.45 g to 354.13 g in the ascending order August > October > September > November.
- Nanocomposite films reinforced with *piyar*-AgNPs were developed for diversified applications through solution casting method.
- Gum tapping dies were fabricated/developed in collaboration with M/s. National Enterprises, Hatia, Ranchi based on the detailed manufacturing design drawing developed in Pro Engineer CAD Software.

Network Project on Conservation of Lac Insect Genetic Resources

- A new lac insect population collected from Madurai, Tamil Nadu on rain tree, *Samanea saman* was described as a new lac insect species *Kerria canalis* Rajgopal in detail with all taxonomic illustrations.
- Barcoding PCRs with *cox1* gene revealed that the new lac insect population collected from Karnataka and Andhra Pradesh to be *Kerria lacca* and from Taiwan to be *Kerria chinensis*. The whitefly sample collected from the lac host plant, *Flemingia semialata* was found to be *Aleurodicus dispersus.*
- Two entomopathogenic fungi (EPFs), *Isaria fumosorosea* and *Isaria javanica* earlier isolated and identified against lac predator *Eublemma amabilis* was found to be extremely safe for lac insects. Occurrence of lac predators *viz. E. amabilis*, *Pseudohypatopa pulverea* and *Chrysopa* spp. were found less in treatments with the EPFs compared to control.
- Among different biocontrol agents, citronella oil and the EPF, *Beauveria bassiana* showed the highest oviposition deterrence and also ovicidal properties against *Callosobruchus chinensis*, an important storage pest of the lac host plant *Flemingia* spp.
- Lac insect was found infesting a host plant Champak, *Magnolia champaca* for the first time in Imphal West district.
- Lac was observed for the first time on *Conocarpus lancifolius* in Tirupati rural mandal of Chittoor district, Kovuru mandal of Nellore district, Guntur and Bapatla areas of Guntur district of Andhra Pradesh.
- Among three pigeon pea varieties (AL 201, AL 882 and PAU 881), AL 201 was found to be promising for cultivation of *rangeeni* strain (*katki* crop) of lac insects providing additional benefits as compared to sole crop under Punjab conditions.

KVK Khunti

- Five On Farm Testing (OFT) and one station trial were conducted in 13.9 ha on the field of 37 beneficiaries during *Kharif* 2020 and critical inputs including seeds were distributed among the farmer beneficiaries. Drought tolerant improved paddy varieties, *Swarna Shreya* performed best with a net return of Rs 58,730 per hectare and B:C ratio of 1.96:1. *Sahbhagi* was found at par with *Swarna Shreya* with B:C ratio of 1.90:1.
- Two treatments, hand weeding (20 DAT and 40 DAT) followed by Butachlor @ 1.0 kg/ha (3-5 DAT) *fb.* 2, 4 D @ 400 g/ha (25-28 DAT) gave higher grain yield with higher B:C ratio of 1:8 for integrated weed management in Paddy. Clipping of seedling at transplanting was cost effective technology to control major insect infestation in paddy during pest management in paddy. It can also be controlled by chemical treatment of Fame (Flubendiamide 39.35% M) and Coragen (Chlorantraniliprole 18.5% SC).
- Broodlac dipping with Fipronil @ 1.5 ml/l of water for 10 minutes + scientific practice of lac cultivation gave maximum broodlac yield as compared to farmers practices with B:C ratio of 2.7:1.

- Motor operated paddy thresher was found suitable for paddy threshing with minimum time and manpower requirement to achieve higher threshing capacity, if electricity availability is not a problem. However, foot (pedal) operated paddy thresher may be one of the alternate options for paddy threshing to achieve higher threshing capacity with reduced time where electricity is not available.
- In mustard, recommended NPK + lime @ 4q/ha + Sulphur @ 20 kg/ha + Boron @ 1 kg/ha gave maximum grain yield of 11.53 q/ha in station trial. The data shows that even with the application of lime farmers can harvest optimum grain yield which was significantly higher than state average yield of 9.70 q/ha and at par to national average productivity of 11.34 q/ha.
- Six Front Line Demonstration (FLDs) were conducted in 33.04 ha area involving 290 beneficiaries. *Sahbhagi* and *Swarna Shreya* gave twice the yield compared to farmers' local varieties. Pigeon pea variety IPA-203 gave 40.7% higher yield than local. Groundnut variety *Dharni* yielded 34.61% higher pod than farmers' variety. Scientific *Kusmi* lac cultivation on *ber* contributed 44.86% higher broodlac yield than farmers' practice.
- To enhance the productivity in *rabi* and summer seasons, good quality seeds of chickpea (390 kg), mustard (40 kg) in *rabi* and green gram (160 kg) in summer season along with critical inputs were distributed among farmers. GNG-1958 variety of pigeon pea gave 27.74% higher yield than local variety. Pusa Mustard-30 had 52.26% higher yield than local variety. The green gram variety IPM 2-3 gave 34.61% higher yield than local variety.
- Twenty-one off campus trainings were conducted for farmers on cultivation of paddy, pigeon pea, *kusmi* lac cultivation, groundnut, soybean, green gram, black gram and vegetable cultivation during *kharif* season, and sixteen off campus trainings on cultivation of chickpea, lentil and rapeseed organized during *rabi* season in which 2512 farmers participated.
- In addition to the above, other extension activities/ programme were organized / arranged *viz*. field day, rain gauge installation, plantation of agroforestry trees, partheninum awareness, *Aatmanirbhar Bharat*, *Poshan* awareness campaign, *Rashtriy Mahila Kisan Diwas*, soil sample collection, training on bio-pesticide preparation, Training on vermicompost preparation, *Swachhata Pakhwada*, awareness on PM *Kisan Yojana*, Agromet advisory under DAMU for 51728 farmers of Khunti district.

कार्यकारी सारांश

लाख कीटों एवं परिपालक पौधों का अभिलक्षण वर्णन तथा संरक्षण

- विभिन्न कृषि–जलवायु क्षेत्रों में लाख कीट जैवविविधता के प्रलेखन के लिए सर्वेक्षण किया गया। गाजियाबाद, उत्तर प्रदेश में जंगली परिपालक *कैलिएन्ड्रा कैलोथिरसस* पर लाख कीट की प्राकृतिक आबादी देखी गई। लाख कीट फिल्ड जीन बैंक में *फ्लेमिंजीया मैक्रोफाइला* पर 56 लाख कीट प्रजाति के 1290 संवर्ध का एवं राष्ट्रीय लाख कीट जीवद्रव केन्द्र (नैटलीजेक) के लाख परिपालक फील्ड जीन बैंक में लाख परिपालक पौधों की 55 प्रजातियों के 89 संग्रह का संरक्षण किया जा रहा है।
- लाख कीट फील्ड जीन बैंक, में संरक्षित लाख कीट की एल आई के 0007, एल आई के 0031 एवं एल आई के 0001 आबादी को संसाधित कर वर्गीकरण अभिलक्षण वर्णन के लिए स्थायी माउन्ट बनाया गया।
- लाख कीट से एन–एसीटाइल ट्रांसफरेज (NAT), डीमिथाइलेज (DM3A) एवं क्रीसन एन एसीटाइल ट्रांसफरेज (CNT) के पूर्णतः सी डी एस का (कोडिंग सिक्वेंस) कृतक बनाया गया। आर एन ए आई तकनीक का उपयोग कर लाख कीट का एसाइल कैरियर प्रोटीन नॉक डाउन उत्परिवर्ती विकसित किया गया। इन कीटों का क्यू पी सी आर एवं तत्व वर्णक के एच पी एल सी विश्लेषण से लाख वर्णक जैवसंश्लेषण में इस एसाइल कैरियर प्रोटीन के लिए ख्यात भूमिका का संकेत मिलता है।
- परीक्षण किए गए पाँच पौध वृद्धि नियामकों में से नियंत्रण की तुलना में लाख परिपालक *फ्लेमिंजीया सेमियालता* पर एन ए ए (100 पी पी एम) के उपचार से बीहनलाख की उपज उच्चतम (592.20 ग्रा./पौधा) रही तथा उसके बाद एन ए ए – 50 पी पी एम (587.40/पौधा) का स्थान रहा। काईनेटीन (100 पी पी एम) से प्रति पौधा छिली लाख नियंत्रण (72. 7) की तुलना में उच्चतम (103.90 ग्रा.) रहा तथा उसके बाद एन ए ए – 50 पी पी एम (100.70 ग्रा.) का स्थान रहा।
- नामकुम (राँची), पेटरवार (बोकारो) एवं मुरहु (खूंटी) से संग्रह किए गए कुसुम के बीज को क्रमशः निर्वात प्लास्टिक जार, एच डी पी ई एवं सूता के थैले में रखकर शीघ्र वृद्धि क्रिया में बीज भंडारण व्यवहार एवं मौसमी भिन्नता का असर देखा गया। यह देखा गया कि निर्वात प्लास्टिक जार, एच डी पी ई एवं सूती थैले में रखे बीज में सितम्बर एवं अक्तूबर महीने में उच्चतम शक्ति बनी रही। भंडारण की अवधि से बीज की जीवन क्षमता में कमी आई। इसके अतिरिक्त भंडारण से पूर्व चीटोसन एवं इमीडाक्लोप्रिड 17.8 एस एल @ 0.04% से उपचारित कुसुम बीजों में उत्तरजीविता, जीवन क्षमता एवं शक्ति में वृद्धि देखी गई।
- ताप के उपचार से कुसुम में बीज के अंकुरण प्रतिशत में उल्लेखनीय वृद्धि देखी गई। उपचारित बीज का अंकुरण प्रतिशत 28 प्रतिशत था जबकि अनुपचारित बीज का अंकुरण केवल 14 प्रतिशत रहा। उपचारित बीजों का अंकुरण बुआई के 44 दिन बाद मे आरंभ हुआ तथा अनुपचारित बीज में बुआई के 58 दिन बाद आरंभ हुआ।

नाशीकीट व्यवहार एवं प्रबंधन

- ग्रीष्म ऋतु (बैशाखी 2020) एवं वर्षा ऋतु (कतकी 2020) की अवधि में लाख कीट के साथ जुड़े परजीवियों एवं परभक्षियों की सापेक्ष प्रचूरता एवं अविर्भाव विवरण से पता चलता है कि इस फसल ऋतु में तीन परजीवी (*एप्रोस्टोसेटस परप्युरियस, टेकार्डीफेगस टेकार्डी* एवं *टिन्डेरीकस क्लेवीकॉर्निस*) एवं एक परभक्षी *युब्लैमा एमाबिलीस* की बहुतायत होती है।
- वैशाखी 2020 एवं कतकी 2020 की अवधि में पिंजरे में रखने की विधियों जैसे प्रतिस्थाने एवं प्रयोगशाला में लाख से जुड़े हुए कीटों के अविर्भाव विवरण की तुलना की गई। बैशाखी फसल के दौरान बेर एवं पलास पर क्रमशः प्रयोगशाला में जाली में रखने (0, 39, 1 एवं 1) एवं (3, 97, 2 एवं 5) की तुलना में प्रतिस्थाने पिंजरा में रखने की विधि में (12, 74, 3, 3) एवं (221, 44, 1, 13 एवं 8) उच्चतर संख्या में *ए परप्यूरियस* (पलास के अतिरिक्त), *टी टेकार्डी, टी क्लेवीकॉर्नीस* एवं *ई एमाविलीस* रिकॉर्ड किया गया। कतकी फसल में बेर एवं पलास पर क्रमशः प्रतिस्थान पिंजरे में रखने की विधि

में (149, 172, 8 एवं 6) एवं (66, 24, 6 एवं 13) प्रयोगशाला में जाली में रखने (56, 1, 2 एवं 5) तथा (42, 2, 1 एवं 13) की तुलना में *ए परप्यूरियस, टी टेकार्डी, टी क्लेवीकॉर्निस* एवं *ई एमाबिलीस* की उच्चतर संख्या रिकॉर्ड की गई।

- 4 सप्ताह से 5 सप्ताह तक लैग मौसम पारामीटर (क्रमशः 83 एवं 86 प्रतिशत) के आधार पर पलास पर ए. *परप्यूरियस* की आबादी में अधिकतम तापमान एवं सापेक्ष आर्द्रता (संध्या) एवं बरसात का सकारात्मक एवं उल्लेखनीय असर रहा तथा 04 सप्ताह के लैग मौसम मानक के आधार पर महत्वपूर्ण भूमिका (75 प्रतिशत) निभाई।
- वर्ष 2018–19 के दौरान प्राप्त मॉडलः पलास से वाई = –94.55+0.93 (अधि. ताप.)+ 1.20 (संध्या सा.आ.) (पाँच सप्ताह लैग) एवं बेर से वाई = –25.64+0.47 (संध्या सा.आ.)+0.16 (आर एफ) (4 सप्ताह लैग) को बैशाखी फसल के दौरान ए *परप्यूरियस* की आबादी का अनुमान लगाने के लिए उपयोग किया जा सकता है।
- उर्वरक के साथ चूने का प्रयोग परिपालक पौधे पलास के इच्छित गुणों को प्राप्त करने में सर्वश्रेष्ठ सिद्ध हुआ। एन पी के. चूना से नियन्त्रण की तुलना में असम्मत प्ररोहों की संख्या में वृद्धि हुई। हालांकि एन पी के. चूने के दोहरे डोज से प्रति यूनिट शाखा की मोटाई पर नये प्ररोहों की संख्या में 50% वृद्धि हुई। ज्यादा आराम (19 महीने) देने से 7 महीने के बाद औसत प्ररोह व्यास में 28.5 प्रतिशत एवं प्ररोह की लम्बाई में 35 प्रतिशत वृद्धि देखी गई। जमीन की स्थलाकृति के कारण अप्रैल महीने में परजीवियों की गिनती उल्लेखनीय रूप से प्रभावित हुई।
- वर्षा ऋतु में *एफ. सेमियालता* एवं भिंडी की अन्तरफसल अन्य संयोजनों से उपज, कुल बायोमास उत्पादन एवं कुल कार्बन स्टॉक की दृष्टि से बेहतर रहा। परिणाम से पता चलता है अकेले भिंडी की तुलना में अन्तरफसल भिंडी के पौधे की लम्बाई ज्यादा (पी < 0.05) थी। अकेले मूली की तुलना में अन्तरफसल मूली की फ्युजीफॉर्म मूसला जड़ की लम्बाई उल्लेखनीय रूप से ज्यादा थी।

प्रयोग एवं उत्पाद विकास

- कुसमी चौरी से मोमरहित विरंजित लाख (डी डी एल) बनाने के लिए लाखः घोलक (2–प्रोपेनॉल) 1:6 अनुपात में सोलह परीक्षण किए गए। इन परीक्षणों में डी डी एल का उत्पादन चौरी के वजन की तुलना में 62 से 82%, तथा औसत उत्पादन 72.75% था। डी डी एल में लाख के रंग मान में कमी (चौरी का रंग मान 12) 06 से 5 के बीच रही। इन परीक्षणों में तैयार किए गए डी डी एल नमूने की तुलना चपड़े से की जा सकती थी। डी डी एल नमूने का मोम, अशुद्धि अंश एवं अम्ल मान बहुत अच्छा पाया गया तथा ज्यादातर परीक्षणों में स्वीकार्य सीमा के अन्दर ही था।
- लाख नमूने (यष्टि लाख, चौरी एवं चपड़ा), जिसे जैव अवक्रमणीयता अध्ययन के लिए सीधे मिट्टी में दबा दिया गया था, उसे एक साल बाद निकाला गया तथा वजन की कमी एवं अन्य गुणों के लिए अध्ययन किया गया। यष्टि लाख, चौरी एवं चपड़ा नमूनों में वजन की कमी क्रमशः 40–60%, 42%, एवं 21–28% थी। नियंत्रण के नमूने की तुलना में, जो प्रवाहित नहीं हो सका, नमूने का भौतिक रासायनिक गुणों जैसे बहाव, ताप के अन्तर्गत जीवन अवधि, रंग सूचकांक एवं ठंडे अल्कोहल में घुलनशीलता वापस आ गई तथा काफी हद तक इसमें सुधार हुआ। यह नमूने के चपड़े के रूप में परिवर्तन के कारण हो सका।
- अवतल सुखाई एवं गर्म हवा से शुष्कन की सहायता के साथ इन्फ्रारेड (निकट एवं दूर) के अन्तर्गत सुखाए गए चौरी की सूखने की गतिकी का अध्ययन किया गया। यह देखा गया कि चौरी फालिंग दर अवधि में सूखता है तथा सुखाने की विधियों के अध्ययन में चौरी के शुष्कन व्यवहार का वर्णन करने के लिए पेज मॉडल सर्वश्रेष्ठ है। चपड़े की गुणवत्ता के रखरखाव के लिए इन्फ्रारेड की सहायता से अवतल शुष्कन सबसे अच्छा है, क्योंकि यह उर्जा एवं सूखने का समय कम लेता है। इन्फ्रारेड के अन्तर्गत चपड़े का अवतल शुष्कन की अनुकूलतम स्थिति इन्फ्रारेड पावर 500 वाट, लदान घनत्व 3 कि.ग्रा./एम^2, वायु वेग 1 एम/एस तथा लैंप एवं उत्पाद सतह के बीच दूरी 15 से.मी. होनी चाहिए।
- छिड़काव शुष्कन तकनीक का प्रयोग कर ग्वार गोंद के खाद्य रेशी से एस्कॉर्बिक अम्ल (विटामिन सी) का सम्पूटिकरण किया गया। सम्पूटिकृत उत्पाद के अभिलक्षण वर्णन से एस्कॉर्बिक अम्ल के सम्पोषित मोचन सुत्रण स्थिति में उपस्थिति

का पता चलता है। फिस मॉडल में संपूटित उत्पाद के जैव उपलब्धता अध्ययन से भी इसके व्यवहारिक खाद्य के रूप में उपयोग के उत्साहवर्द्धक परिणाम मिलता है।

- लाख आधारित ग्लू सूत्रण को रूपांतरित कर उसके चिपकाने की क्षमता में सुधार किया गया, जो कि उड़ते हुए कीटों को पकड़ने एवं फांसने के लिए महत्वपूर्ण है। मोमरहित विरंजित लाख के संश्लेषित लाख सूत्रण के रूप में सुदृढ़ीकरण सें फांसने /आसंजन में सुधार हुआ। पॉलीथीन सीट पर फैलाव क्षमता की वृद्धि के लिए लाख आधारित नहीं शुष्क होने वाले आसंजक में वनस्पति तेल पूरक को डाला गया। सेमियालता, अरहर एवं सरसों की फसल में चिपकने वाले फांस के लिए लाख आधारित ग्लू एवं वाणिज्यिक ग्लू का प्रक्षेत्र परीक्षण प्रयोग किया गया। सभी तरह के लाख ग्लू सूत्रण की कीट को फांसने की क्षमता बहुत अच्छी थी, जो वाणिज्यिक सूत्रण (चिपकु ®) की तुलना में लगभग 80% थी।
- सेरिक अमोनियम नाइट्रेट का मुक्त मौलिक आरंभक के रूप में उपयोग कर विभिन्न क्रॉस लिंकर सांद्रण द्वारा ग्वार गोंद से हाइड्रोजैल का संश्लेषण किया गया। स्कैनिंग इलेक्ट्रोन माइक्रोस्कोपी, एफ टी आई आर, थर्मोग्रेविमेट्रिक एवं तात्विक विश्लेषण का उपयोग कर हाइड्रोजैल का अभिलक्षण वर्णन किया गया।

क्षमता निर्माण एवं प्रशिक्षण

- चार राज्यों असम, झारखंड, छतीसगढ़ एवं उत्तर प्रदेश से आये 160 किसानों के लिए लाख की वैज्ञानिक खेती, प्रसंस्करण एवं उपयोग पर पाँच कृषक प्रशिक्षण कार्यक्रम आयोजित किए गए।
- ''कौशल विकास एवं महिला सशक्तिकरण कार्यक्रम के अन्तर्गत लाख आधारित हस्तशिल्प निर्माण'' पर हेसला, पतरातु (जिला–रामगढ़) झारखंड में 20 महिलाओं के लिए 25 दिन की अवधि का परिसर से बाहर एक प्रशिक्षण कार्यक्रम आयोजित किया गया। कार्यक्रम पतरातु विद्युत उत्पादन निगम लिमिटेड (पी वी यु एन एल), पतरातु, रामगढ़ के द्वारा प्रायोजित था।
- झारखंड के विभिन्न कृषि विज्ञान केन्द्रों में आयोजित 17 कार्यक्रमों में 1588 किसानों के बीच अनुसूचित जाति विकास कार्य योजना (डी ए पी एस सी) के अन्तर्गत मवेशी, कृषि औजार–उपकरण, छिड़काव यंत्र एवं वर्मिन बेड का वितरण किया गया।
- झारखंड के 99 हितधारकों के लिए दो प्रक्षेत्र प्रोत्साहन प्रशिक्षण कार्यक्रम आयोजित किए गए।
- झारखंड एवं प. बंगाल के सरकारी एवं गैरसरकारी संगठनों के साथ समन्वय कर प्राकृतिक राल एवं गोंद पर परिसर में 23 एक दिवसीय अभिविन्यास कार्यक्रम आयोजित किए गए। इन कार्यक्रमों के अन्तर्गत 563 किसानों, स्कूली बच्चों, महाविद्यालय के छात्र/ छात्राओं एवं अधिकारियों ने संस्थान का दौरा किया।
- संस्थान द्वारा बाईस अग्रतर प्रदर्शन कार्यक्रम आयोजित किए गए। संस्थान ने तोरपा प्रखंड परिसर, तोरपा, खूंटी में आयोजित प्रखंड स्तरीय किसान–मेला–सह प्रदर्शनी–2020 नामक एक आयोजन में भी भाग लिया। कुल 431 किसानों ने स्टाल का भ्रमण किया।

प्रक्षेत्र प्रदर्शन, तकनीकी परामर्श एवं प्रसार गतिविधियां

- आइसीटी समर्थित एक से एक कार्यक्रम (ओ टी ओ पी), बाजार आधारित तकनीकी परामर्श सेवा (एम ओ टी ए एस), जाँच के लिए फसल का निरीक्षण एवं औद्योगिक दौरे से छः उद्यमियों समेत 43 हितधारक, सात प्रसंस्करणकर्त्ता/निर्माता, नौ किसान, छः सरकारी संगठन/नीति निर्माता, दो अनुसंधानकर्ता/अनुसंधान अध्येता, दो व्यापारी, नौ गैरसरकारी संगठन एवं भारत के एफ पी ओ लाभान्वित हुए। लाक्षा अपडेट्स नामक सोशल मीडिया व्हाट्सऐप समूह की पहल से हितधारकों के साथ संपर्क को गति मिली।
- प्रशिक्षण शुल्क के रूप में इस अवधि में 3.03850 लाख रूपए अर्जित किए गए।

प्रौद्योगिकी अंगीकरण, प्रभाव मूल्यांकन एवं बाजार अनुसंधान गतिविधियां

- वर्ष 2018–19 की तुलना में 2019–20 के दौरान प्रा.रा.गों. के उत्पादन में 12 प्रतिशत की कमी रिकॉर्ड की गई। यह मुख्य रूप से ग्वार गोंद (13%) के उत्पादन में गिरावट के कारण हुआ। परिणामस्वरूप प्राकृतिक राल एवं गोंद का कुल उत्पादन वर्ष 2018–19 के 6,05,771 टन से घटकर वर्ष 2019–20 में 5,28,194 टन हो गया। भारत में लाख का कुल उत्पादन गत वर्ष की तुलना में ज्यादा रहा। वर्ष 2019–20 में अन्य गोंद, राल जैसे कराया, धावड़ा एवं चीड़ राल के उत्पादन में भी हल्की वृद्धि दर्ज की गई।
- वर्ष 2019–20 में भारत से प्राकृतिक राल एवं गोंद की निर्यात की मात्रा (2.46 लाख टन) एवं निर्यात मूल्य (रू. 3146 करोड़) में गिरावट आई तथा इस अवधि में आयात परिदृश्य लगभग स्थिर रहा। सभी सामग्रियों के लिए विश्व व्यापार समूह यू एन कॉमट्रेड सांख्यिकी पर आधारित आई टी सी गणना से पता चलता है कि वर्ष 2018 में विश्व के 130 निर्यातकर्त्ता देशों में विश्व के कुल निर्यात मूल्य का 1.74% हिस्सेदारी के साथ 19वां स्थान रहा तथा विश्व के कुल आयात मूल्य में 2.71% हिस्सेदारी के साथ भारत का स्थान 9वां रहा।

प्राकृतिक राल एवं गोंद के निष्कर्षण, प्रसंस्करण एवं मूल्यवर्द्धन पर नेटवर्क परियोजना

- वर्ष 2020 में काजरी गोंद उत्प्रेरक से *अकेशिया सेनेगल* के 6465 वृक्षों का उपचार किया गया। इसके परिणामस्वरूप राजस्थान के 48 ग्रामों में लगभग 2.90 टन अरबी गोंद का उत्पादन हुआ। किसानों को गोंद की बिक्री कर रू. 23. 20 लाख का राजस्व प्राप्त हुआ एवं सी ए जेड आर आई, जोधपुर ने गोंद उत्प्रेरक की बिक्री कर रू. 6.46 लाख का संसाधन अर्जित किया।
- गोंद के दोहन की यांत्रिक एवं परम्परागत विधि की तुलना में चिरौंजी (*बुकनेनियां लैंजेन*) तथा रोहिणी (*सोयमिडा फेब्रिफ्यूगा*) से अप्रैल से जून की अवधि में गोंद के दोहन में इथेफोन का उपयोग उल्लेखनीय रूप से प्रभावी था।
- विषरहित ग्वार खाद्य को जब 3% सांद्रण के साथ कुकीज में समाविष्ट किया गया, तो पूरी तरह स्वीकार्यता देखी गई, जिससे रेशा एवं खनिज में उल्लेखनीय वृद्धि हुई।
- एलेन्थस वृक्ष पर इथेफोन इन्जेक्शन विधि का अध्ययन किया गया तथा पाया गया कि यह सबसे अच्छी विधि है, क्योंकि इसमें अन्य विधि की तुलना में ज्यादा उपज हुई। यह देखा गया कि राल के निष्कर्ष के लिए मॉनसून के बाद का समय सबसे अच्छा है।
- विभिन्न सांचों का उपयोग कर काले डामर पावडर से धूप बत्ती तैयार किया गया तथा केरल के विभिन्न जनजातिय क्षेत्रों में 120 प्रशिक्षुओं को प्रशिक्षण प्रदान किया गया।
- कृषि अभियंत्रण महाविद्यालय, थावनूर, के ए यू के सहयोग से हस्तचालित अगरबत्ती बनाने वाली मशीन का अभिकल्पन किया गया। यह मशीन, समूह में रह रहे जनजातिय लोगों के लिए डिजाइन की गई है, जहां विद्युत उपलब्धता एक महत्वपूर्ण मुद्दा है।
- मेघालय के तीन विभिन्न व्यास वर्ग के *पाइनस केसिया* से राल के दोहन से राल के उत्पादन पर सीजन के असर का पता चला। 30–35 से.मी. व्यास वाले पेड़ों के बीच अगस्त > अक्टूबर > सितम्बर > नवम्बर में राल का कुल उत्पादन आरोही क्रम में 89.45 ग्रा. से 354.13 ग्रा. था।
- घोल कास्टिंग विधि के माध्यम से विविध प्रयोगों के लिए पियार–ए जी एन पी एस संवलित नैनोकम्पोजिट फिल्म विकसित की गई है।
- सर्वश्री नेशनल इन्टरप्राइजेज, हटिया, राँची के सहयोग से, प्रो इन्जीनियर सी ए डी सॉफ्टवेयर के द्वारा विकसित निर्माण की डिजाइन के आधार पर गोंद के दोहन का डाई विकसित की गई।

लाख के आनुवंशिक संसाधन के संरक्षण की नेटवर्क परियोजना

- मदुरई, तमिलनाडु में रेन ट्री *समेनियां समन* से नयी लाख कीट आबादी संग्रह की गई। इस नई लाख प्रजाति, *केरिया कैनालिस* राजगोपाल का सभी सचित्र वर्गीकरण के साथ विवरण दिया गया।
- कॉक्स 1 जीन के साथ पी सी आर बारकोडिंग से पता चला कि कर्नाटक एवं आन्ध्रप्रदेश से संग्रह की गई नई लाख आबादी *केरिया लैका* एवं ताइवान से संग्रह किया गया *केरिया चाइनेनसीस* है। लाख परिपालक पौधे *फ्लेमींजीया सेमियालता* से संग्रह किए गए सफेद तितली के नमूने की पहचान *एल्यूरोडिकस डिस्पर्सस* के रूप में की गई।
- दो कीट रोगाणुविक कवक (ई पी एफ) *इसैरिया फ्युमोसोरोसिया* एवं *इसैरिया जैवेनिका* को पहले पृथक्कृत किया गया तथा लाख परभक्षी *युबलीमा एमाबिलिस* के विरूद्ध इसकी पहचान की एवं यह पाया गया कि यह लाख कीटों के लिए पूरी तरह सुरक्षित है। नियंत्रण की तुलना में ई पी एफ के साथ किए गए उपचार से लाख परभक्षियों जैसे *ई. एमाविलिस, श्यूडोहाईपाटोपा पल्वेरिया* एवं क्राइसोपा प्रजाति का आविर्भाव बहुत कम देखा गया।
- लाख परिपालक पौधे फ्लेमींजीया प्रजाति का एक महत्वपूर्ण भंडारण नाशीजीव *कैलोसोब्रुकस चीनेनसीस* के विरूद्ध विभिन्न जैवनियंत्रण अभिकारकों के बीच सीट्रोनेला तेल एवं द इ पी एफ, *वीभेरिया बैसियाना* का अंड निक्षेपण शक्ति सन्तुलन तथा अंडनाशी गुण उच्चतम था।
- इम्फाल पश्चिम जिले में परिपालक पौधे चम्पक, *मैग्नोलिया कैम्पेका* पर पहली बार लाख कीट का ग्रसण देखा गया।
- आन्ध्र प्रदेश के चित्तूर जिले के तिरूपति ग्रामीण क्षेत्र, निल्लोर जिले के कोबुरू क्षेत्र, गुंटूर जिले का गुंटूर एवं बापटला क्षेत्र में *कोनोकार्पस लैन्सीफोलियस* पर पहली बार लाख कीट देखा गया।
- पंजाब की परिस्थितियों के अन्तर्गत अकेली फसल की तुलना में लाख कीट की रंगीनी प्रजाति (कतकी फसल) के लिए अतिरिक्त लाभ प्रदान करते हुए अरहर की तीन किस्मों (ए एल 201, ए एल 882 एवं पी ए यु 881) में ए एल 201 सबसे आशाजनक पाई गई।

कृषि विज्ञान केन्द्र, खूंटी

- खरीफ 2020 के दौरान 37 लाभुकों के पाँच खेत में परीक्षण (ओ एफ टी) एवं एक परीक्षण केन्द्र में किया गया तथा लाभुक किसानों के बीच वांछित सुझाव दिए गए, साथ हीं बीज भी वितरित किए गए। सूखा प्रतिरोधी धान की उन्नत किस्म स्वर्ण श्रेया रू. 58,730/– प्रति हे. के शुद्ध लाभ एवं 1.96:1 के बी:सी अनुपात के साथ सर्वश्रेष्ठ रही। सहभागी भी 1.9:1 के बी सी अनुपात के साथ स्वर्ण श्रेया के बराबर ही रही।
- धान में समेकित खरपतवार प्रबन्धन के अन्तर्गत दो उपचार, हाथ से खरपतवार निकालना (20 डी ए टी एवं 40 डी ए टी) तथा उसके बाद ब्यूटाक्लोर 1.1 कि.ग्रा./हे. (3–5 डी ए टी) एफ बी 2 की दर से 2–4 डी 400 ग्रा./हे. (25–28 डी ए टी) की दर से देने से 1:8 के बी:सी अनुपात के साथ उच्चतर उत्पादन हुआ। धान में नाशीजीव प्रबन्धन के दौरान प्रमुख कीटों के ग्रहण से धान को बचाने के लिए बिचड़े को रोपण के पहले काटने/छांटने की प्रौद्योगिकी किफायती रही। इसे फेम (फ्लूबेंडिमाइड 39.35% एम) एवं कोराजेन (क्लोरैनट्रेनीलिप्रोल 18.5% एस सी) के रासायनिक उपचार से भी नियंत्रित किया जा सकता है।
- किसानों के पारम्परिक तरीके की तुलना में लाख की खेती के लिए बीहनलाख को 10 मिनट के लिए फिप्रोनील में 1.5 मि.ली./लीटर पानी की दर से डूबाने तथा वैज्ञानिक तरीके अपनाने से 2.7:1 के बी:सी अनुपात से बीहनलाख का अधिकतम उत्पादन हुआ।
- अगर विद्युत उपलब्धता की समस्या नहीं है तो उच्चतर गहाई क्षमता प्राप्त करने एवं समय तथा मानवशक्ति बचाने के लिए धान की गहाई हेतु मोटर से चलने वाला थ्रेसर उपयुक्त पाया गया। हालांकि जहां विद्युत उपलब्ध नहीं है, वहां

पैर से चलाने वाला (पेडल) थ्रेसर कम समय में धान की गहाई में उच्च गहाई क्षमता प्राप्त करने के लिए एक वैकल्पिक व्यवस्था हो सकती है।

- केन्द्र में किए गए परीक्षण में अनुशंसित एन पी के + 4 क्वि. प्रति हे. की दर से चूना + 20 कि.ग्रा./हे. की दर से गन्धक तथा 1 कि.ग्रा./हे. की दर से बोरोन देने से सरसों फसल में 11.53 क्वि./हे. की अधिकतम उपज हुई। आंकड़े बताते हैं कि केवल चूने के प्रयोग से भी किसान दाने का उच्चतम उत्पादन कर सकता है जो उल्लेखनीय रूप से राज्य के औसत उपज 9.70 क्वि./हे. से ज्यादा तथा राष्ट्रीय औसत उत्पादकता 11.34 क्वि./हे. के बराबर है।
- 290 लाभुकों को जोड़ते हुए 33.04 हे. क्षेत्र में छः अग्रतर प्रदर्शन (एफ एल डी ए एस) किए गए। किसानों की स्थानीय किस्मों की तुलना में सहभागी एवं श्रेया की उपज दोगुने थे। अरहर की किस्म आई पी ए – 203 ने स्थानीय की तुलना में 40.7% ज्यादा उपज दी। किसानों की किस्म की तुलना में मूंगफली की किस्म धरनी की उपज 34.61% उच्चतर थी। किसानों के तरीके की तुलना में बेर पर कुसमी लाख की वैज्ञानिक खेती से 44.86% ज्यादा बीहनलाख की उपज हुई।
- रबी एवं ग्रीष्म ऋतु की उत्पादकता बढ़ाने के लिए रबी में चना (390 कि.ग्रा.), सरसों (40 कि.ग्रा.) के अच्छे गुणवत्ता के बीज एवं ग्रीष्म ऋतु में मूंग (160 कि.ग्रा.) के बीज का वितरण किसानों के बीच किया गया तथा तकनीकी परामर्श दिए गए। चने की जी एन जी 1958 किस्म की उत्पादकता स्थानीय किस्म की तुलना में 27.74% ज्यादा रही। पूसा सरसों–30 का उत्पादन स्थानीय की तुलना में 52.26% उच्चतर रहा। मूंग की किस्म आई पी एम 2–3 की उपज स्थानीय की तुलना में 34.61% उच्चतर रही।
- खरीफ मौसम के दौरान किसानों के लिए परिसर से बाहर इक्कीस प्रशिक्षण आयोजित किए गए जिसके अन्तर्गत उन्हें धान, अरहर, कुमसी लाख की खेती, मूंगफली सोयाबीन, मूंग, उरद एवं सब्जी की खेती तथा रबी मौसम में परिसर से बाहर सोलह प्रशिक्षण आयोजित किए गए जिसके अंतर्गत उन्हें चना, मसूर एवं रेपसीड सरसों की खेती के बारे में बताया गया। इसमें कुल 2512 किसानों ने भाग लिया।
- इसके अतिरिक्त खूंटी जिले के 51728 किसानों के लिए प्रक्षेत्र दिवस, रेन गेज की स्थापना, वानिकी वृक्षों का रोपण, पार्थेनियम जागरूकता, आत्मनिर्भर भारत, पोषण जागरूकता अभियान, राष्ट्रीय महिला किसान दिवस, मृदा नमूना संग्रह, जैव–नाशकजीवनाशी पर प्रशिक्षण, वर्मिकम्पोस्ट निर्माण प्रशिक्षण, स्वच्छता पखवाड़ा, प्रधानमंत्री किसान योजना पर जागरूकता, डी ए एम यु के अन्तर्गत कृषि मौसम सलाह जैसे प्रसार गतिविधियों/कार्यक्रमों का आयोजन/संयोजन किया गया।

Research Accomplishments

Lac production

1. Productivity and Quality Improvement

1.1. Collection, conservation, characterization and evaluation of lac insect and host plant bio-diversity

Influence of plant growth regulators on morpho-physiology of *Flemingia semialata* (Roxb.) under lac insect (*K. lacca* Kerr.) infested condition

The study was carried out on *F. semialata* grown at institute research farm (IRF) of Indian Institute of Natural Resins and Gums (IINRG), Namkum, Ranchi during 2020-21. The plants were sprayed with plant growth promoters and growth retardants on 16th and 17th June 2020 before lac inoculation. Plants were inoculated with *kusmi* strain of lac insect (*K. lacca* Kerr.) in the month of July 2020. Plants with no spraying along with lac insect served as control. The standard cultural package of practices for *kusmi* lac cultivation were followed.

The plants were sprayed with plant growth regulators with following concentrations in parts per million (ppm) as shown in Table 1.1

Table 1.1: Details of growth regulator treatments

Treatments	Plant growth promoters /growth retardants	Concentration
T1	Naphthalene Acetic Acid	25 ppm
T2	Naphthalene Acetic Acid	50 ppm
T3	Naphthalene Acetic Acid	100 ppm
T4	Kinetin	100 ppm
T5	Kinetin	200 ppm
T6	TIBA	10 ppm
T7	TIBA	15 ppm
T8	Maleic Hydrazide	500 ppm
T9	Maleic Hydrazide	1000 ppm
T10	Control (with lac insect + no spray)	

The treatment Kinetin (200 ppm) recorded highest biomass (2043.20 g/plant) as compared to control (1893.60 g/plant). Treatment NAA (100 ppm) showed highest broodlac weight (592.20 g/plant) followed by NAA-50 ppm (587.40 g/plant) as compared to control (543.80 g/plant). Treatment NAA (100 ppm) showed highest broodlac weight/m encrustation (252.80 g/plant) followed by NAA-50 ppm (241.50 g/plant), Kinetin (100 ppm) as compared to control (214.90 g/plant). Kinetin (100 ppm) showed highest scrapedlac per plant (103.90 g) followed by NAA-50 ppm (100.70 g) as compared to control (72.70 g).

Observation of natural population of lac insect

Lac insect natural populations were observed on *Calliandra surinamensis* at Ghaziabad on 02nd December, 2020 (Fig. 1.1). Lac insect was settled on twigs and it will be collected at the time of maturation for further identification and characterization.

Fig. 1.1: Natural population of lac insects on *Calliandra surinamensis* at Ghaziabad

Broodlac multiplication of *Kerria chinensis* and *Kerria pennyiae* (*kusmi* yellow)

- 90 g Meghalaya stock (*K. chinensis*) broodlac (winter crop 2020) was inoculated on 1 no. of *Calliandra calothyrsus* plant and a yield of 300 g broodlac with scraped weight of 49 g was obtained.
- 200 g Thailand stock (*K. chinensis*) broodlac (winter crop 2020) was inoculated on 2 no. of *C. calothyrsus* plants and a yield of 980 g broodlac with scraped weight of 160 g was obtained.
- 2 kg *Kerria pennyiae* (Odisha *kusmi* yellow) was inoculated on *F. macrophylla* at NATLIGEC and a yield of 7.8 kg broodlac with scraped weight of 1.5 kg was obtained.

Field trials of *C. calothyrsus* at IRF

1.76 kg *rangeeni* broodlac was inoculated on 5 nos. of *C. calothyrsus* plants and a yield of 24 kg broodlac was obtained during *baisakhi* 2020. In *jethwi*, 2020, 2.62 kg *kusmi* broodlac was inoculated on 5 nos. of *C. calothyrsus* plants and a yield of 8.01 kg broodlac and 3.8 kg scraped lac was obtained. 420 g *kusmi* broodlac was inoculated on 3 nos. of *C. calothyrsus* plants and a yield of 1.44 kg broodlac with a scraped weight of 245 g was obtained during *aghani* 2020. *Katki* crop did not survive due to water logging.

On farm field trials of *C. calothyrsus*

280 g *kusmi* broodlac was inoculated at farmers' field on 05 nos. of *C. calothyrsus* plants and a yield of 1.48 kg broodlac with a scraped weight of 209 g was obtained during *aghani* 2020 crop. *Rangeeni* crop did not survive due to water logging at village Lodhama.

Maintenance of lac insect gene bank, host plant gene bank and different host plots

- 89 collections of 55 species are being conserved in the lac host field gene bank.
- 1290 cultures of 56 lac insect lines are being conserved on *F. macrophylla* in National Lac Insect Germplasm Centre (NATLIGEC).
- *Swadi Palas* plantations consisting of 75 plants are being conserved in a separate plot.
- *C. calothyrsus* (132 numbers with spacing of 4×4 meter) and Rain tree (*Samanea saman*) (30 numbers with spacing of 8×8 meter) were raised and developed separate plots for further study.

1.2 Taxonomic studies of lac insects (Hemiptera: Coccoidea: Tachardiidae) and associated insect fauna

Morphological characterization, identification and documentation of the lac insects
***Kerria sharda* Mishra & Sushil**

Material examined: Collected from Gene bank: LIK0007, *Flemingia macrophylla*, ICAR-IINRG, 7 slides (19 ad ♀♀).

Adult female: Mounted material (Fig. 1.2).

Body globular, 2.13-2.6 mm long, 1.5-2.08 mm wide at apex, 2-2.8 mm wide at middle and 1.43-1.95 mm wide at base (n=10).

Dorsum: Brachia mound, club shape and slightly sclerotized, 390-510 µm long. Brachial plate circular, diameter 250-300 µm; brachial crater shallow, centre in position, sub-circular, 150-170 µm wide, with a defined rim, dimples medium to large, distinct, 6-7 in number. Anterior spiracle 140-180 µm long and 90-120 µm wide, 180-300 µm away from the brachial crater. Dorsal spine well developed 240-300 µm long and 110-130 µm wide at the base of pedicle; pedicle large, square to near rectangular, more sclerotized towards spine, 120-160 µm long; spine 130-160 µm long and more sclerotized with 2-3 spinosites at its base. Anal tubercle well developed; pre-anal plate membranous, supra-anal plate 320-350 µm long, 380-440 µm wide, heavily sclerotized, hispid near apex. Anal fringes short, fringe maximum height 40-60 µm. Anal ring 6 sectored with 10 setae.

Venter: Antennae 30-40 µm long, 3 segmented, segmentation obscure, apical segment flatten with 3 long fleshy setae and 2 short setae. Posterior spiracle smaller than the anterior spiracle, born on a sclerotized plate. Marginal duct cluster distinct, 6 in number; arranged in convoluted line; each consisting of 17-20 ducts without any surrounding sclerotization. Perivulvar pore clusters 7-8 in number on each side.

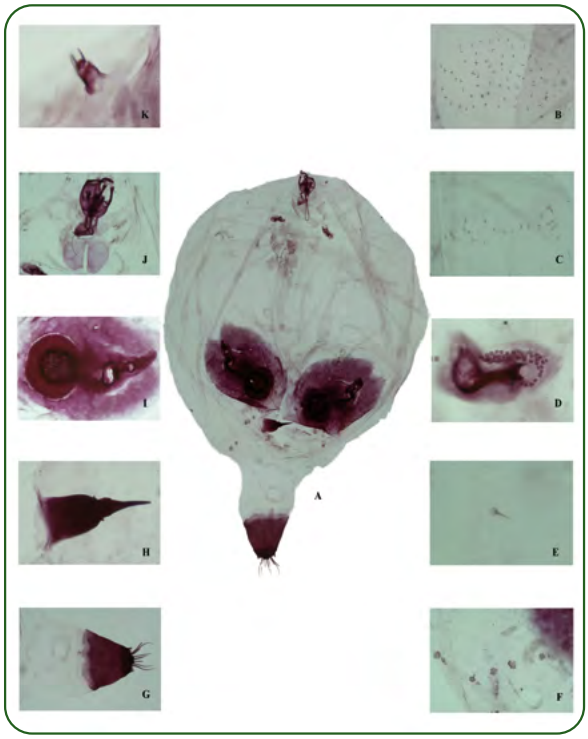


Fig. 1.2: *Kerria sharda* Mishra & Sushil. A, whole mount. B, ventral duct cluster. C, marginal duct cluster. D, posterior spiracle. E, ventral seta. F, perivulvar pore cluster. G, anal tubercle. H, dorsal spine. I, brachia with anterior spiracle. J, mouthparts. K, antenna

Kerria chinensis (Mahdihassan)

Material examined: Collected form Gene bank: LIK0031, *Flemingia macrophylla*, ICAR-IINRG, 4 slides (13 ad ♀♀).

Adult female: Mounted material (Fig. 1.3).

Body elongate, 2.83-3.25 mm long, 2-2.37 mm wide at apex, 2.57-3.2 mm wide at middle and 1.87-2 mm wide at base (n=10).

Dorsum: Brachia elevated, cylindrical shape and heavily sclerotized, 470-560 µm long. Brachial plate circular, diameter 175-225 µm; brachial crater shallow, centre in position, sub-rectangular, 80-85 µm wide, with a defined rim, dimples small, distinct, 10-12 in number. Anterior spiracle 150-180 µm long and 110-150 µm wide, 225-360 µm away from the brachial crater, with sclerotized trailing or canellar band, below anterior spiracles measuring about the length of the branchia. Dorsal spine well developed 250-290 µm long and 80-90 µm wide at the base of pedicle; pedicle small, bulbous, less sclerotized,100-120 µm long; spine 140-150 µm long and more sclerotized with 2-3 spinosites at its base. Anal tubercle well developed; pre-anal plate membranous, supra-anal plate 330-380 µm long, 300-350 µm wide, heavily sclerotized, hispid near apex. Anal fringes short, fringe maximum height 30-50 µm. Anal ring 6 sectored with 10 setae.

Venter: Antennae 30-40 µm long, 3 segmented, segmentation obscure, apical segment flatten with 3 long fleshy setae and 2 short setae. Posterior spiracle born on a sclerotized plate. Marginal duct cluster distinct, 6 in number; arranged in convoluted line; each consisting of 60-79 ducts without any surrounding sclerotization. Perivulvar pore clusters 9-13 in number on each side. Ventral duct cluster present, irregular in shape and totalling to 3 pairs.

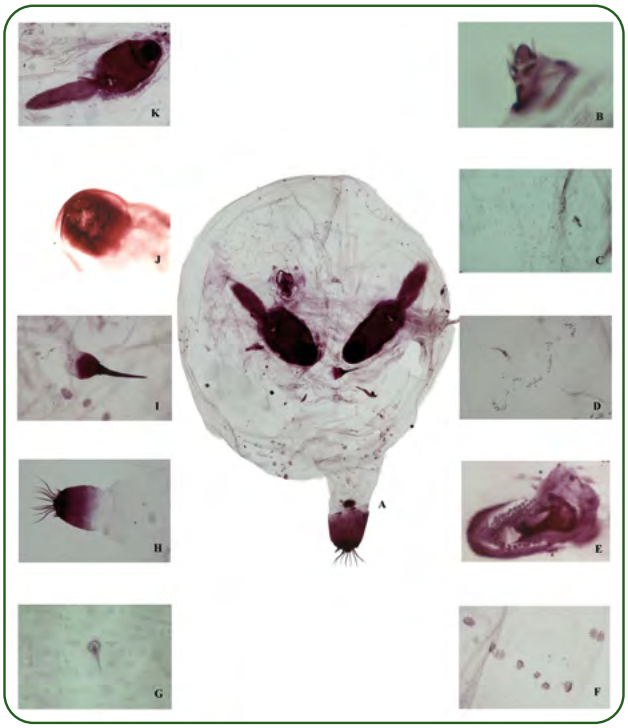


Fig. 1.3: *Kerria chinensis* (Mahdihassan). A, whole mount. B, antenna. C, ventral duct cluster. D, marginal duct cluster. E, posterior spiracle. F, perivulvar pore cluster. G, ventral seta. H, anal tubercle. I, dorsal spine. J, brachial crater with dimples. K, Branchia with anterior spiracle and sclerotized trailing

Kerria pusana (Misra)

Material examined: Collected from Gene bank: LIK0001, *Flemingia macrophylla*, ICAR-IINRG, 4 slides (10 ad ♀♀).

Adult female: Mounted material (Fig. 1.4).

Body globular, 3.23-3.3.82 mm long, 2.52-2.91 mm wide at middle (n=10).

Dorsum: Brachia elevated, cylindrical shape and heavily sclerotized, 259-357 µm long. Brachial plate circular,

diameter 274-282 µm; brachial crater shallow, centre in position, sub-circular, 128-175 µm wide, with a defined rim, dimples small, distinct, 5-6 in number. Anterior spiracle 254-330 µm long and 164-179 µm wide. Dorsal spine well developed 403-481 µm long; pedicle 242-341 µm long; spine 161-201 µm long and more sclerotized with 1-2 spinosites at its base. Anal tubercle well developed; pre-anal plate membranous, supra-anal plate 409-587 µm long, 429-518 µm wide, heavily sclerotized, hispid near apex.

Venter: Posterior spiracle born on a sclerotized plate. Marginal duct cluster distinct, 6 in number; arranged in convoluted line; each consisting of 23-26 ducts without any surrounding sclerotization. Perivulvar pore clusters 9-12 in number on each side. Ventral duct cluster present, irregular in shape and totaling to 3 pairs.

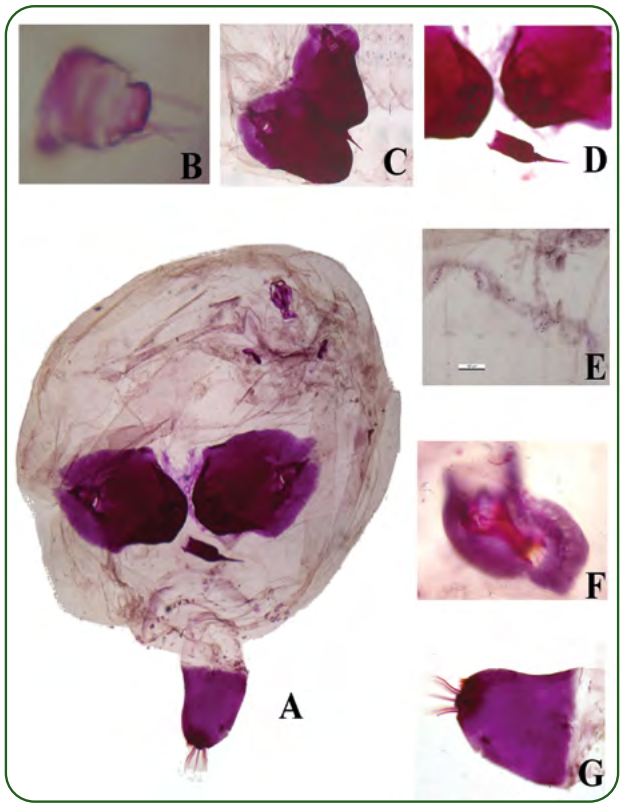


Fig. 1.4: *Kerria pusana* (Misra). A, whole mount. B, antenna. C, brachia. D, brachial plate, crater with dorsal spine. E, marginal duct cluster. F, posterior spiracle. G, anal tubercle

Taxonomic studies on lac host plant associated insect fauna

Common *Ficus* species are reported to support wild natural lac insect populations in different parts of India and considered as good host for *in-situ* lac insect conservation. Detailed understanding of fig biology as well as fig associated insects is required for sustainable conservation effort. However, little is known about the diversity of lac associated entomofauna in fig hosts. A survey was conducted to document fig and fig wasp diversity at campus and institute research farm of ICAR-IINRG, Ranchi, Jharkhand. Survey revealed occurrence of 8 *Ficus* species in the campus. Over 1200 fig wasp (Chalcidoidea: Hymenoptera) specimens were collected from D-phase mature syconia of 4 different *Ficus* species *viz. F. lacor*, *F. rumphii*, *F. racemosa*, and *F. religiosa*. Fifteen species of fig wasps were identified from the collection including 5 potential new species in the superfamily Chalcidoidea. Further, the study established new distribution record for 7 genera of fig wasps *viz. Apocrypta* Coquerel 1855, *Camarothorax* Mayr l906, *Eupristina* Saunders 1883, *Otitesella* Westwood l883, *Sycophaga* Westwood 1840, *Sycophila* Walker 1871 and *Sycoscapter* Saunders 1883 from the state of Jharkhand. Comprehensive sampling efforts are required to uncover the hidden biodiversity of *Ficus* associated entomofauna.

1.3 Morpho-physiological characterization *vis-à-vis* strategies to augment quality and storability of seeds of *Schleichera oleosa* under ambient condition

Seed storage behavior and germination dynamics

Data of three years *viz.*, 2018, 2019 and 2020 revealed a significant difference for the seed germination of *kusum* seeds collected from Namkum (Ranchi), Petarwar (Bokaro) and Murhu (Khunti) and stored under airtight plastic jar, HDPE and cotton bag which are shown in Fig. 1.5(a-c). In general, September shown seeds found higher germination percent followed by October and November in the all studied collections. During first year of experimentation, the seeds from Namkum stored in airtight plastic jar observed highest germination percent of 55 in September followed by 40 percent in October and 10 percent in November whereas the Murhu seed stored under this condition found 95 percent germination in September followed by 90 percent in October and 40 percent in November. Likewise, seeds of Petarwar stored under airtight plastic jar observed 45 percent germination percent followed by 35 percent in October and 15 percent in November. Wherever, HDPE storage condition, the seeds of Namkum showed 50 percent germination in the

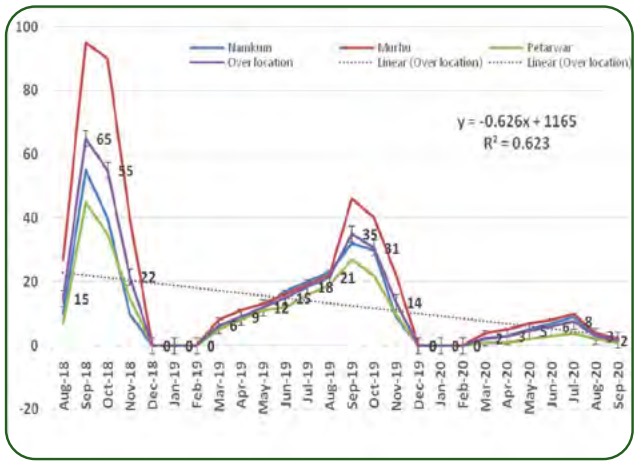
Month of September followed by 40 percent in October and 10 percent in November. The seeds of Murhu in HDPE storage condition showed 75 percent germination in October followed by 55 percent in October and 15 percent in November, whereas, 60 percent seed germination observed in September, 43 percent in October and 25 percent in November sown seeds of Petarwar. Cotton bag storage condition did not showed very well for the storage of *kusum* seed.

Seeds of Namkum stored under cotton bag observed 25 percent germination in September followed by 20 percent in October and the seeds of Murhu observed 45 percent in November and 35 percent in October whereas 44 percent seed germination observed in September and 28 percent seed germination observed in November of the seed collected from Peterwar.

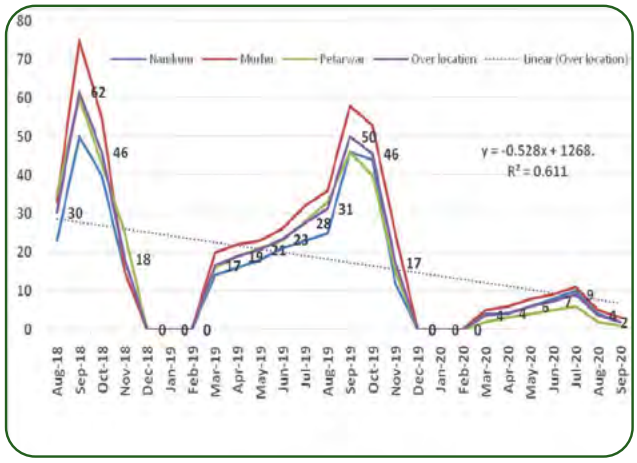
During the second year, significant variations in germination were recorded from the stored seeds under different conditions. September sown seeds from Murhu showed higher germination percent (58) of seeds followed by October (53) stored under HDPE. The same trend was observed with the seeds of Namkum (46 & 44) and Petarwar (46 & 44), respectively. However, the seed stored under Plastic jar showed close vicinity with the HDPE storage *viz*., 46 & 40 (Murhu) followed by 23 & 32 (Namkum) and 27 & 22 (Petarwar) during September and October, respectively. Cotton bag stored seed showed poor germination but the seeds showed higher germination percent in September *viz*., 32 (Murhu), 22 (Namkum) and 28 (Petarwar) followed by October which was 28 (Murhu), 23 (Petarwar) and 20 (Namkum), respectively. Seed germination in June & July was relatively better than the seed sown in March-May. During third year, a sharp declination in germination percent was observed irrespective to storage condition and duration. The seed germinated during September-October were relatively better. However, germination of *kusum* seed effected strikingly during December, January and February which might be due low temperature irrespective to location of seed collection and storage conditions. The study inferred that the seeds maintain its high vigour in the month of September and October, and stored under plastic jar and HDPE bag.

Storage behavior of pretreated seeds and germination dynamics

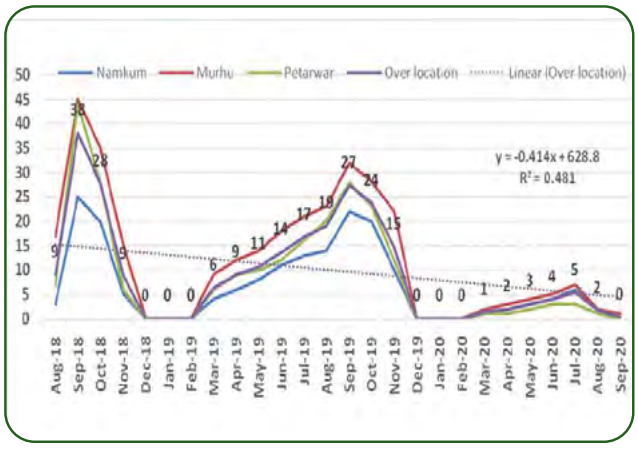
The experiment was carried out during 2019 and 2020. Seeds from all the three locations were pretreated in Product Development Lab 3 with Chitosan (T1), Imidacloprid 17.8



(a): Germination dynamics of *kusum* seed stored under air tight plastic jar



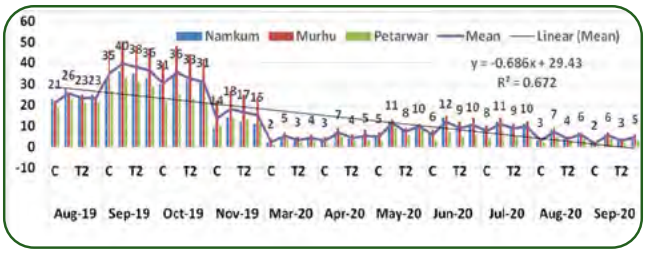
(b): Germination dynamics of *kusum* seed stored under HDPE bag



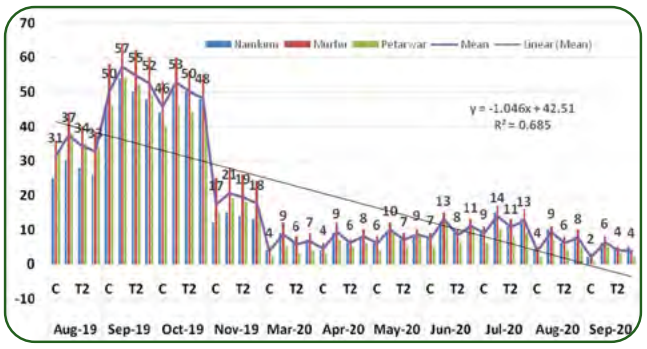
(c): Germination dynamics of *kusum* seed stored under Cotton bag

Fig. 1.5: Germination dynamics of kusum seed under different storage conditions

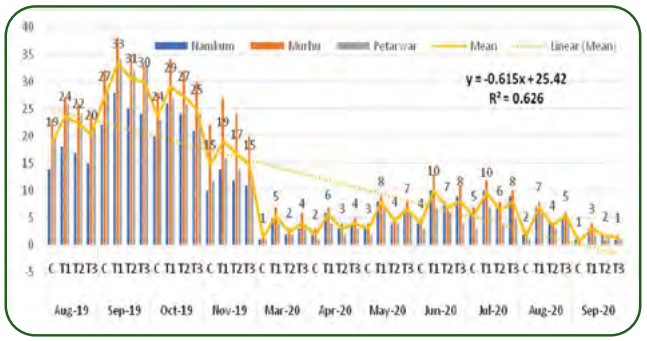
SL @ 0.04% (T2) and lac polymer (T3) before storing in the three different types of containers to ascertain their effect on germination as shown in Fig. 1.6 (a-c). In general, it was observed an enhancement in germination rate in all studied seasons *i.e.* August, September, October and November. Higher enhancement in germination percent observed in the seed collected from Murhu and sown in September followed by October irrespective of the storage conditions. Higher germination observed in the seed treated with Chitosan (50.0) followed by Imidacloprid (48.0) and Lac coating (47.0) with respect to control (46.0) in the seed stored under plastic jar, whereas HDPE stored seed also observed higher germination enhancement in Chitosan treated seed (64.0) followed by Imidacloprid (62.0) and Lac coating (60.0) with respect to control (58.0). Under Cotton bag storage, Chitosan treated seed showed higher germination enhancement of 38.0 followed by Imidacloprid (35.0) and Lac coating (33.0) with respect to control (32.0) . During the second year, it was observed as the same trend of the treatment as observed in the previous year. Further, storage duration, location of seed collection and seed pre-treatment significantly influence the germination. It is evident that interaction of location of seed collection at individual storage duration (AXB) has a significant effect on seed germination. Moderate to high value of R^2 for germination dynamics in treated *kusum* seeds in storage conditions revealed that the observed variation can be explained by the model's inputs.



(a) Effect of seed pretreatment on germination of *kusum* seed stored under air tight plastic jar



(b) Effect of seed pretreatment on germination of *kusum* seed stored under HDPE bag



(c) Effect of seed pretreatment on germination of *kusum* seed stored under Cotton bag

Fig. 1.6: Effect of seed pretreatment on germination of *kusum* seed under different storage conditions

1.4 Understanding lac insect-host plant interaction- a molecular approach

An attempt to understand the host reaction to insect has been taken up by the study under this project. High-throughput transcriptome data will be generated for lac-host plant *Flemingia semialata* species for the first time. This study will help us in guiding the role of host plants in lac production which is an interaction-mediated product. In this study, host response has been tried to snapshot using certain Reactive Oxygen species marker enzymes which have shown response. Different host plants are showing differential response to lac insect strain differently. Thus, this reinforces that lac-host plant interaction is specific and not co-incident. To get further understanding of the interaction host's transcriptome response has been captured which is predicted to lead us further into this study. Following are certain images (Fig. 1.7 to 1.12) from the study till date.

Fig. 1.7: Inoculation of broodlac on 3-month old seedling of lac host plant

Fig. 1.8: Insect settlement on three-month old seedlings of lac host plant

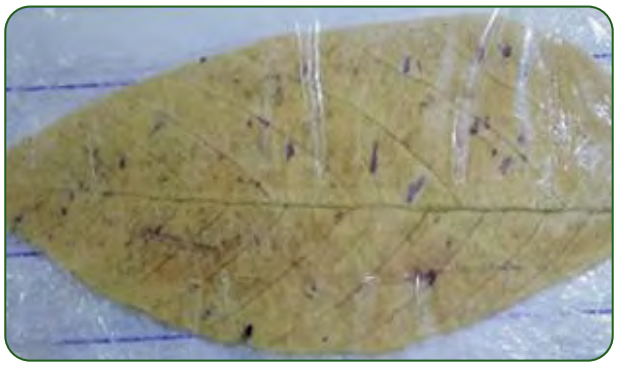


Fig. 1.9: NBT staining of leaf from insect-inoculated host plant

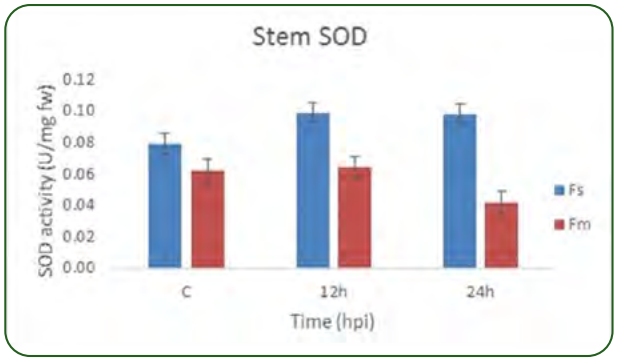


Fig. 1.10: SOD enzyme activity in stem of two different lac hosts at different duration of inoculation

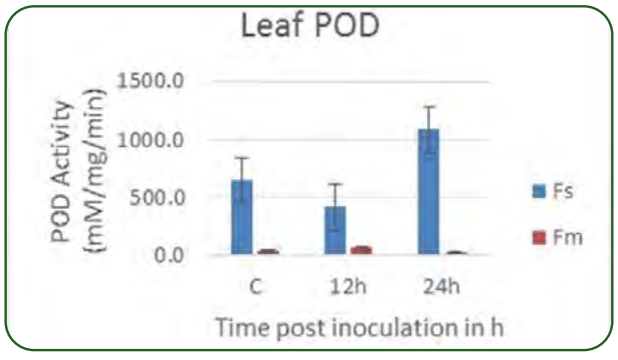


Fig. 1.11: Peroxidase enzyme activity in leaf of two different lac hosts at different duration of inoculation

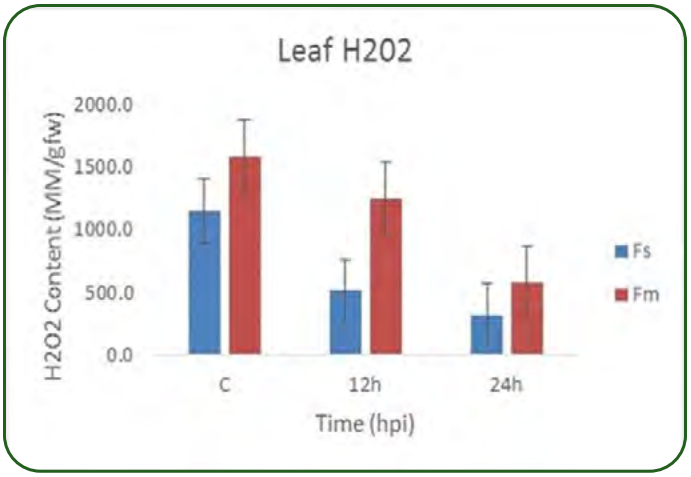


Fig. 1.12: H_2O_2 content leaf tissue of two different lac hosts at different duration of inoculation

1.5 Agronomic interventions influencing lac production in *palas* (*Butea monosperma*) in summer season

To visualize effect of topography (upland/ lowland), fertility levels (control, liming, NPK + liming and double dose NPK + liming) and rest (7 months and 19 months) on tree growth and lac production, different tree growth attributes were recorded prior to harvesting of lac crop. Mean summary is presented in Table 1.2. Pruning response was tested in two different levels *i.e.* big branch to medium sized branch generation (*i.e.* prune point generation) and from prune point to inoculable shoot regeneration. For uniform comparison, values were converted into shoots produced per unit diameter.

Topography, in general, did not show any significant variation among different growth attributes. However, soil fertility levels could influence number of shoots per 10 cm branch thickness and number of rejected shoots (after collecting broodlac). Fertilization along with liming proved to be the best. NPK+ liming increased number of rejected shoots to the tune of 100% over control. However, double dose of NPK+ liming produced 50% increase in number of new shoots per unit branch thickness.

More rest (19 months) could increase average shoot diameter 28.5 percent and shoot length 35 percent over 7 months rest.

Table 1.2: Tree growth parameters, lac yield and yield attributes affected by topography, soil fertility and rest levels during Jan to July 2020

	No. shoots/ 10 cm branch thick-ness	No. shoots/ 10 mm PP thick-ness (with-out lac)	No. shoots/ 10 mm PP thick-ness (with lac)	Average new shoot diam-eter (mm) in Jun	Average new shoot length (cm) in Jun	No. re-jected shoots	Re-jected shoot wt. (kg)	New flash arrival (Std. week)	Fruits per bunch	No. flower bunch per tree	Dry matter per-cent (April)	Dry mat-ter per-cent (Jun)
U	3.4	1.5	1.3	10.4	48.0	98.2	6.4	16.5	25.5	12.4	35.0	37.8
L	4.1	1.5	1.2	10.4	49.2	96.4	5.9	16.4	31.6	15.0	33.7	38.7
CD	0.7 (NS)	0.2(NS)	0.4(NS)	0.9 (NS)	7.0 (NS)	38.7 (NS)	2.6 (NS)	0.4 (NS)	13.6 (NS)	4.9(NS)	2.5 (NS)	2.1 (NS)
F0	3.2	1.6	1.3	11.0	60.5	80.8	5.1	16.1	27.8	15.3	35.3	39.0
F1	3.7	1.4	1.0	9.6	43.8	70.8	4.6	16.3	27.2	13.4	32.6	37.4
F2	3.5	1.5	1.3	10.3	45.4	161.5	10.0	16.8	33.5	12.7	34.4	38.2
F3	4.8	1.5	1.4	10.6	44.7	76.1	4.9	16.6	25.6	13.3	35.0	38.5
CD	1.0*	0.3 (NS)	0.5 (NS)	1.3 (NS)	9.8 (NS)	54.8*	3.7 (NS)	0.5 (NS)	19.2 (NS)	7.0 (NS)	3.6 (NS)	3.0 (NS)
R1	4.1	1.5		9.1	41.2			16.6	22.6	11.6		
R2	3.5	1.5		11.7	56.0			16.3	34.4	15.7		
CD	0.7 (NS)	0.2 (NS)		0.9*	7.0*			0.4 (NS)	13.6 (NS)	4.9 (NS)		
	NS	NS										

U: Upland, L: Lowland, F0-F3: Levels of soil fertility, R1,R2: Rest periods

NS: Non-significant; * Significant

Other tree growth attributes like new flash arrival in different standard weeks, fruits per bunch, dry matter percent in April and June, number of flower bunch per tree and shoot dry matter percent were recorded. None of these attributes were influenced significantly due to any of the factors under study.

Table 1.3: Tree and insect growth attributes affected by topography, soil fertility and rest period

	Eublemma count per meter	*Pseudo-hypatopa* count per meter	Parasite count per meter (March)	Parasite count per meter (April)	Borers holes per tree (6 feet height)	Scraplac percent	Encrusta-tion thick-ness mm	Yield ratio
U	4.4	2.5	11.0	8.9	0.2	38.8	4.5	2.5
L	7.9	2.1	5.1	3.6	0.5	37.1	4.3	3.4
CD	3.1 (NS)	1.8 (NS)	6.5 (NS)	4.3*	0.5 (NS)	5.5 (NS)	0.3 (NS)	1.3 (NS)
F0	3.8	2.6	12.6	5.7	0.0	39.0	4.4	2.5
F1	5.6	1.9	1.4	2.4	0.9	36.4	4.4	3.0
F2	9.8	2.4	9.8	7.9	0.1	38.7	4.5	4.2
F3	5.6	2.3	8.3	8.9	0.4	37.7	4.5	2.0
CD	4.4 (NS)	2.6 (NS)	9.2 (NS)	6.1 (NS)	0.7 (NS)	7.8 (NS)	0.5 (NS)	1.9 (NS)

	Eublemma count per meter	*Pseudo-hypatopa* count per meter	Parasite count per meter (March)	Parasite count per meter (April)	Borers holes per tree (6 feet height)	Scraplac percent	Encrustation thickness mm	Yield ratio
R1					0.5			
R2					0.2			
CD					0.5 (NS)			

Observations on different lac yield, yield attributes and predator/ parasite infestation are presented in Table 1.3. No significant difference in scrap lac percent, encrustation thickness and lac yield ratio was observed as affected by topography, fertility levels and rest period. Yield ratio varied from 2.5 to 3.4 in upland and lowland conditions and from 2.5 to 4.2 due to different fertility levels. However, parasite count in the month of April was influenced significantly (~2.5 times increase in upland) due to topography of land.

The effect of land topography (upland and lowland), fertilizer levels and rest period (7 and 19 months) on shoot dry matter percent, percent increase in shoot diameter and length was examined in December 2020. Increased growth was observed only in case of shoot diameter (Table 1.4). Shoot tended to be succulent under lowland and higher soil fertility. Only rest period could influence shoot growth significantly.

Table 1.4: Tree growth parameters affected by topography, soil fertility and rest period during July to December 2020

	Shoot dry matter percent	Percent increase in Shoot diameter	Percent increase in Shoot length
U	35.9	10.9	9.9
L	34.4	10.6	8.4
$CD_{(0.05)}$	1.6 (NS)	1.2 (NS)	5.0 (NS)
F0	35.6	11.8	7.9
F1	35.5	9.8	9.9
F2	35.1	9.8	8.3
F3	34.4	11.3	10.6
$CD_{(0.05)}$	2.3 (NS)	1.7 (NS)	7.0 (NS)
R1	34.7	9.6	10.3
R2	35.6	11.8	8.1
$CD_{(0.05)}$	1.6 (NS)	1.2*	5.0 (NS)

Soil moisture retention study for lowland and upland

For differentiating upland and lowland, fortnightly soil moisture percent from 15 cm depth was estimated from November month onwards. Apparently, lowland recorded 5-10 percent higher moisture percent compared to upland. During Nov to Dec period, range of the same in lowland and upland was 16.1-19.8 percent and 9.3-12.6 percent respectively (Fig. 1.13). Also rate of moisture depletion is higher in upland than lowland conditions.

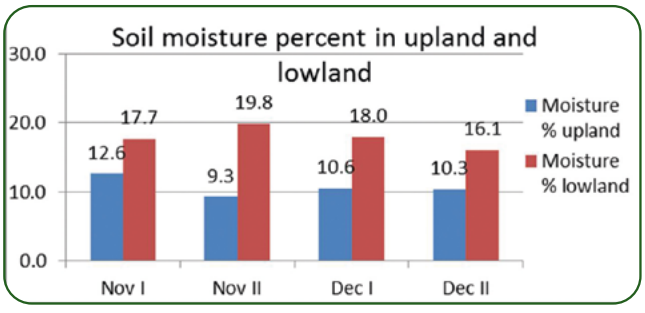


Fig. 1.13: Soil moisture percent in upland and lowland over time

Validation of the result of the effect of heat treatment on *kusum* seed germination

Earlier, it was reported that best germination of *kusum* seed can be obtained with heat treatment at 50°C temperature for 3-6 hours. For validation of the same two blocks of filled up polytubes (50 each) with soil mixture were sown with treated and untreated *kusum* seeds. Average seed weight of the lot was 605 mg and 20 percent seeds were below 500 mg weight before sowing. Each polytube in each lot (heat treated and untreated) was sown with a single seed on mid August.

Seed germination percent increased significantly due to heat treatment. Treated seed recorded 28 percent germination, while untreated lot observed 14 percent only. Germination of treated seed initiated at 44 days after sowing and that for untreated seed was at 58 days after sowing. The differences observed were significant (Table 1.5). However, cotyledon length of germinated seeds and weight of un-germinated seeds did not vary significantly.

Correlation study was done whether there is any relationship between cotyledon length and germination initiation time. The relationship observed was non-significant with a correlation coefficient of 0.1.

Table 1.5: Effect of heat treatment on *kusum* seed germination

	Germination%	Germination initiation time (days)	Cotyledon length (mm)	Un-germinated seed wt
Heat Treat	28	43.9	25.8	570.4
Untreated	14	58.4	27.8	554.8
$CD_{(0.05)}$	9.52*			
$p_{(0.05)}$ for t-test		0.02	0.17	0.27

2. Crop Production System Management

2.1. Lac Integrated Cropping System through Participatory Approach

Lac host *Flemingia semialata* based cropping system

Relative performance, biomass production and carbon stock under lac host semialata based cropping system in rainy season were studied at Institute Research Farm. Cropping models *viz.*, sole okra, tomato and radish; intercrops semialata+okra, semialata+tomato and semialata+radish were evaluated in rainy season of 2020.

Relative performance under lac host semialata based cropping system in rainy season

For ease in comparison, okra equivalent yield (kg/ha) as influenced by different cropping system has been worked out (Table 2.1). The significantly maximum okra equivalent yield (p<0.05) was found in sole okra (7681.13 kg/ha) whereas, the minimum was obtained in intercrop semialata+tomato (2216.19 kg/ha).

Table 2.1: Effect of different cropping system on okra equivalent yield (kg/ha) in rainy season

Treatments	Crop yield (kg/ha)	Okra equivalent yield (kg/ha)
Okra	7681.13	7681.13
Tomato	2898.12	4497.08
Radish	4888.60	4214.31
Semialata+ Okra	5958.91	5958.91
Semialata+ Tomato	1428.21	2216.19
Semialata+ Radish	3597.32	3101.14
$CD_{0.05}$		829.60

Effect of intercropping with *semialata* on the growth of okra, tomato and radish

The effect of intercropping with *Flemingia semialata* on the growth of okra, tomato and radish was studied during rainy season of 2020. The results as revealed through t-test, showed that the plant height of intercrop okra was significantly higher (p<0.05) than sole okra in 15 DAS (Days after Sowing), 45 DAS and 60 DAS with values of 11.73 cm, 111.32 cm and 145.67 cm respectively for intercrop okra and 9.70 cm, 95.63 cm and 120.07 cm respectively for sole okra. While in 30 DAS the plant height of intercrop okra (32.48 cm) was not significantly higher than sole okra (30.39 cm). The result showed that there is no significant difference (p>0.05) in plant height between sole tomato and intercrop tomato in all the period of observation. The plant height of intercrop radish was significantly higher (p<0.05) than sole radish in 15 DAS (Days after Sowing) and 30 DAS with values of 14.64 cm and 25.19 cm respectively for intercrop radish and 13.13

cm and 20.11 cm respectively for sole radish. The fresh fusiform tap root length of intercrop radish (13.04 cm) was significantly higher than the sole radish (9.43 cm).

Biomass production under lac host *F. semialata* based cropping system in rainy season

Different cropping system significantly influenced total biomass (above and below ground) of the crops (p<0.05) in rainy season. Among the intercrops the maximum total biomass was obtained in intercropping semialata+okra (3.47 t/ha) whereas, the minimum was recorded in intercropping semialata+tomato (0.26 t/ha).

2.2. Evaluation of the effect of drip irrigation and plastic mulch on growth and yield of *Flemingia semialata*

A study was conducted to assess the effect of drip irrigation and plastic mulch on growth and seed yield of *Flemingia semialata*. Two types of plastic mulch (green and silver/black) were tested at three levels (25%,50%,75%) of simulated (i.e. irrigation was provided manually) drip irrigation. There were all together twelve treatments *viz*. T1-drip irrigation at 75% simulated irrigation, t2-drip irrigation at 75% simulated irrigation with silver/black plastic mulch, T3- drip irrigation at 75% simulated irrigation with green plastic mulch, F4- drip irrigation at 50% simulated irrigation, T5- drip irrigation at 50% simulated irrigation with silver/black plastic mulch, T6-drip irrigation at 50% simulated irrigation with green plastic mulch, T7- drip irrigation at 25% simulated irrigation, T8- drip irrigation at 25% simulated irrigation with silver/black plastic mulch, T9- drip irrigation at 25% simulated irrigation with green plastic mulch, T10-no drip no plastic mulch(control), T11-no drip with silver/black plastic mulch, T12-no drip with green plastic mulch

- Maximum growth of shoot height (18.75cm) recorded with simulated drip irrigation and green plastic mulch at 75% level of irrigation. Maximum increase in plant girth (1.80mm) was recorded with simulated drip irrigation and silver/black plastic mulch at 75% level of irrigation and maximum leaf area (117.64 cm^2) is recorded with simulated drip irrigation and silver/black plastic mulch at 50% level of irrigation, as compared to all other treatments including control (Fig. 2.1)
- Maximum number of flowers recorded in silver/black mulch alone treatment (54.58) followed by green plastic mulch alone treatment (54.00). As far as treatments of drip irrigation and plastic mulch are concerned, the treatment of simulated drip irrigation with green plastic mulch at 50% level of irrigation produced highest number of flowers (51.66) including control (33.75).
- Average maximum number of pods/plant (176.33) were recorded with treatment of silver/black plastic mulch alone followed by 172.25 pods/plant in treatment of simulated drip irrigation at 50% level with green plastic mulch compared to other treatments including control.
- Last year maximum seed yield of *F. semialata* was recorded as 9 g/plant in the treatment of drip irrigation with green plastic mulch at 50% irrigation level.

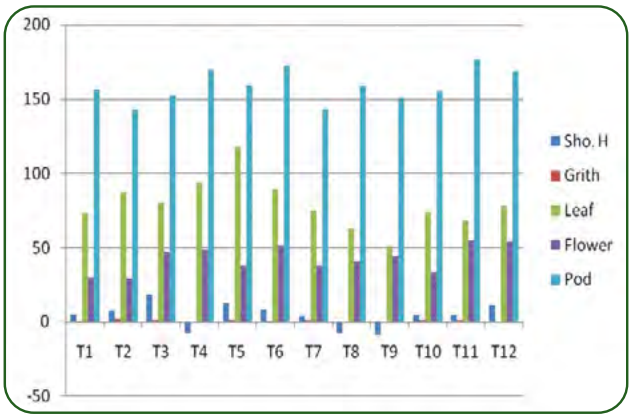


Fig. 2.1: Treatments *vs* Growth Parameters (Legends: Sho.H= Shoot ht. diff. (cm), Girth diff. (mm), Leaf= Leaf area (cm^2), Flower= Flower no./plant, Pod= Pod no./plant

2.3. Effect of abiotic factors on lac associated fauna in *rangeeni* crop (Phase II)

Relative abundance and emergence profile of parasitoids and predators associated with lac insect were recorded at Institute Research Farm during summer season (*baisakhi*) and rainy season (*katki*) crops of *rangeeni* strain sprayed with fungicide (Chlorothalonil) only. The information generated reveals that, three parasitoids (*Aprostocetus purpureus*, *Tachardiaephagus tachardiae* and *Tyndarichus clavicornis*) and one predator *Eublemma amabilis* were abundant in *baisakhi* and *katki*, 2020. Among lac associated fauna, *Aprostocetus purpureus* was recorded in more numbers on *ber* and *palas* during *baisakhi* and *katki*, 2020 (Table 2.2).

Table 2.2: Relative abundance of lac associated fauna during *Baisakhi* and *Katki* 2020

Lac associated fauna (Numbers per meter lac encrustation)	*Baisakhi* 2020		*Katki* 2020	
	Ber (Upto May 2020)	*Palas*	*Ber*	*Palas*
Tachardiaephagus tachardiae	0	10	3	7
Aprostocetus purpureus	130	294	173	139
Tyndarichus clavicornis	2	6	7	3
Eublemma amabilis	0	14	14	41
Total	132	324	197	190

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

Study on weekly emergence profile of lac associated fauna (per meter lac encrustation) showed maximum population of *A. purpureus* in those samples which were collected 38 on *ber* in 11th Standard Meteorological Week (SMW) during sexual maturity period and 165 on *palas* in 29th SMW during crop maturity period when caged during *baisakhi* 2020. In *Katki*, 2020, the maximum emergence of *A. purpureus* was recorded during crop maturity period (44 and 45 SMW) when raised on *ber* (41) and *palas* (40) respectively. (Fig. 2.2 to 2.5).

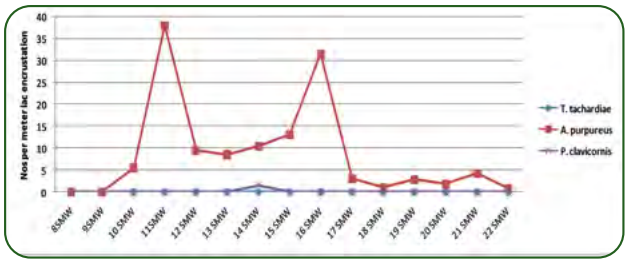


Fig. 2.2: Emergence profile of lac associated fauna on *ber* during *baisakhi* 2020

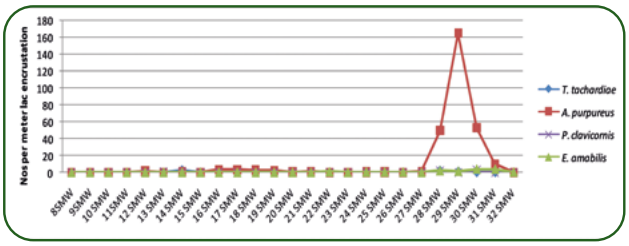


Fig. 2.3: Emergence profile of lac associated fauna on *palas* during *baisakhi* 2020

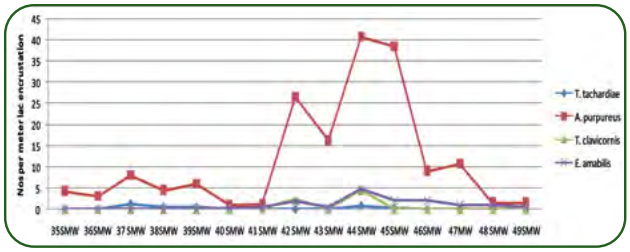


Fig. 2.4: Emergence profile of lac associated fauna on *ber* during *katki* 2020

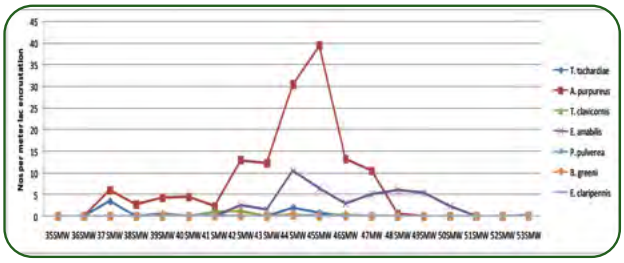


Fig. 2.5: Emergence profile of lac associated fauna on *palas* during *katki* 2020

In-situ and lab caging study on emergence of lac associated fauna

Emergence profile of lac associated fauna was compared between different caging methods *viz. in-situ* caging and lab caging during *baisakhi* 2020 and *katki*, 2020. Higher numbers of *A. purpureus* (except in *Palas*), *T. tachardiae*, *T. clavicornis* and *E. amabilis* were recorded *in situ* caging method (12, 74, 3 and 3) (221, 44, 13 and 8) compared to lab caging (0, 39, 1 and 1) (3, 97, 2 and 5) on *ber* and *palas*, respectively during *baisakhi*, 2020. In *katki*, higher numbers of *A. purpureus*, *T. tachardiae*, *T. clavicornis* and *E. amabilis* were recorded in *in-situ* caging (149 ,172, 8 and 6), (66, 24, 6 and 13) compared to lab caging (56, 1, 2 and 5) (42, 2, 1 and 13) on *ber* and *palas*, respectively. Un-emerged *E. amabilis* (immature stages *viz.*, larva and pupa) were also recorded while pricking/scrapping of lac encrustation sample on both the host and methods of caging during *baisakhi* and *katki*, 2020 (Fig. 2.6 & 2.7).

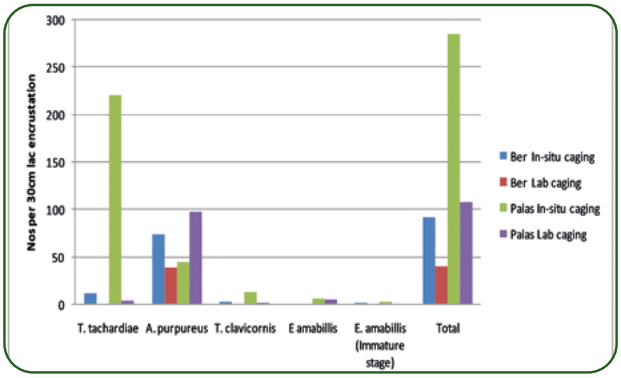


Fig. 2.6: Emergence profile of lac associated fauna using different methods on *ber* and *palas* during *baisakhi* 2020

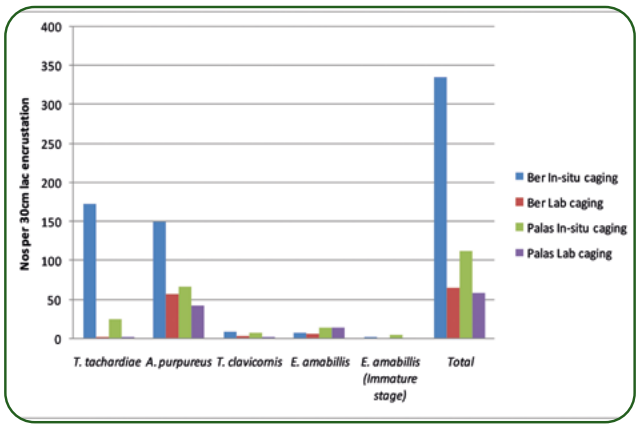


Fig. 2.7: Emergence profile of lac associated fauna using different methods on *ber* and *palas* during *katki* 2020

Correlation analysis between weather parameters and lac insect associated fauna

Weather parameters *viz.*, Maximum and Minimum temperature, Morning and Evening relative humidity and rainfall data were collected from IINRG Agro-meteorological unit. Correlation and stepwise regression analysis was done using pooled weather data of Standard Meteorological Week (4 week lag and 5 week lag) with critical period of *A. purpureus* population (SMW 8 to SMW 20) recorded from *ber* and *palas* during *baisakhi* 2011-12 to 2019-20. Significant negative correlation with maximum and minimum temperature and significant positive correlation with relative humidity (Morning) and relative humidity (Evening) {highly significant on *palas*} on *palas* and *ber* based on 4 week lag weather parameters. Significant negative correlation with maximum and minimum temperature and highly significant positive correlation with relative humidity (Morning) and relative humidity (Evening) {except RH (Mor.) on *ber*} on *palas* and *ber* based on 5 week lag weather parameters (Table 2.3).

Table 2.3: Correlation analysis on the population fluctuation of *A. purpureus* on *Palas* and *Ber*

Correlation coefficients					
Weather parameters	**Max Tem**	**Min Tem**	**RH(Mor)**	**RH(Eve)**	**RF**
palas					
4 week lag	-0.581*	-0.589*	0.623*	0.730**	0.326
5 week lag	-0.647*	-0.602*	0.673**	0.757**	0.087
ber					
4 week lag	-0.582*	-0.533*	0.573*	0.625*	0.415
5 week lag	-0.578*	-0.565*	0.612*	0.667**	0.018

** Significant at p = 0.05; ** at p=0.01; Max Tem = Maximum Temperature, Min Tem=Minimum Temperature, RH (Mor)= Relative Humidity (Morning), RH (Eve)= Relative Humidity (Evening) and RF= Rainfall*

Stepwise regression analysis of *A. purpureus* population during *baisakhi* crop

The impact of weather factors on the population of *A. purpureus* on *palas* showed that the Maximum temperature, relative humidity (Evening) significant positively contributed and also played major role (83 and 86 per cent) based on 4 week and 5 week lag weather parameters, respectively. The impact of weather factors on the population of *A. purpureus* on *ber* showed that the Relative humidity (Evening), rainfall significant and positively contributed and also played major role (75 per cent) based on 4 week lag weather parameters. Derived regression equation on *palas and ber* are as follows (Table 2.4 & 2.5).

Table 2.4: Regression models on the population fluctuation of *A. purpureus* on *palas*

Regression equation	R square	Sig. F	P Value
4 week lag : Y=-87.2798+0.877(Max temp)+1.11(Eve RH)	0.83	0.0028	Max temp.: 0.048 Eve RH: 0.007
5 week lag : Y=-94.55+0.93(Max temp)+1.20 (Eve RH)	0.86	0.0010	Max temp.: 0.047 Eve RH: 0.004

Table 2.5: Regression models on the population fluctuation of *A. purpureus* on *ber*

Regression equation	R square	Sig. F	P Value
4 week lag : Y=-24.56+0.45(Eve RH)+0.19 (RF)	0.75	0.015	Max temp.: 0.013 Eve RH: 0.073
5 week lag : Y=-60.18+0.48 (Max Temp)+0.83 (Eve RH)	0.76	0.013	Max temp.: 0.38 Eve RH: 0.080

Forecasting the population of *A. purpureus* on *palas* and *ber* for the year 2019-20

During the year 2018-19 derived models: Y=-94.55+0.93(Max temp) + 1.20 (Eve RH) from *Palas* (5 Week Lag) and Y=-25.64+0.47(Eve RH)+0.16 (RF) from *ber* (4 Week Lag) were used for predicting population of *A. purpureus* during *baisakhi* crops. Observed value, predicted values are given in Fig. 2.8 & 2.9.

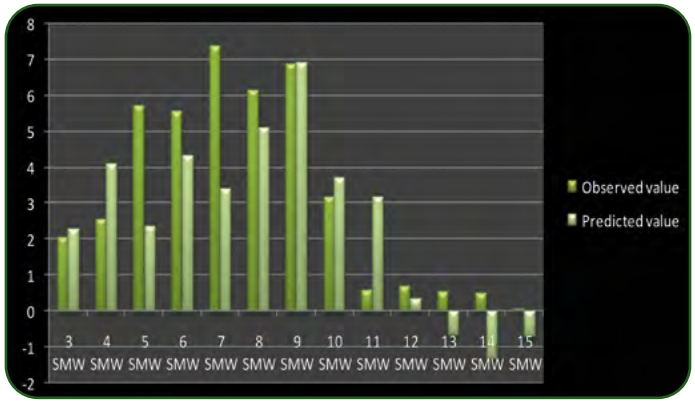


Fig. 2.8: Predicting population of *A. purpureus* from *palas* (5 Week Lag) during *baisakhi* crops

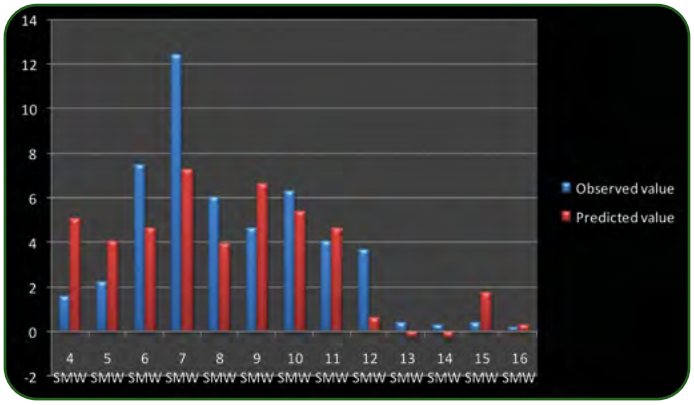


Fig. 2.9: Predicting population of *A. purpureus* from *ber* (4 Week Lag) during *baisakhi* crops

2.4. Exploratory study

Genetic manipulation in lac host plant (*F. semialata*) to establish better plant lac insect interaction

The *semialata* seeds were treated with Colchicine @ 0.05%, 0.1%, 0.15%, 0.2%, 0.25%, 0.5% for 6 hr, 12 hr, 18 hr and 30 hr duration during August, October and December 2020 (Fig. 2.10). Seeds were sown in Coco pit and vermi-compost medium. No significant germination was observed. With the recommendation of IRC for use of quality seeds, reduction of soaking time and repetition of experiment will be attempted during April-May 2021.

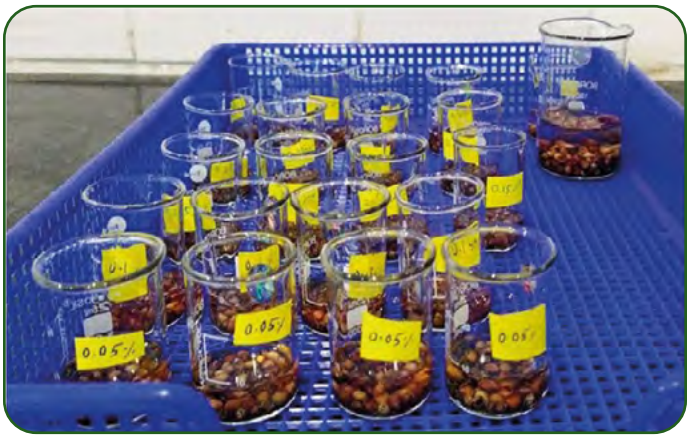


Fig. 2.10: Soaking *semialata* seeds treated with colchicine

2.5. Externally Funded Project

1. Identification, cloning and characterization of genes involved in pigment biosynthesis of the Indian lac insect, *Kerria lacca* (Kerr)

Cloning of putative key genes of lac pigment biosynthesis

RACE (Rapid Amplification of cDNA Ends) primers were designed from the transcriptome data for cloning of 3´ and 5´ ends of the genes namely, N-acetyl transferase (*nat*), demethylase (*dm3a*) and crimson N Acetyl transferase (*cnt*). Both 3´ and 5´ ends of the cDNAs were cloned from cDNA of the fertilized female lac insects using RLM-RACE kits (Invitrogen). After obtaining the 3´ and 5´ end sequences, they were assembled with the already available partial sequences to obtain the full length sequences. Full length sequences thus obtained were submitted to GenBank database of NCBI. The accession numbers received for N-acetyl transferase (*nat*), demethylase (*dm3a*) and crimson N Acetyl transferase (*cnt*) full length CDS sequences of lac insects were MW505933, MW492589 and MT501726, respectively.

Creation of lac insect *acp* knock down mutants

Double stranded RNA (ds-RNA) of the lac insect acyl carrier protein (*acp*) was synthesized by using the pGEMT vector containing around 400 bp of *acp* CDS as template and T7 and SP6 RNA polymerases. After purification, *acp* ds-RNA was injected into pumpkin harbouring lac insects at post fertilization stage. Lac insects were collected from pumpkin without ds-RNA injection (Control) and from injected pumpkin (Treatments) for 4 consecutive days after injection of ds-RNA. RNA was isolated from the control and treated lac insects, cDNA was synthesized and qPCR was conducted with the cDNA as template keeping actin as an internal control to study the expression level of *acp*. Expression of *acp* was downregulated to 0.198 fold, 0.337 fold, 0.288 fold and 0.517 fold, respectively in 1 DAI (days after injection), 2 DAI, 3 DAI and 4 DAI in the treated lac insects (Fig. 2.11).

HPLC analysis of the dye samples collected from control and ds-RNA injected insects

The body pigments of ds-RNA treated lac insect samples and control lac insect samples were extracted in PBS buffer and were analyzed for the quantitative presence of lac dye components through HPLC. Reverse phase HPLC (Waters 510) detector: waters 486 tenable absorbance detector was used. Absorbance was taken at 254 nm using the solvent

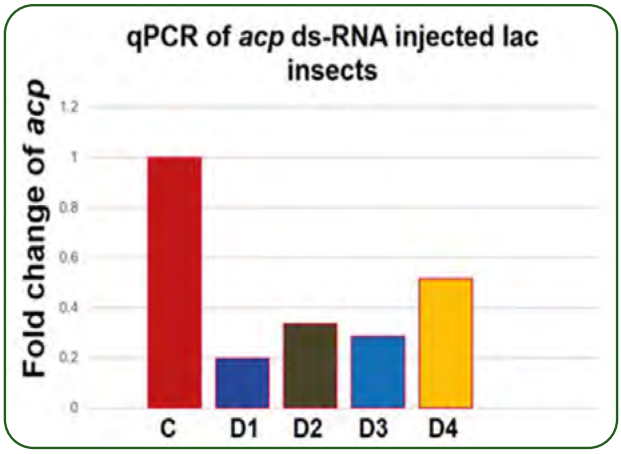


Fig. 2.11: Expression level of *acp* in control and treated lac insect samples, C: Control, D1-D4: Treated lac insects 1DAI, 2DAI, 3DAI and 4DAI

system as Phosphate buffer (pH=7.0, 0.1M) and Methanol in the ratio 16:5 with a flow rate of 0.40 ml/min. Injection Volume was kept at 20 µl and the column used was C-18 column.

The results clearly indicated that the relative abundance of the pigment showed a decreasing trend in *acp* knock down mutants in comparison with control. It gives us an indication that *acp* would probably be involved in lac pigment biosynthesis (Fig. 2.12).

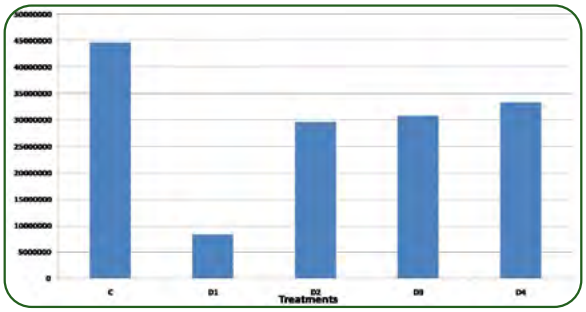


Fig. 2.12: HPLC analysis of lac body pigments of the control and treated lac insects. The bars represent total areas of all the peaks obtained in HPLC analysis, C: Control, D1-D4: Treated lac insects 1DAI, 2DAI, 3DAI and 4DAI

2. IINRG-ICRAF Project code 1.1.054: Enabling tribal communities to improve their livelihood through agro-forestry system on a sustainable basis

Four farmers from Silda village of Khunti district adopted the lac based agro forestry Model (*Kusum*/*Ber* + *Palas* + *Semialata* + *Calliandra* + Vegetables). Two farmers from Roro village of Khunti district benefited under the scheme. They adopted lac based agro forestry Model *Kusum*/*Ber* + *Semialata* + *Callinadra* + Vegetables and Ber + *Callandra* + Fruits. Five farmers from Kota village of Khunti district

adopted lac (*rangeeni/kusmi*) based agro forestry Model (*Ber* + *Palas* + *Semialata* + *Callinadra* + Vegetables). A farmer from Hesatu village of Ranchi district adopted *Ber* + *Palas* + *Semialata* + *Calliandra* + Vegetables. Two farmers from Munghadi village of Ranchi district adopted lac based agro forestry Model (*Ber* + *Semialata* + *Calliandra* + Vegetables). In the absence of lac host trees like *Kusum*, alternate lac host plants like *Semialata* and *Calliandra* may be useful to complete the crop cycle. Therefore, planting material including seedlings of papaya, *Semialata*, *ber* and *Calliandra* were provided among the beneficiaries to ensure the broodlac availability for sustainable lac cultivation. Quality vegetable seeds were also provided to interested farmers. Moreover, Lac production kit including pesticides (insecticides & fungicides), Rocker sprayer, Knapsack sprayer, Tree pruner and Secateurs were also provided among the beneficiaries for practicing the scientific lac cultivation and effective pest management. Overall, inputs worth of Rs 3.75 lakh were provided and they could get Rs 14.32 lakh during the year 2019-20 and 2020-21. Net returns are estimated as Rs 10.56 lakh. Benefit cost ratio under the model estimated as 3.82.

Monitoring, diagnostic visits and technical guidance

Team of the project monitored *kusmi* lac on *Semialata*, *Calliandra* and *ber* (Fig. 2.13 to 2.16) and advised to cultivate provided vegetable seeds in between *Semialata* plants on 5th September, 2020. Advisory service of spraying of pesticide and its recommended dosage was provided to adopted farmers under ICRAF project and also provided advisory of removing of excess leaves from the base upto one fourth areas of *Semialata* plants to maintain humidity and aeration in the lac crops.

Team of the project monitored *kusmi* lac on *Semialata*, *Calliandra*, *ber* and *Rangeeni* lac on *ber* and *Palas* on 29th September, 2020 (Fig. 2.17 to 2.20). Both *rangeeni* and *kusmi* lac crops were progressing well. One of the adopted farmer raised vegetables *viz*., Tomato, Chilli and Cauliflower under Lac integrated agro-forestry system and its growth was found to be progressing well. Pesticides *viz*., Indaxacarb and Chlorotholonil were provided to adopted farmers under ICRAF project. Advisory service of spraying of pesticide and its recommended dosage was provided to them. Provided advisory of removing of excess settled lac insect and informed to maintain 30 to

Fig. 2.13 *Kusmi* lac on *Calliandra* in the field of Shri Maheshwar Mahto at Benyazara

Fig. 2.14 *Kusmi* lac on *Semialata* in the field of Smt. Hela Mani at Munghadi

Fig. 2.15 *Kusmi* lac on *Semialata* in the field of Shri. Laldev Bedia at Munghadi

Fig. 2.16 *Kusmi* lac on *Semialata* in the field of Shri. Jagnau Oraon at Hesatu

Fig. 2.17 *Kusmi* lac on *Semialata* in the field of Shri. Ragu Surin at Silda

Fig. 2.18 *Rangeeni* lac on *ber* at Silda

Fig. 2.19 *Kusmi* lac on *Semialata* in the field of Shri. Ashok Binjhiya at Silda

Fig. 2.20 *Rangeeni* lac on *Calliandra* in the field of Shri. Dashrath Binjhiya at Silda

Fig. 2.21 Lay out for raising Lac Integrated Agro-forestry System (LIAFS) at Roro, Khunti

Fig. 2.22 Providing *Semialata* and *Calliandra* saplings to Shri. Prem Ranjan Purti for developing LIAFS at Roro, Khunti

40 per cent length area of lac insect on *Semialata* twigs and also recommended to remove excess settled lac insect manually using cloth. Shri Prem Ranjan Purti, Roro shown keen interest to adopt Lac Integrated agro-forestry system and his model is *Semialata* + *Ber* + *Calliandra* + Vegetables. Layout was made to transplant *Semialata* (400 nos.); one-meter distance between plants, 75 cm between rows in paired row system and 2.5 m spacing was given between two paired row for cultivating vegetables and *Calliandra* plants (20 nos.) were planted in the border area at 5 m distance between plants (Fig. 2.21 and 2.22). Lac crop on *Semialata* and *Calliandra* was monitored in the field of Shri Puyish Purti and Shri Sudarshan Purti, Roro, Khunti on 29th September, 2020.

Shri. Radesh Shyam farmer field was visited and monitored the Lac integrated Agro Forestry Model (*Semialata* + *Ber* + *Calliandra* + Papaya) and he inoculated lac on *Semialata* and *ber*. We observed that better lac encrustation along with sooty mould problem on his lac crop. We advised to cultivate winter Season vegetable crops between *semialata*

Fig. 2.23: Lac integrated Agro Forestry Model (*Semialata+ Ber+ Calliandra*+ Papaya) at Munghadi, Ranchi district

Fig. 2.24: Lac integrated Agro Forestry Model (*Semialata + Ber + Calliandra* + Papaya + French Bean) at Munghadi, Ranchi district

Fig. 2.25: *Kusmi* lac on *semialata* at Kota, Khunti district

plants. He raised Papaya plants during last year and fruits are being harvested this year onwards. Recently, he sold around 30 kg papaya in local market @ Rs.10 per kg (Fig. 2.23). One more farmer, Shri Lal Dev Bedia followed the Lac integrated Agro Forestry Model (*Semialata* + *Ber* + *Calliandra* + Papaya + French Bean). He inoculated lac on *semialata, ber* and cultivated French bean between *semialata* plants. We observed that better lac encrustation along with sooty mould problem and good French bean crop (Fig. 2.24). We advised and recommended immediate spray of fungicide either Carbendazim or Chlorotholonil @ 1 gram per liter of water and remove the fungal mat using brush to both farmers at Munghadi, Ranchi district on 27th November, 2020.

Shri Mahaveer Singh Munda, Amit Munda and Indra Munda farmers' field were visited and monitored *kusmi* lac on *Semialata* plant. We observed that lac was not progressing well, no vegetables were planted between *semialata* plants and not cleaned properly (Fig. 2.25). So, we advised and recommended the cultural practices for proper maintenance of the field at Kota, Khunti district on 27th November, 2020.

Shri. Ragu Surin and Bira Munda's field was visited 04.12.2020 and monitoring and data collection of the Lac integrated Agro Forestry Model was done which involved *Semialata*, *Calliandra* and *ber* and found that their lac on *Semialata* is not properly settled. Raghu Surin and Beera Munda had planted okra in their fields (Fig. 2.26). It was found that Shri Bira Munda had sold 80 kg Okra at rate of 30-35 rupees per kg in local market. *Semialata* plants of Shri Bira Munda field was found to be infested with scale insects, the sample of which was collected and given to Shri Rajgopal N.N. Scientist for further identification.

Shri Ashok Singh's field was visited for monitoring lac inoculated *Semialata* plants and fields. It was found that they have already harvested their lac and 50 Kg scraped lac was sold in local market @ Rs. 400 per kg. He has planted vegetables like tomato, chilli, cauliflower and brinjal for integrated agroforestry system under ICRAF Project. He sold 50 kg tomato @ Rs. 40/kg, 5 kg chilli @ Rs. 100/kg

and 6 Kg Brinjal @ Rs. 60/kg (Fig. 2.27). Cauliflower was ready for harvest and it was observed that two different varieties of brinjal were grown in which fruit and shoot borer infestation was observed and suggestions were given for spraying of neem based as well as systemic chemical pesticides.

Dasrath Bhinjhiya's farmers field in Silda village was visited on the same day for monitoring and it was found that he had already harvested lac at pre mature stage due to fear of theft by local people and 109 Kg scraped lac was sold @ Rs. 400 per kg in local market. They had planted vegetables like tomato and brinjal of two different varieties. There vegetables were in good condition at flowering stage and some beneficial insects like ladybird beetle were observed on it. Hence suggestions were given that any insecticides should not be sprayed on the crop as natural biological pest control is already operating. We also monitored lac inoculated *Calliandra* plants and found they were in good condition (Fig. 2.27). Suggestions were given for spraying fungicides on the crop.

Fig. 2.26 Lac integrated Agro Forestry Model (*Semialata+ Ber+ Calliandra+* Vegetables) at Silda, Khunti

Fig. 2.27: *Kusmi* lac on *Calliandra* at Silda, Khunti district

Fig. 2.28: Lac integrated Agro Forestry Model *(Semialata+ Ber+* vegetables*)* at Roro, Khunti district

Prem Ranjan Purti's field in Roro village, Murhu, Khunti was also visited on the very same day for monitoring his *Semialata* plants and vegetables and found that they have planted tomato, pea, carrot, spinach and french bean based on integrated agro farming system under ICRAF project (Fig. 2.28).

Fig. 2.29 Lac integrated Agro Forestry Model (*Semialata+ Ber+ Calliandra+* Papaya+ Vegetables) at Munghadi, Ranchi district

Farmers of Mungadih and Hesatu villages selected under ICRAF project were visited on 14.12.2020 and their fields were monitored. The condition of their lac crop on *F. semialata* was observed and recommendations were given to control fungal infestation on lac crop and weeds in their fields. It was found that some of them earned good income by sale of vegetables viz. radish, tomato, french bean and okra that they had grown by integration with their lac crops. Other farmers were also encouraged to perform lac integrated cropping of vegetables and other field crops. Mustard seeds were distributed amongst the farmers for lac integrated agroforestry system (Fig. 2.29).

Economic evaluation of the lac based agro forestry system

Cost of lac based agro forestry system across the various adopted villages during 2019-20 to 2020-21

Name of the farmer	Village	District	Inputs					
			Vegetables	Broodlac	Seedlings	Pesticides	Implements	Total
Dasharath Singh Bhinjiya	Silda	Khunti	5436.0	33150.0	550.0	5999.0	2195.0	47330.0
Raghu Munda	Silda	Khunti	1708.0	9675.0	150.0	2605.0	1075.0	15213.0
Bira Munda	Silda	Khunti	3815.0	10545.0	820.0	2610.0	6021.1	23811.1
Ashok Singh	Silda	Khunti	5555.0	32450.0	630.0	5929.0	6421.1	50985.1
Piyush Purti	Roro	Khunti	1075.0	7925.0	0.0	1045.0	2195.0	12240.0
Sudarshan Purti	Roro	Khunti	380.0	3500.0	0.0	270.0	0.0	4150.0
Shambhunath Munda	Kota	Khunti	3300.0	5900.0	0.0	0.0	400.0	9600.0
Mahesh Singh Munda	Kota	Khunti	1570.0	16780.0	0.0	640.0	1120.0	20110.0
Nagen Singh Munda	Bade Chun-chuniya	Saraikela Kharsawan	1500.0	5900.0	0.0	1030.0	7541.1	15971.1
Phulcand Mahato	Purihensa	Saraikela Kharsawan	675.0	0.0	0.0	1380.0	1475.0	3530.0
Jagran Mahato	Purihensa	Saraikela Kharsawan	1675.0	2950.0	0.0	1240.0	0.0	5865.0
Radheshyam Bediya	Mungadih	Ranchi	2659.0	11900.0	2325.0	3793.0	7975.0	28652.0
Mahabeer Singh Munda	Kota	Khunti	3585.0	8750.0	15000.0	2008.0	13321.1	42664.1
Amit Singh Munda	Kota	Khunti	2255.0	3500.0	11450.0	813.0	0.0	18018.0
Indra Munda	Kota	Khunti	1295.0	5250.0	5550.0	978.0	0.0	13073.0
Laldev Bediya	Mungadih	Ranchi	2604.0	9500.0	6700.0	913.0	0.0	19717.0
Jaganu Oraon	Hesatu	Ranchi	2715.0	32625.0	0.0	1638.0	7300.0	44278.0
Total			41802.00	200300.00	43175.00	32891.00	57039.48	375207.48

Returns in lac based agro forestry system across the various adopted villages during 2019-20 to 2020-21

Name of the farmer	Village	District	Gross Area covered (ha)	Outputs		
				Vegetables & Fruits	Broodlac	Total
Dasharath Singh Bhinjiya	Silda	Khunti	1.384	48900.0	111000.0	159900.0
Raghu Munda	Silda	Khunti	0.179	13400.0	43500.0	56900.0

Name of the farmer	Village	District	Gross Area covered (ha)	Outputs		
				Vegetables & Fruits	Broodlac	Total
Bira Munda	Silda	Khunti	0.626	32875.0	40500.0	73375.0
Ashok Singh	Silda	Khunti	0.961	54465.0	99400.0	153865.0
Piyush Purti	Roro	Khunti	0.149	7050.0	68000.0	75050.0
Sudarshan Purti	Roro	Khunti	0.075	1620.0	38000.0	39620.0
Shambhunath Munda	Kota	Khunti	0.625	9500.0	52500.0	62000.0
Mahesh Singh Munda	Kota	Khunti	0.430	37975.0	36000.0	73975.0
Nagen Singh Munda	Bade Chunchuniya	Saraikela Kharsawan	0.202	5272.0	54000.0	59272.0
Phulcand Mahato	Purihensa	Saraikela Kharsawan	0.095	15850.0	0.0	15850.0
Jagran Mahato	Purihensa	Saraikela Kharsawan	0.368	14150.0	22500.0	36650.0
Radheshyam Bediya	Mungadih	Ranchi	0.614	21810.0	186000.0	207810.0
Mahabeer Singh Munda	Kota	Khunti	0.892	27060.0	60000.0	87060.0
Amit Singh Munda	Kota	Khunti	0.739	16520.0	40000.0	56520.0
Indra Munda	Kota	Khunti	0.251	10850.0	54000.0	64850.0
Laldev Bediya	Mungadih	Ranchi	0.577	18875.0	42000.0	60875.0
Jaganu Oraon	Hesatu	Ranchi	0.901	23150.0	125000.0	148150.0
Total			9.100	359322.00	0.092	1431722.00

Economic evaluation of the lac based agro forestry system

Economic parameters	Particulars	Amount (Rs)
Gross cost	Vegetables seeds	41802.00
	Broodlac	200300.00
	Seedlings (Lac host & fruits for Agro forestry Model)	43175.00
	Pesticides	32891.00
	Implements	57039.48
	Total	375207.48
Gross returns	Vegetables + Fruits	359322.00
	Broodlac	1072400.00
	Total	1431722.00
B:C ratio		3.82

Success stories

Success story at Silda, Khunti district, Jharkhand

ICAR-Indian Institute of Natural Resins and Gums Ranchi is conducting World Agro-forestry sponsored project entitled "Enabling tribal communities to improve their livelihoods through Agro-forestry systems on a sustainable basis" which was started from October 2017. Initially base line data of general profile of the identified areas was collected. During the baseline survey and participatory rural appraisal of identified villages, it was found that limited livelihood options were the major cause of migration in the selected areas. It was found that cropping system is dominated by paddy with

livestock activities in majority of villages. Although the people were aware about the lac cultivation, but not practicing it since 10 years due to incomplete life cycle of the lac insect and consequently shortage of broodlac. Hence, Lac based Agro- forestry Model in the identified villages was introduced with planting of *Flemingia semialata, Calliandra spp.*, and, other lac host and fruit trees. Therefore, quality planting material with broodlac was distributed among the interested farmers. In total 23 farmers were selected from three different districts viz., Ranchi, Khunti and Seraikela Kharsawan. Out of 23 farmers, six farmers were selected in Silda Khunti. Planting materials viz *Semialata, Calliandra*, fruit trees and vegetables were prouded. Provision of non-credit inputs including lac production kit and pest management kit enabled the beneficiaries in adoption of recommended practice. We have conducted 38 Field Level Demonstration, 3 Field Days and one each Kisan Ghosti and Farmers Field School. A four days training program on "Lac Integrated Agro-forestry System for Livelihood Security was organized at ICAR-IINRG during October 29 to November 1, 2019 in which 23 farmers gained knowledge. Under this scheme 68 tribal farm households of 9 villages used about 766 kg of broodlac for inoculation on pruned lac host trees and harvested 2400 kg of broodlac/scraped lac. Out of these 4 farmers of the Silda village adopted the Lac Integrated Agro forestry Model. Consequently, a total of Rs 1.85 lakh was earned within two years of the project period. Thus, average annual income of these farmers enhanced by Rs 20000/- as an additional income through mobilizing the local resources under the technological interventions. Thus, participatory model could impact the livelihood of the tribal community significantly by providing additional employment and income by utilizing the existing resources. These models may be very useful and strategic option to control the migration issue as well as mitigating the adverse impact of climate change on lac cultivation particularly in lac producing areas of the country.

After intervention of Lac Integrated Agro forestry Model at farmers field, Silda, Khunti district

2.6. Transfer of Technology Activity

Field Level Demonstration at village Gumpela, Jaria Panchayat, PS Murhu was conducted on "Increasing *kusmi* lac production on *ber* through use of chemical fertilizers". Twenty trees were applied with recommended dose of fertilizers in two locations. Besides this, a progressive farmer from Chhattisgarh (Shri Shrawan Shukla) has conducted a FLD at his own initiative to test application of recommended dose of fertilizers on growth and lac yield on *F. semialata*. In both the locations farmers were satisfied with the results.

Processing and Product Development

3. Processing, Storage and Quality Management

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

Study on types of charcoal and time duration in DDL preparation

Trials were carried out to observe effect of different types of charcoal and time duration of treatment in dewaxed decolourised lac (DDL) preparation. A total 16 nos. fresh trial carried in 2-Propanol (lac-solvent ratio 1:6) for DDL preparation from *kusmi* seedlac. The initial colour value of seedlac used for these trials was 12. Time duration for charcoal treatment in refluxing was kept 0.5 to 2 hrs. Wax removals were carried out in thick jeans cloth in place of filter paper of lab process suitable for up-scaling. Hot filtration of charcoal was also carried out in thick cloth in place of filter paper of lab process so that process can be up-scaled. For colour removal of lac in solution, 20% fresh charcoal of different make (CDH powder, SRL granular, SRL 100-200 mesh & 60-100 mesh) were used during refluxing of lac solution in solvent (Table 3.1 and Fig. 3.1).

Table 3.1: Effect of different types of charcoal and duration of charcoal treatment

Sl. no.	Colour seedlac	20% Charcoal	Reflux time, hrs	Lac-solvent ratio (w/v)	Yield of DDL(%)	Colour of DDL	Wax (%)	Impurity (%)	Acid value	Flow (mm)	Life (min.)
1	12	SRL 1	1.0	1:6	82	4.0	1.58	0.20	70.68	115	53
2	12	SRL 1	1.0	1:6	81	5.0	1.62	0.19	69.48	122	54
3	12	SRL 1	1.0	1:6	79	3.4	0.73	45.95	39.27	Nil	Nil
4	12	SRL 1	0.5	1:6	75	5.0	1.52	2.46	69.50	125	57
5	12	SRL 1	0.5	1:6	77	5.0	1.42	0.07	69.50	122	55
6	12	CDH	0.5	1:6	73	1.0	0.70	0.69	67.27	115	59
7	12	CDH	1.5	1:6	71	1.0	1.22	1.11	67.25	5	58
8	12	SRL 2	1.5	1:6	73	2.0	1.06	0.12	70.68	03	58
9	12	SRL 2	1.5	1:6	68	1.2	0.90	0.33	71.80	7	50
10	12	SRL 2	2.0	1:6	65	0.6	0.86	0.35	71.79	97	58
11	12	SRL 2	2.0	1:6	65	0.7	0.55	1.21	66.32	60	55
12	12	DH	2.0	1:6	76	0.8	0.72	1.17	70.92	70	63
13	12	SRL 2	0.5	1:6	63	5.0	1.66	2.81	70.86	40	08
14	12	SRL 2	0.5	1:6	74	4.6	1.13	1.08	69.80	10	63
15	12	CDH	1.5	1:6	62	0.7	0.51	0.36	69.72	40	55
16	12	SRL 3	1.5	1:6	80						

SRL1- SRL make granular SRL2-SRL make 100-200 mesh SRL3-SRL make 60-100 mesh
CDH- CDH make powder *To be evaluated*

In these trials, yields of DDL were 62 to 82% by weight of seedlac with average yield 72.75%. Reduction in colour value of lac (seedlac colour value 12) in DDL was varied from 0.6 to 5 and maximum colour reduction up to colour value 0.6 was achieved. Time duration of charcoal treatment was kept 0.5 to 2 hrs. Flow and life of DDL samples prepared in these trials varied from 40-140 mm and 50 to 63 minutes, respectively and comparable with shellac. Wax, impurity content and acid value of DDL samples were also better and within acceptable limit for most of trials. The colour value of DDL was also evaluated with Hunter Lab Colorimeter.

On treatment with SRL granular Charcoal (5mm size approx.) although yields were higher and above 75% with ease in filtration but colour of samples were also higher (3.4-5.0). With CDH Charcoal powder, colour value of DDL varied from 0.7 to 1.0, whereas with SRL 100-200 mesh charcoal, colour values were 0.6 to 2.0. High impurities in sample at Sl.no.3 are due to manual error in heat treatment during removal of moisture before sheeting and may be due to heat polymerization. Higher colour values of DDL in trials 13 & 14 were due to passing of charcoal while hot filtration. Use of coarser grain size charcoal need to be further tried for easy filtration through Jeans/thick cloth and colour removal.

Seed lac for DDL trials

DDL from SRL1 granular charcoal treatment

DDL from SRL2 charcoal treatment

DDL from CDH charcoal

Fig. 3.1: Raw material seedlac and DDL obtained from it through various trials

3.2 Biodegradation studies of lac resin under soil burial method

Biodegradation Study of lac samples, buried directly in the soils:

The lac samples, buried directly in the soil (without net) were drawn from the soil after one year of interval and washed thoroughly with water to remove soil attached to the samples. The samples were cleaned meticulously to remove all types of impurities (sand, stones, brick pieces, wood pieces, root twigs, coal, plant leaves etc.) and weight loss was determined. 20%, 20% and 10-21% weight loss were calculated for sticklac, seedlac and shellac samples respectively (Fig. 3.2). The samples were refluxed with spirit to remove further impurities from the samples. The impurities (hot alcohol insoluble%) obtained from the samples are given in the Fig. 3.3.

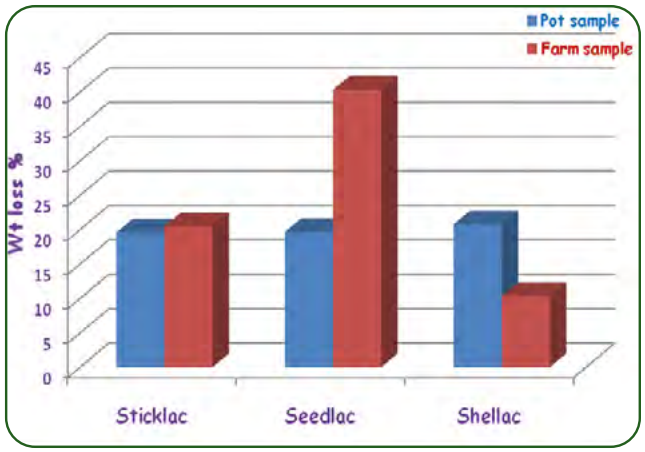


Fig. 3.2: Weight loss% in sticklac, seedlac and shellac samples

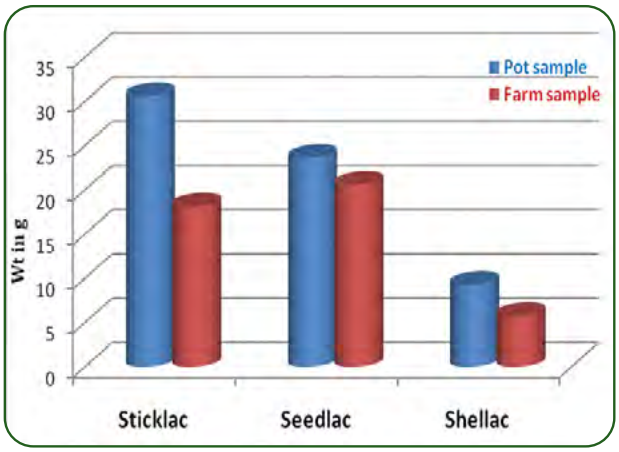


Fig.3.3: Weight of impurities filtered out from sticklac, seedlac and shellac samples

The samples were distilled with spirit and precipitated with water. Moisture was removed from the samples and all the samples were converted into shellac only (Fig. 3.4). Weight losses were found 40-60%, 42% and 21-28% from sticklac, seedlac and shellac samples respectively (Fig. 3.5).

Study on physico-chemical properties

Physico-chemical properties of the samples prepared were studied. It was observed that flow, life under heat, colour index and cold alcohol insoluble% improved as compared to that of the samples which are not refluxed out. It is obvious that the samples have been converted into shellac because of refluxing and precipitation, thus the properties have become almost same. Flow of the samples which are buried in farm pit and pot soil for one year, greatly improved after conversion into shellac (refluxing and precipitation). Sticklac and seedlac control samples which were not showing any fluidity, measured 20-45 mm flow (Fig. 3.6). Life under heat of buried samples were expected to show zero or very less, but the samples showed very good life (at par with the control samples) unexpectedly, owing to its conversion into shellac (Fig. 3.7).

Fig 3.4: Samples obtained after refluxing from sticklac, seedlac and shellac samples

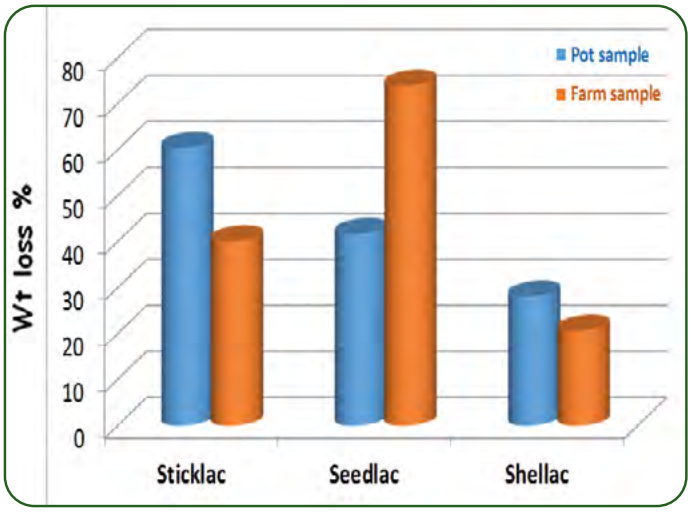


Fig 3.5: Weight loss% recorded from sticklac, seedlac and shellac samples

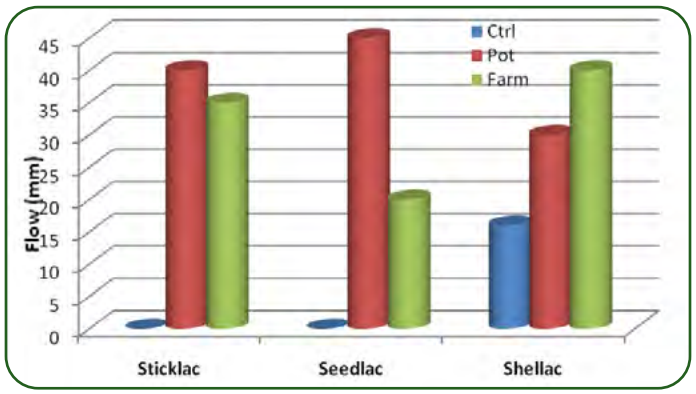


Fig. 3.6: Flow of lac samples afer one year of direct burial

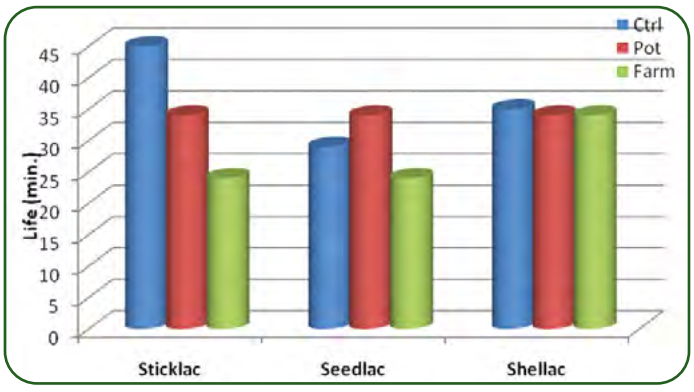


Fig. 3.7: Life under heat of lac samples afer one year of direct burial

Similarly, colour index and cold alcohol insoluble% of the samples obtained from buried samples decreased, attributed to its conversion into shellac, otherwise both the properties are expected to show increase in colour and insolublity (Fig. 3.8 & 3.9).

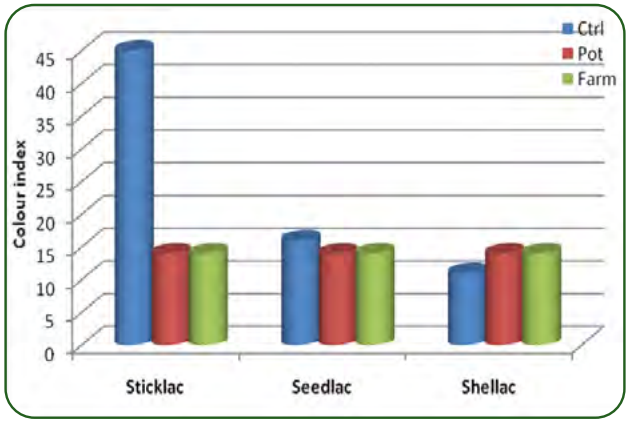


Fig. 3.8: Colour index of lac samples afer one year of direct burial

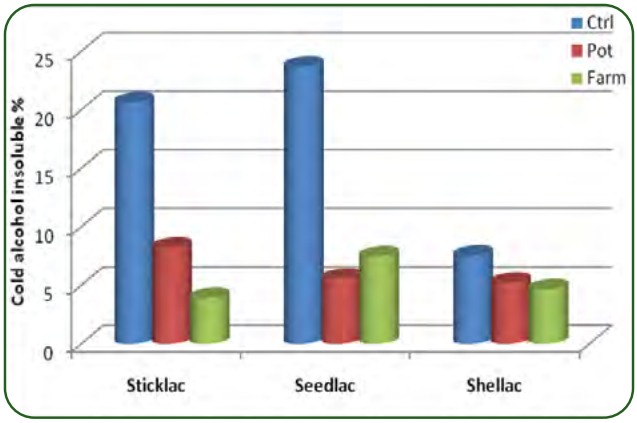


Fig. 3.9: Cold alcohol insoluble% of lac samples afer one year of direct burial

3.3 Development of pilot plant of guar gum derivative for training and demonstration

Experimentation on carboxy methyl guar gum derivative preparation

Trials of carboxy methyl guar gum derivative preparation from guar gum powder using reagents with variation in mixing time (30, 60 and 90 min), reaction time (3, 4 and 5 h) and drying time (3, 4 and 5 h) carried out to observe the difference in quality parameters (viscosity, pH and degree of substitution) of carboxy methyl guar gum derivative. Effect of processing parameters (mixing time, reaction time and drying time) on quality parameter of prepared carboxy methyl guar gum derivative are detailed below:

Effect of processing parameters on viscosity of prepared carboxy methyl guar gum derivative

Experimental trials of carboxy methyl guar gum derivative preparation from guar gum powder using reagents with variation in mixing time (30, 60 and 90 min), reaction time (3, 4 and 5 h) and drying time (3, 4 and 5 h) carried out and observed that with reaction time 3 h, mean viscosity of the prepared carboxy methyl guar gum derivative was higher at all levels of mixing time (30, 60 and 90 min) and drying time (3, 4 and 5 h) compared to 4 and 5 h reaction time with same treatment of mixing time and drying time (Fig. 3.10). Mean viscosity value of carboxy methyl guar gum derivative prepared with 30 min mixing time, 3 h reaction time and 3 h drying time was higher compared to 30 min mixing time, 4 and 5 h reaction time and 4 and 5 h drying time followed by 30 min mixing time, 5 h reaction time and 3 h drying time (Fig. 3.10).

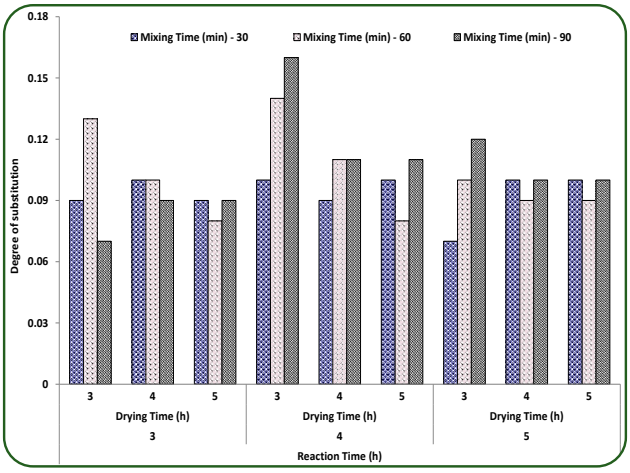


Fig. 3.10: Effect of processing parameters on viscosity of carboxy methyl guar gum derivative

Effect of processing parameters on pH of prepared carboxy methyl guar gum derivative

Trials of carboxy methyl guar gum derivative preparation from guar gum powder using reagents with variation in mixing time (30, 60 and 90 min), reaction time (3, 4 and 5 h) and drying time (3, 4 and 5 h) carried out and observed that with mixing time 90 min, reaction time 4 h and drying time 5 h, mean pH of the prepared carboxy methyl guar gum derivative was higher compared to mixing time 30 and 60 min, 3 and 5 h reaction time and drying time 3 and 5 h (Fig. 3.11). Mean pH value of carboxy methyl guar gum derivative prepared with 30 and 60 min mixing time, 3, 4 and 5 h reaction time and 3, 4 and 5 h drying time was observed to be almost similar (Fig. 3.11).

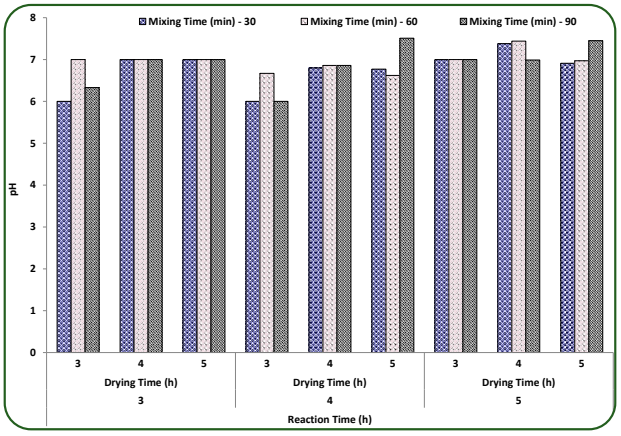


Fig. 3.11: Effect of processing parameters on pH of carboxy methyl guar gum derivative

Effect of processing parameters on degree of substitution of prepared carboxy methyl guar gum derivative

Experimental trials of carboxy methyl guar gum derivative preparation from guar gum powder using reagents with variation in processing parameters *i.e.* mixing time (30, 60 and 90 min), reaction time (3, 4 and 5 h) and drying time (3, 4 and 5 h) carried out and observed that with reaction time 4 h, mean degree of substitution of the prepared carboxy methyl guar gum derivative was higher at 90 min mixing time, 4 h reaction time and 3 h drying time compared to 60 min mixing time, 4 h reaction time and 3 h drying time (Fig. 3.12). Mean value of degree of substitution of carboxy methyl guar gum derivative prepared with 30, 60 and 90 min mixing time, 3 and 5 h reaction time and 3, 4 and 5 h drying time was observed to be almost similar (Fig. 3.12).

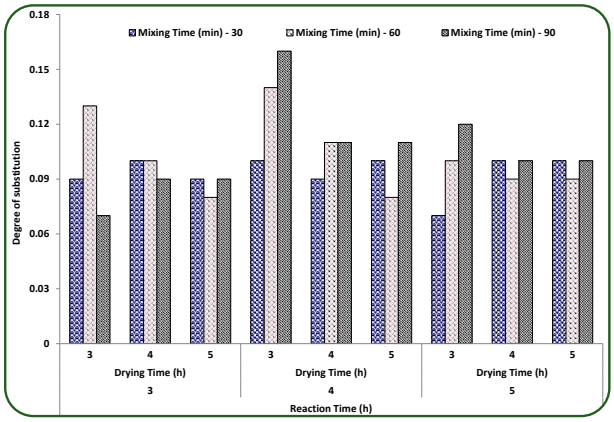


Fig. 3.12: Effect of processing parameters on degree of substitution of carboxy methyl guar gum derivative

3.4 Studies on spray drying of gum ghatti (*Anogeissus latifolia*).

Experimental section of the study divided into three parts (Fig. 3.13). Briefly, gum ghatti tears were primary processed and macerated initially. Afterwards, the macerated gum ghatti solutions were filtered for spray drying according to the selected parameters.

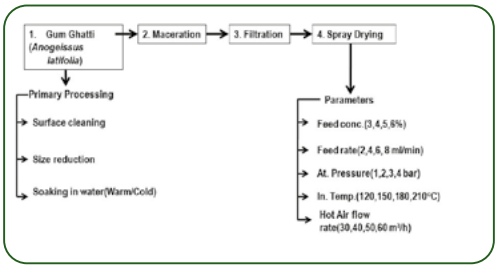


Fig. 3.13: Schematic illustration of the experiments

A simplified model based on Taguchi's design, L16 (4^5) approach (Table 3.2) and utility concept is used to determine the optimal setting of process parameters for a multi-characteristics response as shown in table 3.3. The model is used to predict optimal setting of process parameters to yield the optimum quality characteristics of spray dried powder.

Table 3.2: Selected factors and their levels for Taguchi Experimental Design (DoE)

Factor	Designation	Level 1	Level 2	Level 3	Level 4
Concentration (%)	A	3	4	5	6
Feed rate (ml/ min)	B	2	4	6	8
Atomization pressure (bar)	C	1	2	3	4
Temperature (°C)	D	120	150	180	210
Hot air flow rate (m^3/h)	E	30	40	50	60

Table 3.3: Parameter used to find utility value

Terms	L* (max)	a* (min)	b* (min)	Chroma, C* (max)	Hue angle, H° (min)	Visocsity, cP (max)	Molecular weight, KDa (max)	Dissolution time, min (min)	Temp Diff, ΔT (min)	Power consumption, kWh (min)
Optimum value, x*	95.12	0.22	1.51	12.24	79.28	430	55.18	1.80	38	1.5
Acceptable Value, x_i	77	0.45	12	1.5	89	255	16	3.5	117	12.5
Weight, W	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

According, ANOVA of overall utility, the most, second most and third most parameters are inlet temp, feed rate and atomization pressure then concentration and hot air flow rate as per means of utility value. The percentage contribution of process parameters is; inlet temperature (80.52%), feed rate (12.13%), atomization pressure (4.85%), concentration (2.26%) and hot air flow rate (0.24%). The optimal process was found at concentration 3%, feed rate 8ml/min, atomization pressure 2 bar, Temp. 120°C & Hot air flow rate, 30m^3/hr as shown in Fig. 3.14 & Fig. 3.15.

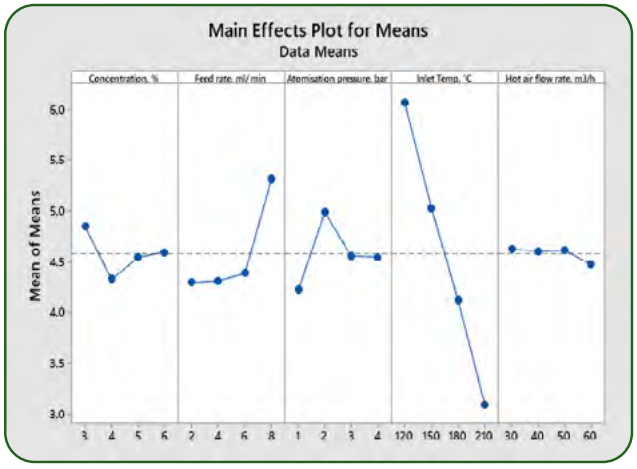


Fig. 3.14: Main effects plot for multi- response utility value

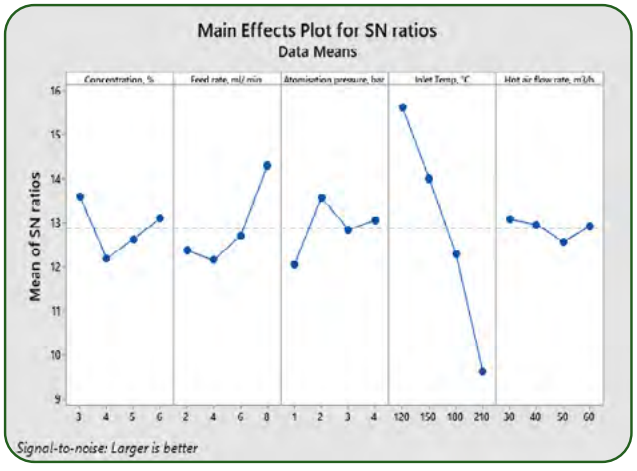


Fig. 3.15: Main effects plot for multi- response S/N ratio utility value

Laser diffraction particle size analyzer (LS 13 320) was used to evaluate the particle size distribution of spray dried gum ghatti. The increase in concentration of feed solution, increase the particle size as shown in Fig. 3.16. The effect of atomization pressure on particle size distribution is illustrated in Fig. 3.17. The increase of atomization pressure results in decrease in particle size. The particle size is decreased as projected to the producing finer droplets with higher atomization pressures. Differential thermal analysis and thermo gravimetric analysis (DTA-TGA, Shimadzu, Japan; DTG-60) were carried out to determine the thermal behavior of spray dried gum ghatti powder up to 800℃. Spray dried particle exhibit similar TGA and DTA behavior. Three main parts of weight loss are observed in TGA curve. In 1st part of TGA curve gradual change in weight loss of particle were 5-10%, up to 200℃, is due to the removal of physically adsorbed water on the surface of gum ghatti.

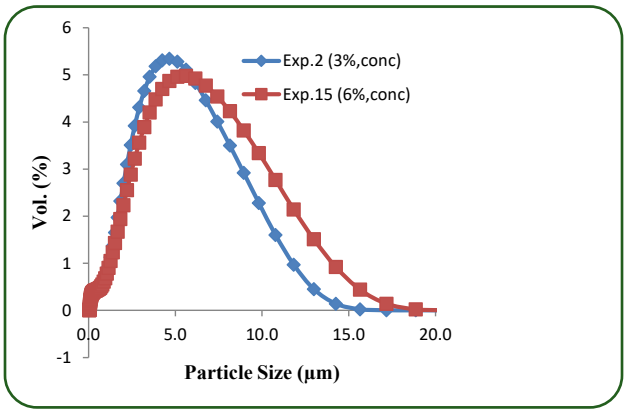


Fig. 3.16: Effect of feed concentration on particle size distribution SD-GG

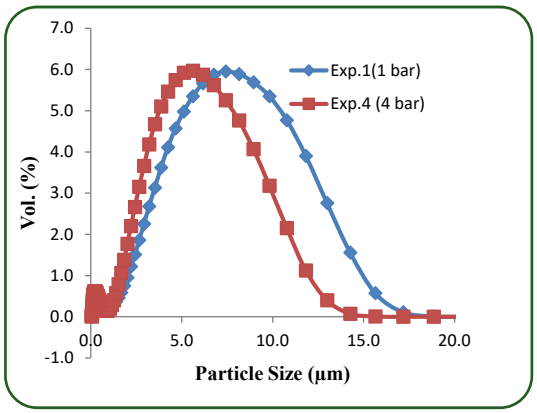


Fig. 3.17: Effect of feed atomization pressure on particle size distribution SD-GG

The surface morphology of spray dried gum ghatti by FESEM, field emission scanning electron microscopy (ZEISS Sigma 300, Germany) was carried out. FESEM images of raw gum ghatti (grinded) and spray-dried spray gum ghatti powder are shown in Fig. 3.18 & 3.19. The raw gum ghatti (grinded) had irregular, sharp edge and non-spherical morphology (Fig. 3.18). Whereas spray dried gum ghatti powder had spherical morphology and smooth surface (Fig. 3.19). Fig. 3.20, 3.21 & 3.22 represent raw gum ghatti sample, sketch diagram of spray drying system and spray dried gum ghatti powder respectively which is processed by various parameter as shown in Fig. 3.13.

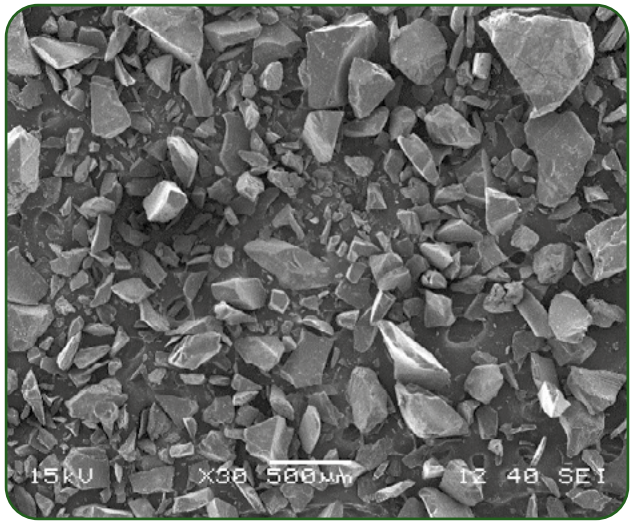


Fig. 3.18: Morphology of grinded gum ghatti by FESEM

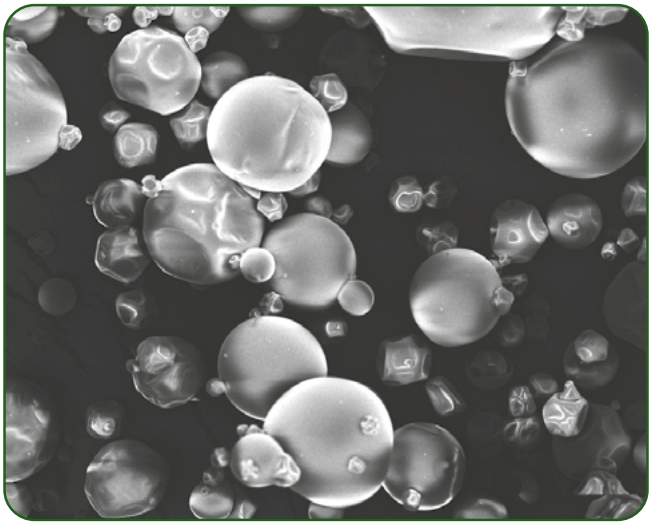


Fig. 3.19: Morphology of spray dried gum ghatti by FESEM

Fig. 3.20: Raw gum ghatti

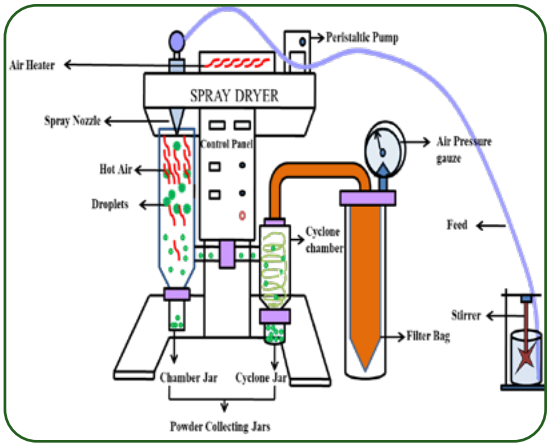


Fig. 3.21 Spray drying system

Fig. 3.22: Spray dried gum ghatti

3.5 Study on infrared drying of seedlac

Drying kinetics of seedlac

Infrared (IR) drying kinetics of seedlac was studied at three levels of IR power (450, 650, 850 W), three levels of loading density (3, 4, 5 kg/m^2) and two levels of airflow (0 and 1m/s). Convective drying experiments were performed by keeping constant air velocity (1 m/s) and varying air temperature (50, 60, 70℃) and loading density (3, 4, 5 kg/m^2). The system was provided with a vibrator to facilitate proper mixing of the sample. It was observed that drying of seedlac takes place in the falling rate period. However seedlac contains only surface moisture, no constant rate period during drying was observed. This may be due to presence of many micro pores at the surface of seedlac (as observed in Fig. 3.23) which traps water during washing. Six drying models (Lewis, Page, Modified page, Henderson and Pabis, Logarithmic, Wang and Singh) have been used to describe drying curves. The criterion used for model selection was magnitude of average value of regression coefficients and RMSE for each model. Page model was found best among all the fitted models with highest average regression coefficient (~0.99) and lowest RMSE for all the drying methods.

Comparative evaluation of different drying methods

Seedlac was dried using different methods *viz.* infrared drying, infrared assisted convective drying and hot air drying. For comparing the different methods system operated under either of the following settings; 1) Near infrared drying (550 W); 2) Near infrared assisted convective drying (550 W, with forced ambient air at 30 ℃ and air flow of 1 m/s); 3) Far infrared drying (550 W); 4) Far infrared assisted convective drying (550W, with forced ambient air at 30^{0}C and air flow of 1 m/s); 5) Hot air convection (HA) drying at an air temperature of 60^{0}C and air flow velocity 1 m/s but without infrared heating. Initial loading density of sample was kept constant at approximately 3 kg/m^2 for all drying experiments. Results of comparative evaluation of different drying methods are given in Table 3.4. Far infrared assisted convective drying was found best as it required least drying time and energy while maintaining the quality of seedlac.

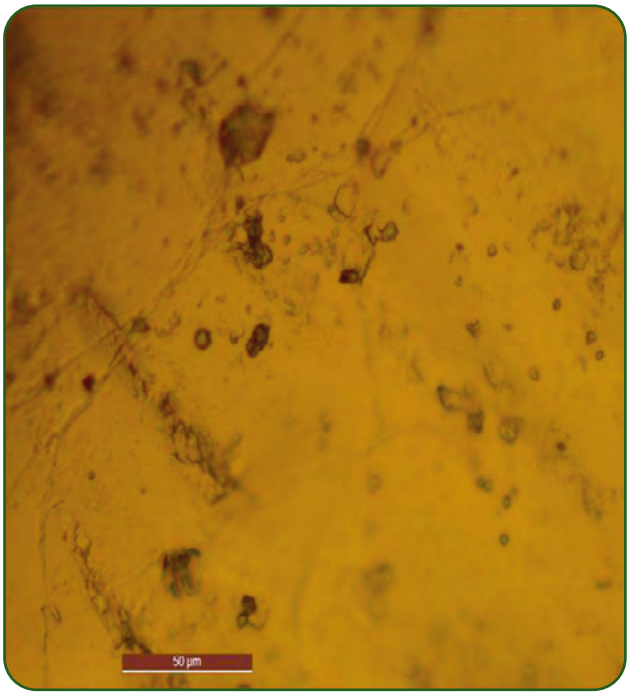


Fig. 3.23: Seedlac surface morphology

Table 3.4: Comparative evaluation of different drying methods

S.No.	Drying	Flow (mm)	Life (min)	Color index	Impurity%	Drying time (min)	Total color difference	Energy consumption (kWh/100kg material)
1	NIR	78.33 ±3.51^{a}	62.33 ±5.50^{ab}	7.33±0.58^{ab}	1.11 ± 0.20^{ab}	7.5±0.5^{c}	12.62±1.88^{a}	36.18±2.41^{c}
2	NIRAC	79.33 ±1.15^{a}	62.33 ±5.51^{ab}	6.67±1.15^{ab}	0.93 ± 0.06^{b}	6.5±0.5^{c}	10.36 ± 1.25^{a}	33.07 ± 2.54^{c}
3	FIR	77.33 ±6.43^{a}	61 ± 1.73^{ab}	7.67± 0.58^{a}	1.06 ± 0.19^{ab}	11.33±1.15^{a}	6.26 ± 0.87^{b}	54.68 ± 5.58^{b}
4	FIRAC	79.67 ±2.52^{a}	60.67 ± 4.04^{b}	6.33 ±0.58^{b}	0.94± 0.51^{ab}	6.5±0.5^{c}	6.03 ± 2.02^{b}	33.07 ± 2.54^{c}
5	HA	75.67 ±0.58^{a}	68.33 ± 1.15^{a}	6.33 ±0.58^{b}	1.56 ± 0.38^{a}	9.16±0.29^{b}	5.21 ± 2.75^{b}	88.45± 2.79^{a}
6	Control	79± 3.61^{a}	60.67± 3.21^{b}	6.33± 0.58^{b}	0.92± 0.21^{b}	-	-	-

Means with the same letter in a column are not significantly different

Optimization of infrared assisted convective drying method

Far infrared assisted convective (FIRAC) drying was found best among all the methods studied and its process parameters were optimized using response surface methodology. Infrared power (450-850 W), loading density (3-5 kg/m^2), air velocity (0-1 m/s) and distance between lamp and product surface (15-35 cm) were selected as independent variables and drying time, energy consumption and quality parameters - life, flow, color and hot alcohol insoluble were dependent parameters. The multiple response optimization was carried out. Optimized value of independent variable obtained by numerical optimization were 500W Infrared power, loading density 3 kg/m^2, Air velocity 1m/s and distance between lamp and product surface 15 cm.

4. Value Addition, Application Development and Product Diversification

4.1 Study on natural gum based dietary fibre as encapsulant for delivery of functional feed

Encapsulation of ascorbic acid (Vitamin C) with guar gum dietary fibre was accomplished using spray drying technique (Fig. 4.1). The wall material used for encapsulation is dietary fibre isolated form guar gum and ascorbic acid as core material. The process optimization of spray drying for encapsulation of ascorbic acid was done using response surface methodology (RSM) using Box-Behken Design. The three independent factors i.e. inlet temperature, concentration of the wall material, cone of ascorbic acid as core material were taken for experiment and each factor having three levels. Total 13 numbers of experiments were carried out to fit the requirement of design and statistical analysis was accomplished using Design Expert® software. The response as encapsulation efficiency was determined by estimation of the ascorbic acid content of the spray dried material by indophenol titrimetric method. The encapsulation efficiency of the ascorbic acid was optimized using prediction of RSM data (Fig. 4.2) and 88% encapsulation efficiency of the ascorbic acid was achieved.

The particle sizes of the encapsulated materials were estimated using particle size analyzer. The mean diameter of the spray dried material was estimated as d_{50} 5.88 µm to d_{50} 75.74 µm (Fig. 4.3). The higher inlet temperature, lower concentration of wall and core material produces smaller size of the particle. The smallest optimum particle size was obtained 5.18 µm using prediction of RSM data. As the estimated particle is in micron range, so the process may be called as microencapsulation of ascorbic acid.

Characterization of encapsulated ascorbic acid powder was done by FT-IR spectroscopy and Field Emission-Scanning Electron Microscopy (FE-SEM). FT-IR spectra of the dietary fibre encapsulated ascorbic acid were studied to ensure the encapsulation of ascorbic acid (Fig. 4.4). The FT-IR spectrum showed peaks at 1636 cm^{-1} and 1374 cm^{-1}, can be attributed to the stretching vibration of C-C double bond and of enol-hydroxyl of ascorbic acid confirming the presence of the active compound in the encapsulated product. FE-SEM images (Fig. 4.5) of the spray dried encapsulated particle indicated that AA was encapsulated inside the spherical capsule of the wall material.

Fig. 4.1: Spray dried dietary fibre encapsulated ascorbic acid

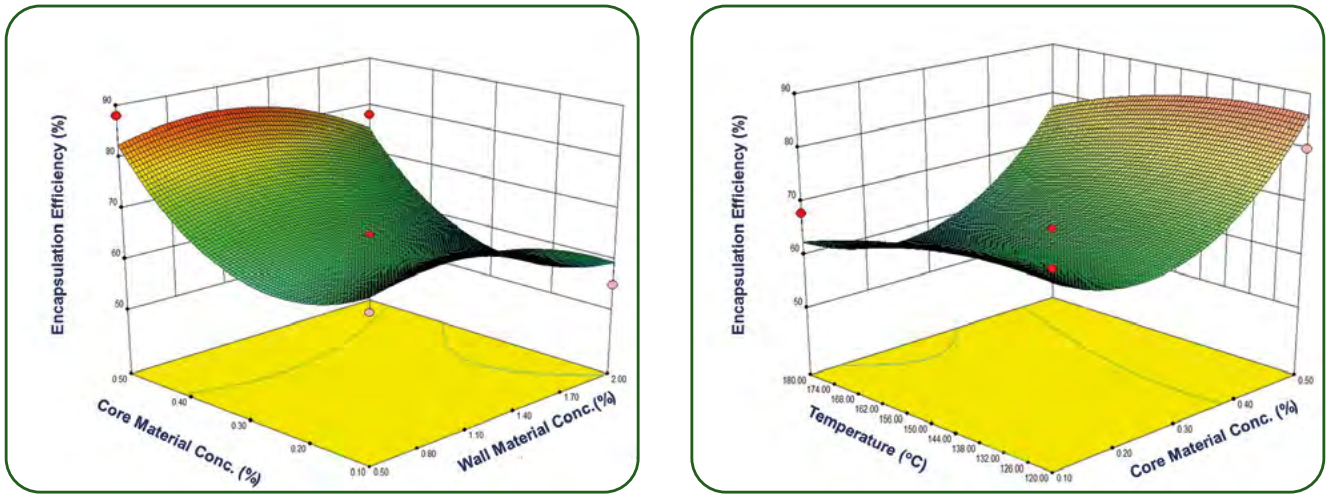


Fig. 4.2: Response surface graph for optimization of the encapsulation of ascorbic acid

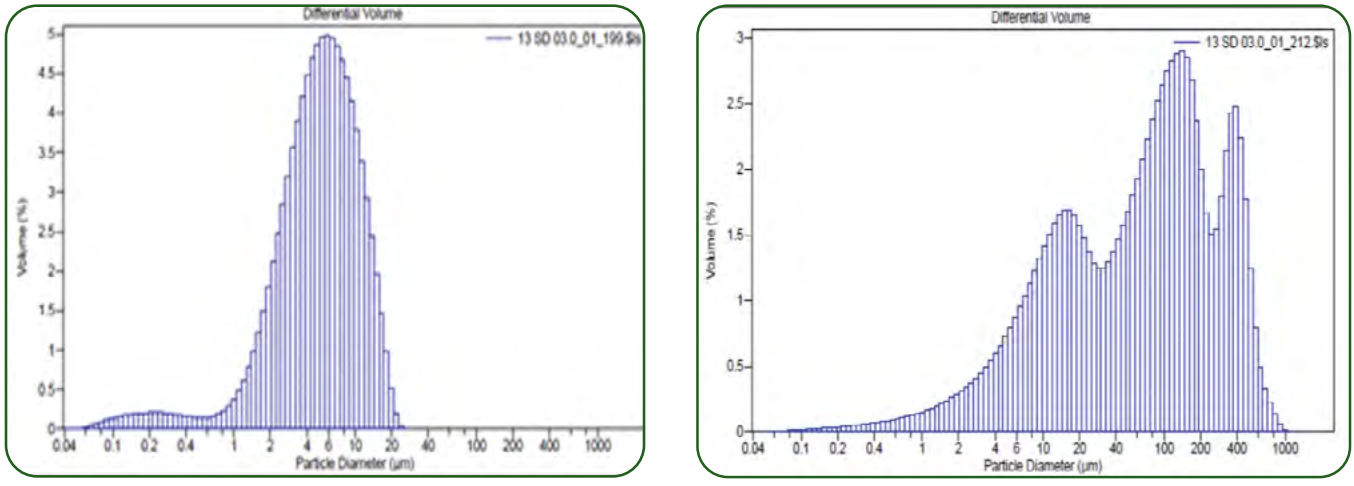


Fig. 4.3: Particle size distribution of spray dried encapsulated material

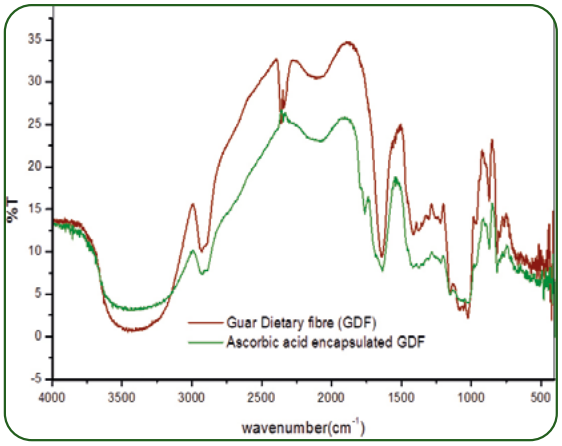


Fig. 4.4 : FT-IR spectra of dietary fibre encapsulated ascorbic acid

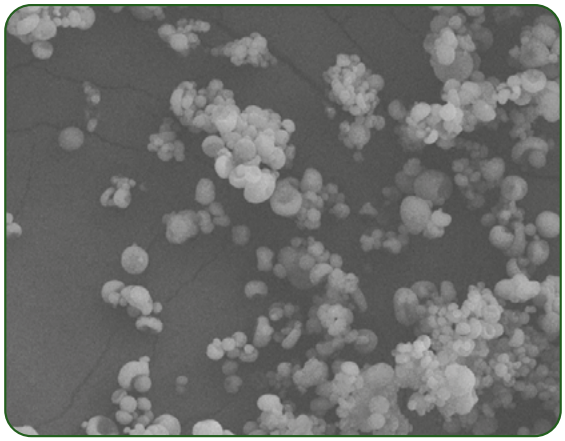


Fig. 4.5: FE-SEM images of the spray dried encapsulated product

Release study of ascorbic acid encapsulated with guar dietary fibre in the phosphate buffer saline medium shows that the release of ascorbic acid from the matrix is time dependent. The study recorded 80% release of ascorbic acid in the medium after 4 hrs. The data of release kinetics fitted in exponential Korsemeyer-Peppas equation and indicated the sustained release of ascorbic acid from the matrix.

Bioavailability study of the PHGG encapsulated ascorbic acid (AA) in fish model was started using fingerlings of Indian major carp. The experiment was carried out using four treatments. Two doses (40mgkg^{-1}AA and 20mgkg^{-1}AA) of the PHGG encapsulated AA was taken as treatment (T1 and T2) and commercial fish feed was taken control (C). Commercial fish feed was mixed with required doses of encapsulated AA and AA without encapsulation (40mgkg^{-1}AA) was taken as positive control (PC). After the 15 days of acclimatization, the fish fingerlings were randomly divided into four groups and each treatment consists of 15 fingerlings. Fish was fed twice a day 5% of their body weight. The water was replaced after every two days interval. The samples fish was taken for estimation of AA content in the tissues at 30 days, 45 days and 60 days after feeding. The fish was dissected (Fig. 4.6) and muscle and liver tissues were separated and AA content of the tissues were estimated using DNPH method. The study shows that the treatment with encapsulated AA feed shows highest accumulation of AA in both the tissues (Fig. 4.7).

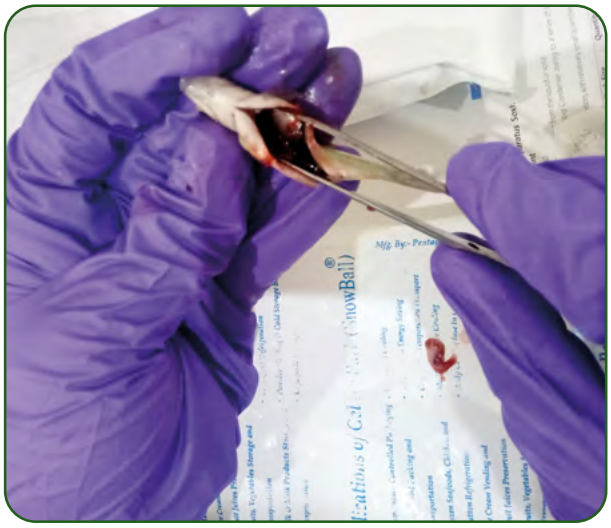


Fig. 4.6: Dissection of fish for tissues for AA estimation

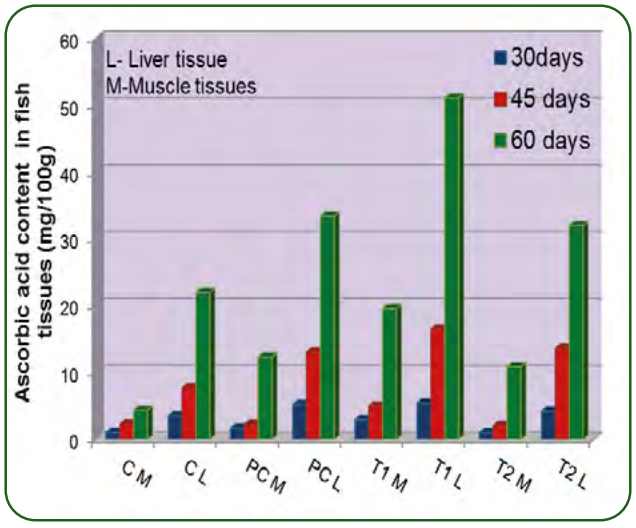


Fig. 4.7: Ascorbic acid content in fish tissues in bioavailability study

4.2 Development and evaluation of resin/ gum based sticky insect trap

Reaction conditions and concentration of the reactants were optimized for synthesis of hydrolyzed lac to get best possible yield of quality non-drying adhesive. To obtain hydrolyzed lac with light color shade, the process was modified further and various combinations starting from chocolate brown to golden yellow color were obtained. Trials on improving yield of lac based non-drying adhesive were done. It was found that number of washings during post reaction processing decreases the yield but at the same time improves the color and consistency of the adhesive. Effect of ageing on adhesive strength of hydrolyzed lac was tested by UTM. The testing of sample up to 2 years revealed that, the adhesive strength of sample increases on storage. This may be because of increase in viscosity of sample due to slow and gradual drying.

Lac based glue formulations were further modified to improve their tack and thread forming ability which is crucial in trapping and holding flying insects. Existing hydrolyzed lac based formulations were modified by treatment of acid, synthetic resin and lac resin, with varying proportions. Addition of raw lac to the formulation showed improved adhesion as compared to other formulations. Further addition of dewaxed decolorized lac gave the similar effect without darkening the color. To increase spreading ability on polythene sheet, some vegetable oil based fillers were added to the lac based non-drying adhesive. As the hydrolyzed lac is not soluble in vegetable oils, a heat-cool cycle protocol was developed to make these two phases compatible for blending.

Experiments were conducted for the field trials of lac based glue and commercial glue for sticky traps of two shapes (flat and cylindrical) and two colours (yellow and blue). Traps were installed 30 cm above the crop canopy with the help of stick and distance between the two traps was 5 meters. Yellow colour gave promising results than blue and cylindrical shapes were found better than that of the flat shape. Lac based glue showed good insect trapping efficiency although it was slightly lesser than that of the commercial glue based sticky traps.

(a) (b)

Fig. 4.8: Field trial of sticky insect trap in (a) Pigeon pea and (b) Mustard

Field trials of the lac based glue formulations for the sticky traps were carried out at the Institute Research Farm in the semialata plot. Several combinations of the diluents and co-formulants were tried along with the modified lac base. The best performing formulation was identified based on maximum insect trapping efficiency. Based on the preliminary trial's results, six different combinations of the lac based non-drying glue were tried in comparison with the commercial formulation. The best performing formulation was found at par with the commercial formulation (Chipku®) for the control of white flies.

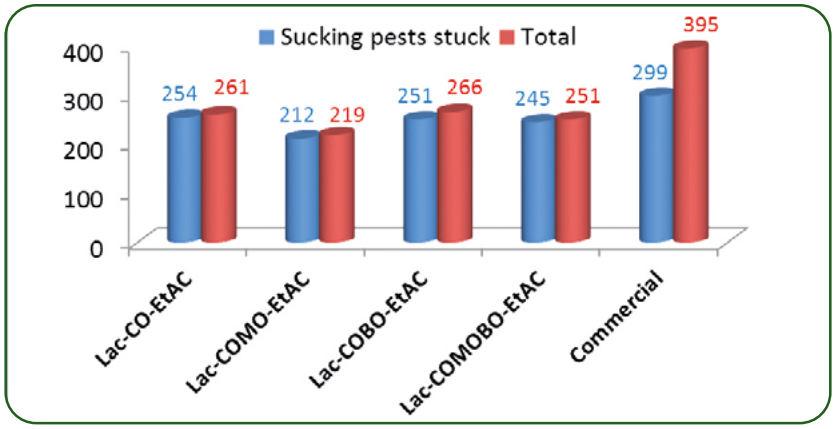


Fig. 4.9: Comparative insect trapping efficiency of lac based formulation in Mustard crop

Field trials of the lac based glue formulations for the sticky traps were carried out at the Institute Research Farm in the Pigeon pea (Fig. 4.8a) and mustard plot (Fig. 4.8b). Five different combinations of the lac based non-drying glue were tried in comparison with the commercial formulation. All lac glue formulations showed fairly good attraction efficiency against sucking pests, sticking about 240 sucking pests on an average (Fig. 4.9). Efficiency of the lac formulations was observed as 80% as compared to Commercial formulation (Chipku®).

Transfer of Technology

5. Capacity Building of Farmers and Entrepreneurship Development

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

The institute has conducted different types of training programmes pertaining to scientific lac cultivation, processing and utilization under Capacity Building and Entrepreneurship Development programme. It continuously assessing the needs of stakeholders and modified 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 total of 3215 stakeholders were benefited under various capacity building and skill development programs (Table 5.1).

Table 5.1: Details of capacity building and entrepreneurship development programme

Sl. No.	Name of programme	No. of batch/campus	Male	Female	No. of beneficiaries
1.	Farmers training programme on "Scientific lac cultivation, processing and utilization"	05	120	40	160
2.	Lac based handicraft making training under Skill Development (25 days, Off-Campus)	01	-	20	20
3.	Schedule Caste Sub-Plan (SC -SP)	17	-	-	1588
4.	On-farm Motivational/ Supplementary training programme on lac cultivation	02	26	73	99
5.	On-campus one-day Orientation programme on lac cultivation	23	419	144	563
6.	Front Line Demonstration (FLD)	22	-	185	185
7.	Awareness cum Village Survey Programme for Impact Assessment of the stakeholders under Capacity Building Programme	47	-	-	169
8.	Participation in Exhibition/Kisan Mela	01	196	235	431
	Total	**118**	**761**	**697**	**3215**

Farmer's training programme on scientific lac cultivation, processing and utilization

The programme on scientific lac cultivation, processing and utilization is for one week and it covers lac cultivation, processing at farm level and its uses. A total of 160 farmers from different districts of four states *viz.*, Jharkhand, Assam, Chhattisgarh and Uttar Pradesh participated in the programme. The participants were sponsored by various organizations and details are given in *Annexure 1.*

Lac based handicraft making training under skill development (off-campus)

One off-campus training programme of 25 days duration on lac based handicraft making training under skill development and women empowerment organized at Panchayat Bhawan, Hesla, Patratu district of Ramgarh, Jharkhand. The programme was sponsored by Patratu Vidyut Utpadan Nigam Limited (PVUNL), Patratu, Ramgarh. A total of 20 women participated in the programme. The details are given below in *Annexure 2.*

Schedule Caste Sub-Plan (SC-SP)

Distributed livestock, farm tool-kit, sprayer and vermin bed under Development Action Plan for Schedule Caste (DAPSC) among selected farmers. A total 1588 farmers participated in 17 programmes organized at different KVKs of Jharkhand as detailed in *Annexure 3.*

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

A total of 99 participants from Hazaribagh and Palamu district of Jharkhand trained in on-farm motivational/ supplementary training programme on lac cultivation in collaboration with various NGOs and GOs of Jharkhand. The details are enclosed in *Annexure 4.*

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

23 in-campus, one-day orientation programme on natural resins and gums were organized in collaboration with GOs and NGOs of Jharkhand and West Bengal states. 563

farmers, school children, college students and executives visited the institute for this purpose. These participants were nominated by various agencies as mentioned in *Annexure 5*.

Front line demonstration (FLDs)

Twenty two front line demonstrations were conducted at different villages of Ranchi and Khunti districts of Jharkhand and demonstrated dipping technology of broodlac and spraying technology in the respective villages. A total of 185 lac farmers participated in the programme as detailed in *Annexure 6*.

Diagnostic and crop monitoring visits

One crop monitoring visit was conducted at Hazaribag district of Jharkhand (*Annexure 7*).

Awareness cum village survey programme for impact assessment of the stakeholders under capacity building programme

Forty seven awareness-cum-village survey programmes for impact assessment of the stakeholders were conducted at different villages of Ranchi and Khunti districts of Jharkhand. A total of 169 beneficiaries, non-beneficiaries and village *Mukhiya* surveyed in the programme. The details are enclosed in *Annexure 8*.

Participation in exhibitions/*kisan melas*

The experts from ICAR-IINRG, Ranchi, participated in one block level *kisan mela*-cum-exhibition-2020 at Torpa Block Ground, Torpa, Khunti, Jharkhand organized by Govt. of Jharkhand on 22.12.2020 and provide technical expertise on NRGs to stakeholders. About 431 beneficiaries got benefitted and made aware about the technologies of ICAR-IINRG. Need based advisory services were also provided to the various stakeholders (*Annexure 9*).

6. Technology Evaluation, Refinement, Dissemination and Demonstration

6.1 Market information support (MIS) and impact assessment of technological interventions for NRGs

Interacted with 636 stakeholders including, 257 farmers, 82 traders, 97 processors/whole salers/exporters, 200 resource persons from various institutions through visits and telephonic conversations in 48 districts of 18 states of India. Secondary data on NRGs about production was collected from various central and state government organizations.

A decrease in the production of NRGs was found during 2019-20 in comparison to 2018-19. This decline in production was observed in *guar* gum (13%). Consequently, total production of NRGs has decreased slightly from 6,05,771.0 tons in 2018-19 to 5,28,194.0 tons in 2019-20 (Table 6.1). A decline of about 12.0% in the production of NRGs was observed over the previous year. Total production of lac in India was observed around 2.14% higher than the previous year. Production of other resins and gums increased slightly in 2019-20. Overall, NRGs production level during 2019-20 is estimated comparatively lower than the previous year. However, lac and gum *karaya* production increased by 2.14 and 20.0%, respectively (Table 6.1).

ITC calculations based on UN COMTRADE statistics, the world trade aggregation of all commodities during 2018 revealed that out of 130 exporting countries in the world, India ranks 19th in export with a share of 1.74% in the total world export value. Similarly, out of 130 importing countries of the world, India ranks 9th in import with a share of 2.71% in the total world import value. In these figures, re-export and re-import is excluded.

Table 6.1: Total NRG production during 2012-13 to 2019-20 (in tons)

Name of product	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20*
Guar gum*	11,30,247	10,94,989	9,38,404	6,01,740	6,38,877	5,80,104	5,02,000
Lac	21,008	16,978	18,746	16,352	14,230	18,537	18,944
Pine resin	6,875	6,699	5,726	5,773	5,254	5,000	5,000
Karaya gum	129	83	100	145	150	160	200
Dhawda gum	448	295	194	240	200	180	150
Other gums	567	333	389	380	400	390	400
Other resins and gums	975	1,190	980	1,140	1,500	1,400	1,500
Grand Total	11,60,250	11,20,567	9,64,540	6,25,770	6,60,612	6,05,771	5,28,194

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

Table 6.2: Total NRGs export and import during 2012-13 to 2019-20

Year	Export		Import	
	Quantity (in tons)	Value (in ₹lakhs)	Quantity (in tons)	Value (in ₹lakhs)
2012-13	340384.75	2176118.62	89746.33	78534.90
2013-14	483060.85	1217055.20	89535.92	96501.64
2014-15	543620.51	963270.94	86189.81	107413.18
2015-16	272462.21	343995.98	96387.62	129169.37
2016-17	329045.55	289060.92	109764.64	137165.89
2017-18	379979.77	406496.80	107399.56	148878.70
2018-19	375412.29	445725.07	100010.17	153290.13
2019-20	246342.47	314623.88	103282.14	166454.53

Export quantity as well as value of NRGs from India decreased significantly while the value of exported products increased significantly and import scenario looks relatively increasing over the period. Export of NRGs in terms of the quantity declined (34%) and the earning of foreign exchange has also declined (29%) significantly in 2019-20 in comparison to the 2018-19. On the other hand, import of NRGs in terms of the quantity increased (3%) slightly but the value of imported NRGs has increased (9%) in 2019-20 in comparison to the 2018-19 (Table 6.2). During the year 2020, the MSP announced by the Government for gum *karaya* remained Rs. 10,800 per quintal. During 2019-20, price of rosin and turpentine oil ranged from Rs.35-109/kg and Rs.126 to 150/litre, respectively (HPSFC Ltd.).

On the basis of survey in the markets and processing centers of different lac producing states, the estimated national production of sticklac during 2019-20 was approximately 18,194 tons (Fig. 6.1). Jharkhand state ranks 1st followed by Chhattisgarh and Madhya Pradesh. These three states contribute more than 85% to the lac production in India (Fig. 6.2).

The data on prices of *rangeeni* and *kusmi* sticklac and seedlac have been collected from the lac markets on quarterly basis. During previous year, the market price for lac has improved and it was higher than the MSP declared by GOI (Fig. 6.3). Procurement of lac by the state level federations under the nodal agency of TRIFED is depicted in Table 6.3.

Price at various levels of the market for the *guar* seed (local), *guar* seed (delivery), *guar* split and *guar* gum (powder) were recorded and ranged from Rs. 20-25/kg for *guar Churi*, Rs.30-35/kg for *guar Korma*, Rs.35-52/kg for *guar* seed, Rs.80-100/kg for *guar* split and Rs. 100-120/kg for *guar* gum powder. Presently, local as well as overseas demand of the *guar* split has declined and factories for a *guar* split are running under capacity. Discussion on various issues including processing, production and marketing of natural tree gums was carried out. Discussion was also made with the dealers/suppliers of seedlac for paint and varnish, stone cutting and polishing enterprises, traditional lac bangle clusters, handicraft designers, NRGs based exporters, processors/manufactures/wholesalers, traders, experts, farmers, forest dwellers and other concerned officials.

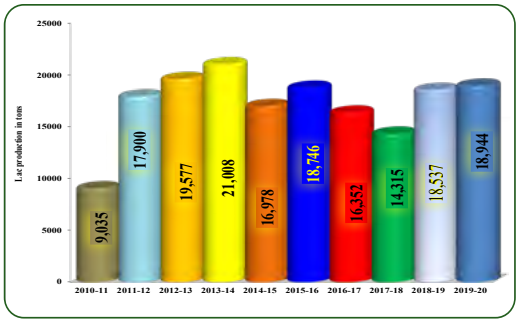


Fig. 6.1: Lac production in India during recent years

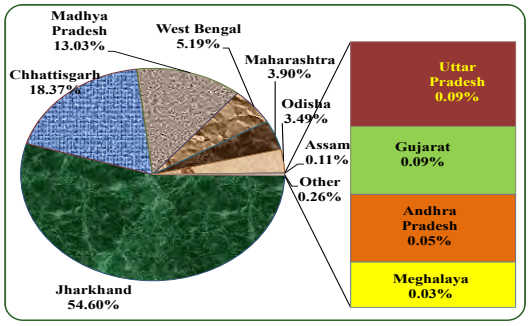


Fig. 6.2: State wise lac production (%)

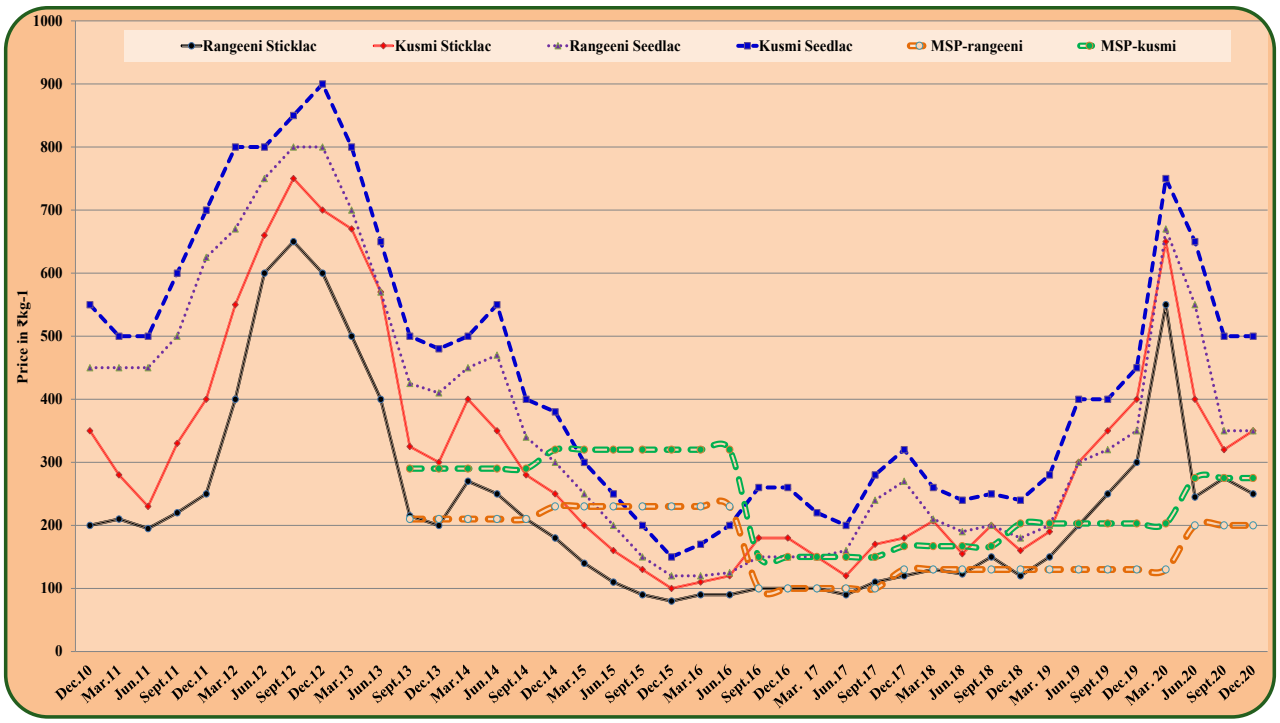


Fig. 6.3: Movement in prices of scrapedlac and seedlac during last 12 years

Table 6.3: Procurement of lac at minimum support price (MSP)

Year	Crop type	State Name/units	Chhattisgarh	Jharkhand	Gujarat	Total
2014-15	Lac *Rangeeni*	Quantity MT	0.00	0.00	0.00	0.00
		Value(₹ in Lakhs)	0.00	0.00	0.00	0.00
	Lac *Kusumi*	Quantity MT	0.00	0.00	19.51	19.51
		Value(₹ in Lakhs)	0.00	0.00	6.24	6.24
2015-16	Lac *Rangeeni*	Quantity MT	140	0.00	0.00	140
		Value(₹ in Lakhs)	348	0.00	0.00	348
	Lac *Kusumi*	Quantity MT	333.7	0.00	0.00	333.7
		Value(₹ in Lakhs)	1150	0.00	0.00	1150
2016-17	Lac *Rangeeni*	Quantity MT	101.17	0.00	0.00	101.17
		Value(₹ in Lakhs)	250.92	0.00	0.00	250.92
	Lac *Kusumi*	Quantity MT	350.63	3.91	2.66	357.2
		Value(₹ in Lakhs)	1208.14	5.87	0.46	1214.47
2017-18	Lac *Rangeeni*	Quantity MT	16.09	0.00	0.65	16.74
		Value(₹ in Lakhs)	17.71	0.00	1.02	18.73
	Lac *Kusumi*	Quantity MT	2.03	0.00	0.00	2.03
		Value(₹ in Lakhs)	3.05	0.00	0.00	3.05

Year	Crop type	State Name/units	Chhattisgarh	Jharkhand	Gujarat	Total
2018-19	Lac *Rangeeni*	Quantity MT	0.00	2.52	0.00	2.52
		Value(₹ in Lakhs)	0.00	32.3	0.00	32.3
	Lac *Kusumi*	Quantity MT	0.00	54.27	1.052	55.322
		Value(₹ in Lakhs)	0.00	102.21	1.75709	103.967
2019-20	Lac *Rangeeni*	Quantity MT	0.00	0.00	0.00	0.00
		Value(₹ in Lakhs)	0.00	0.00	0.00	0.00
	Lac *Kusumi*	Quantity MT	0.00	0.00	2.185	2.185
		Value(₹ in Lakhs)	0.00	0.00	0.44355	0.44355
Total		**Quantity MT**	**943.62**	**60.7**	**26.057**	**1030.38**
		Value (₹ in Lakhs)	**2977.82**	**140.38**	**9.92064**	**3128.12**

Lac processing in India during last ten years is shown in Fig. 6.4. There is sharp increase in value of lac based export items during the year 2019-20 (Fig. 6.5). Composition and trends in overseas demand of lac and its value added products illustrated in Fig. 6.6. Distribution of the overseas demand of lac and its value added products with the major destinations and rest 66 countries is depicted in Fig. 6.7.

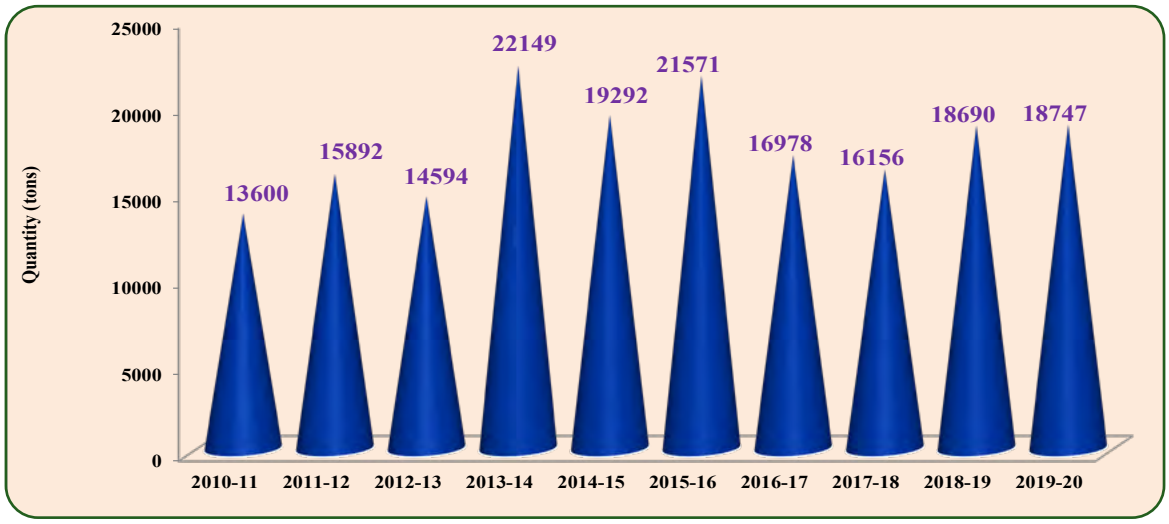


Fig. 6.4: Lac processing in India during last ten years

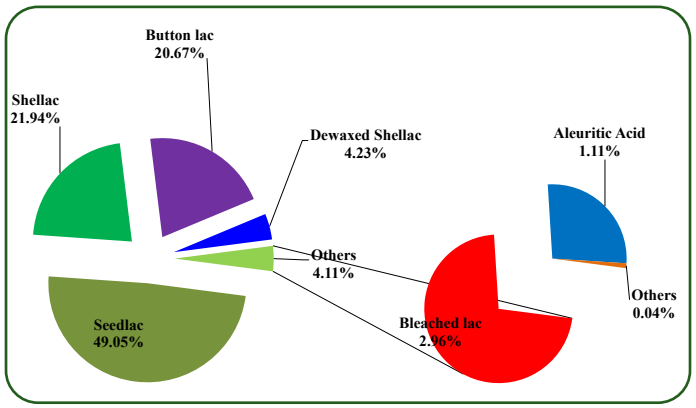


Fig. 6.5: Value added products of lac prepared during 2019-20

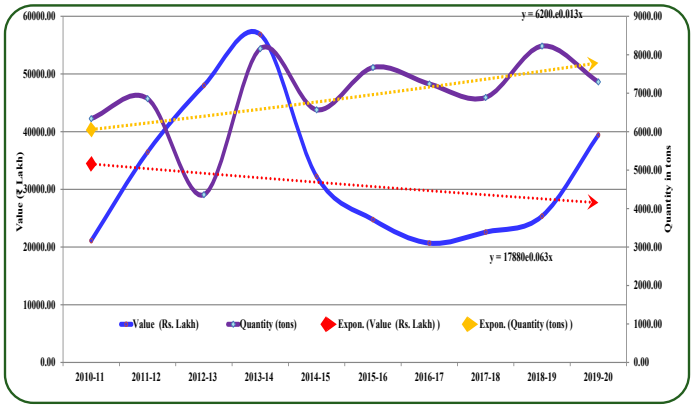


Fig. 6.6: Trend in overseas demand of lac and its value added products

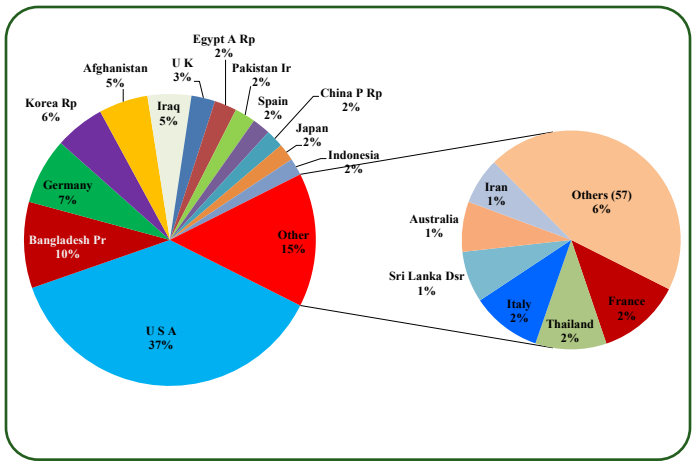


Fig. 6.7: Distribution of the overseas demand of lac and its value added products

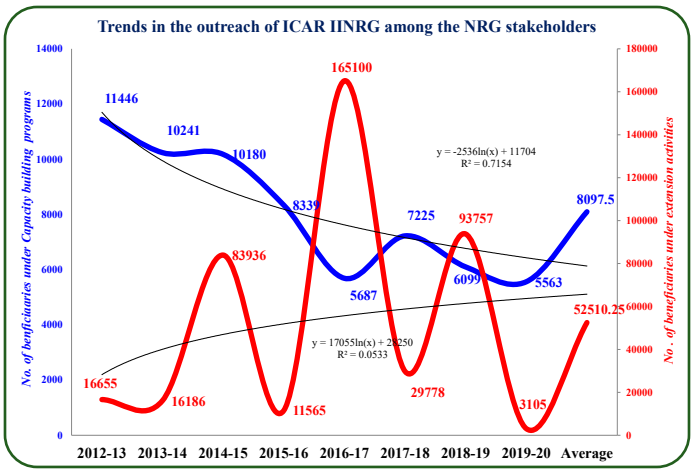


Fig. 6.8: Footprints of NRG based Knowledge over the time

Impact assessment: Socio economic characteristics and utilization pattern

Utilization of host trees for lac cultivation in the study area was observed as 18.24, 6.82 and 3.09% for *Butea monosperma* (*Palas*), *Ziziphus mauritiana* (*Ber*) and *Schleichera oleosa* (*Kusum*), respectively. This indicated a greater scope for increasing lac production by utilizing more lac hosts trees and creating gainful employment opportunities for the migrating rural population at local level. Dissemination of the knowledge through trainings plays an important role in human resource development. Aims of the training are to improve upon the skills, knowledge and capabilities of the beneficiaries as well as his neighbors also. This study aimed to analyze the trends of capacity building and skill development programs on scientific lac cultivation and value addition.

Trends in knowledge dissemination among the NRG stakeholders

Time series data set for the period 2012-13 to 2019-20 on different capacity building and skill development programs comprises one week trainings, one-day orientation, product demonstrations, exhibitions, educational and motivational programs. Trend of the number of stakeholders benefitted under capacity building and skill development programs showed a decreasing trend with its peak level 11,446 stakeholders from different parts of the country during 2012-13 to 5563 stakeholders in 2019-20 (Fig. 6.8). It happened due to extensive linkages with GOs and NGOs which might be able to start such programs through convergence as well as with the help of master trainers particularly in Chhattisgarh and West Bengal. Similarly, number of stakeholders benefitted under extension programs showed an increasing trend.

Peak levels of the coverage ranged from 0.5 lakh to 1.5 lakh stakeholders during 2014-15 (83,936), 2016-17 (1,65,100) and 2018-19 (93,757) due to the convergence with corporate sector during *Krishi Vasant*, Global Investors Meet, Momentum Jharkhand, *etc.* Overall, about 8000 stakeholders benefitted under capacity building and skill development programs annually with the existing infrastructure. This figure needs to be doubled for extensive coverage of the stakeholders by developing required infrastructure as well as manpower. About 50,000 stakeholders may be covered through extension and other awareness programs. However, post Covid scenario affected the regular trend adversely and it demands the ICT interventions to disseminate the good agricultural practices (GAP) among the stakeholders in the period of new normal.

Survey-cum-awareness program-2020:

More than 100 trainees from different villages of Khunti, Ranchi, West Singhbhum and Dhanbad districts of Jharkhand state have contacted under Survey-cum-Awareness Program-2020. Extension literatures about scientific lac cultivation were distributed among the lac growers. Village level interactive session with the local representatives and key resource person were made to record the feedback of the stakeholders. Survey team observed that knowledge level of the trainees improved and few farmers adopted recommended practices of lac cultivation but major hurdle in adoption was the timely availability, accessibility and affordability of inputs. Non-trainees were also interviewed for comparative analysis.

Survey –cum-awareness programmes at different districts of Jharkhand

Extension activities

NRGs information cell (NIC) and market oriented technical advisory services (MOTAS)

Based on the information generated under market support, a database has been maintained in the NIC. During 2019, information related to NRGs production, price/ minimum support price (MSP), transferable technologies, bankable projects, promotional awards, Post COVID-19 management aspects, marketing, processing, export and policy issues disseminated through the direct interactive meetings, discussions, writing, telephonic and mails to a total of 43 stakeholders including 6 Entrepreneurs, 7 processors/manufactures/exporters, 9 farmers, 6 government organizations/policy makers, 2 researchers/ research scholars, 2 traders, 9 NGOs and other agencies line departments, FPOs, VLOs, *etc.* from India (Table 6.4). Beneficiaries belonged from 16 districts spread over the 7 states (Fig. 6.9). Data on NRG production, processing, EXIM were also sent to IASRI for Agriculture Research Data book.

Table 6.4: Details of the activities of NIC and MOTAS under one to one program (OTOP)

State	Organization/District/Place	Category	Number
Andhra Pradesh	Vishakhapatnam	NGO	4
		Organization	1
		Entrepreneur	1
	Vijayavada	Research	1
Bihar	Gopalganj	Trader	1
Chhattisgarh	Jashpur	Organization	1
	Raipur	Trader	1
Chandigarh	Chandigarh	Processor	2

State	Organization/District/Place	Category	Number
Jharkhand	Ranchi	Entrepreneur	4
		Farmer	5
		Research	2
		NGO	2
	Gumla	Organization	4
	Palamu	Others	1
	Palamua	Farmer	1
	Khunti	Farmer	1
		NGO	1
Karnataka	Banglore	Exporter	1
Maharashtra	Nandurbar	Farmer	1
Odisha	Bolangir	Farmer	1
Telengana	Hyde	Entrepreneur	1
West Bengal	Purulia	Exporter	1
		NGO	2
		Processor	1
	Kolkata	Exporter	1
		Processor	1
Total			43

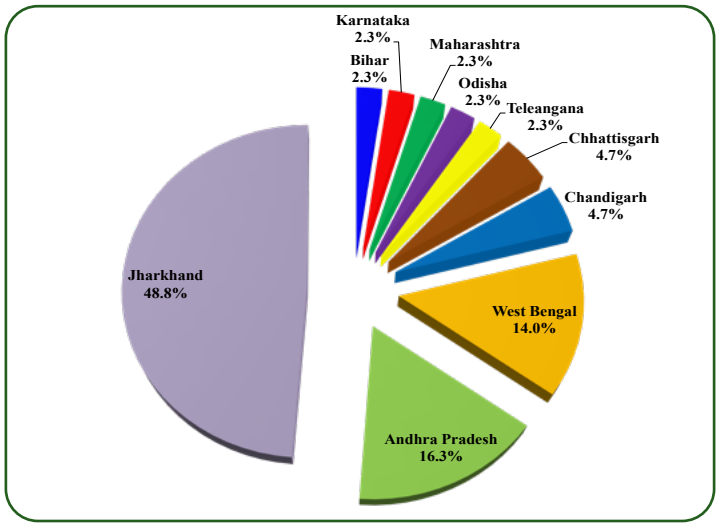


Fig. 6.9: State wise beneficiaries under NIC and MOTAS

ICT based Intervention: *Laksha Updates*

Keeping in view the importance of ICT enabled interventions; a social media group was initiated with the objective to provide a virtual platform to experienced faculties, key resource person market agencies, industrialists, young entrepreneurs and progressive/ innovative farmers of lac sector for the interaction with lac growers.

ICT based intervention made the task easy in linking the stakeholders with institute to manage the Post COVID-19 scenario. Monthly advisories released by the institute and shared regularly with guidelines, meteorological

advisories and market updates (Fig. 6.10). More than 1000 responses were recorded and stakeholders got benefited. Due to strong linkage mechanism and accessibility of stakeholders with huge number of experts, stakeholders feel motivated and encouraged.

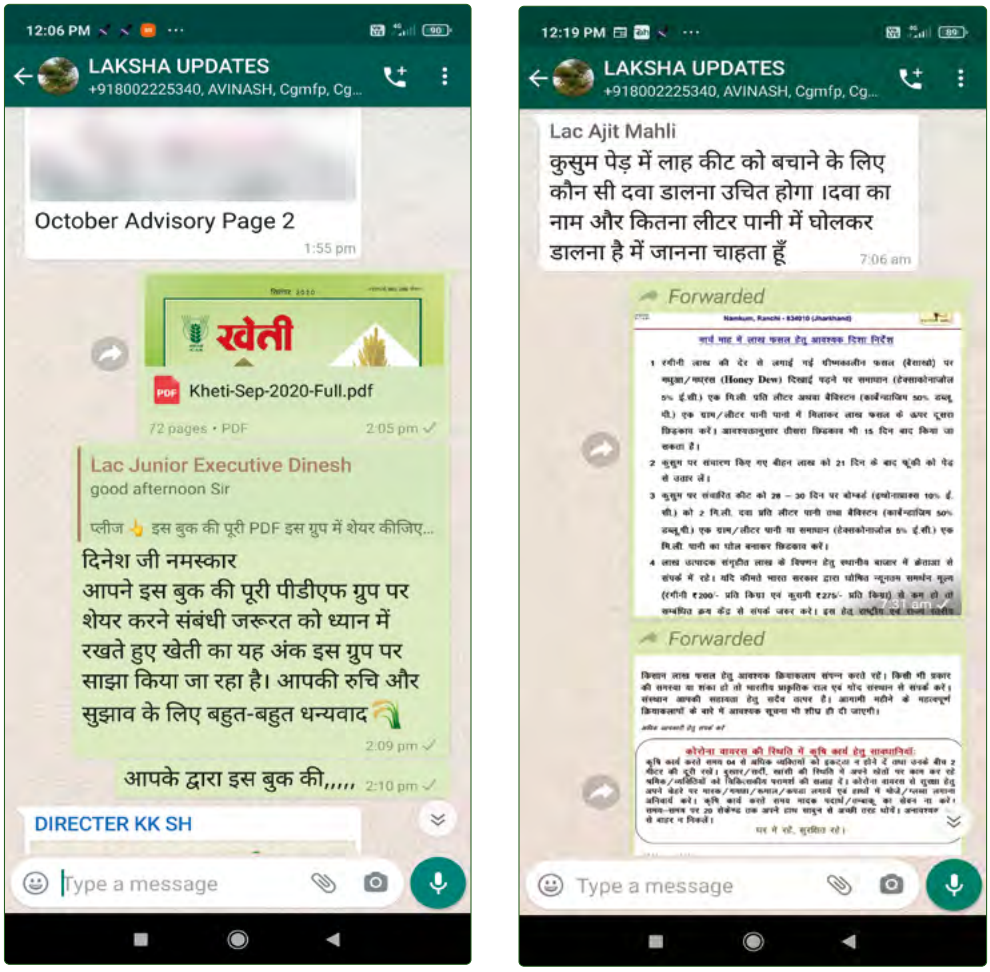


Fig. 6.10: Screenshot of the activities at ICT enabled module *Laksha Updates*

DAPSC training to SC farmers though KVKs of Jharkhand

KVK	Date:	Topic	Beneficiaries	Total
Chatra	24-28 Dec.2020	Integrated Farming System	50	**160**
	25-29 Nov.2020	Integrated Farming System	50	
	19-20 Sept 2020	Rearing of Goat	20	
	16-17 Sept 2020	Pig rearing	20	
	14-15 Sept 2020	Poultry rearing	20	
Garhwa	15-16 Sept2020	Pig rearing	25	**180**
	17-18 Sept2020	Backyard Poultry	25	
	19-20 Sept2020	Care and maintenance of farm implements	25	
	21-22 Sept2020	Goat rearing	25	
	3-7 Dec2020	Vermi compost Production	29	

KVK	Date:	Topic	Beneficiaries	Total
	7-11 Dec.2020	Apiculture Production	26	
	23-27 Nov.2020	Mushroom Production	25	
Giridih	01-03 Dec.2020	Care, maintenance and use of agriculture implements	25	**125**
(5)	27-29 Nov.2020	Scientific method of Poultry Production	25	
	24-26 Nov. 2020	Scientific cultivation of vegetable production	25	
	04 -06- Dec. 2020	Scientific production of Goatery	25	
	08-10 Dec.2020	Integrated Farming System	25	
Bokaro (1)	15-30 Mar. 2020	Stitching of SC women for entrepreneurship development	30	**30**
Palamu	15-16 Sept.2020	Pig rearing	20	**100**
(5)	17-18 Sept.2020	Backyard poultry	20	
	21-22 Sept.2020	Goat rearing	20	
	3-7 Dec.2020	Vermicompost production	20	
	7-11 Dec.2020	Mushroom production	20	
23				**595**

Distribution of farm tool kits, vermibed, sprayers etc among SC trained farmers through KVKs

KVKs	Name Items	No. of beneficiaries	Total
Chatra	Farm tool kits,	100	325
	Vermibed,	100	
	Sprayers	100	
	Sewing machine	25	
Garhwa	Farm tool kits,	75	305
	Vermibed,	100	
	Sprayers	75	
	Sewing machine	30	
	Honey Bee kit	250 (25)	
Palamu	Farm tool kits,	75	225
	Vermibed,	100	
	Sprayers	50	
Giridih	Farm tool kits,	50	175
	Vermibed,	100	
	Sprayers	25	
Total			1030

6.2 Success Stories

Details of farmers who are able to earn substantial income from their farm/enterprises and they are the role models in their area for other farmers.

1. **Shri. Laxman Oraon:** Vill- Konhapa, Panchayat- Limda, Block- Karra, District- Khunti, Jharkhand. Mobile: – 9572862488

This farmer does farming on 5-6 ha of land. He grows paddy, sweet corn, vegetables like potato, tomato, brinjal, bitter gourd, beans, chilli, green peas, garlic, onion, radish, carrot, coriander, fruits like melon, water melon, etc. He has 7 goats, 45 ducks, 20 hens, one cow and a calf in his farm. He sells his farm produce by himself in the nearby retail markets. Average annual income- 5-6 lakhs INR (net profit).

2. **Smt. Snehlata Gudia:** Vill- Banaitoli, Block- Torpa, Dist.- Khunti, Jharkhand. Mobile: 7765061248

She is having a group of 14 women farmers. Together all are doing agriculture/Animal Husbandry/ apiculture in village and their earning increased by 20%. They are having 70 cows, 100 goats, 150 hens, 40 pigs, 60 *ber* tree for lac cultivation. Together they have planted paddy in 15-acre land and horticulture crop in 10-acre land. They have taken training in lac cultivation from KVK, Khunti under ICAR-IINRG, bee keeping and vegetable production from MVK, Torpa, and mushroom production from PRADAN, Torpa, Khunti.

3. **Smt. Vilashi Topno:** Village- Diyakel, Block- Torpa, Dist.- Khunti, Jharkhand. Mobile: 9572565701

She is having 30-acre land and using 20-acre area for the agriculture, Bee Keeping and Animal Husbandry. She has taken training for Lac cultivation from KVK, Khunti under ICAR-IINRG, bee keeping and vegetable production from MVK, Torpa, and Mushroom production from PRADAN, Torpa, Khunti. Currently she is having 15 pigs, 8 No. honey bee boxes, mango and guava orchard in 2-acre area. She is producing mushroom in small scale and selling at village level. She has planted paddy in 10-acre land and horticultural crops in 5-acre land. After diversifying her agricultural operations, she has reported an increase of 25% in her income.

4. **Smt. Seteng Bhengra:** Village- Gorbeda -Village, Block- Torpa, Dist.- Khunti, Jharkhand. Mobile: 7033479212

Seteng Bhengra is one of the successful entrepreneurs in Gorbeda village in Torpa block of Khunti district. Udyogini's staff oriented her about the model and services of VLRAC (Village Level Retail and Aggregation Center) and also about the trainings which Udyogini gives to the entrepreneurs. As Seteng always thought about her business and how she could establish her business to provide better platform for income for her family, she got interested in VLRAC model and was ready to take trainings from Udyogini. She took training in 2015. She got training on entrepreneurship, marketing, Four Ps of market, business idea generation, record keeping. After her regular hard work, she established enterprise and now she is providing services of retailing of grocery items, aggregation of mango, tamarind and paddy. She is also doing fishery of rehu, katla, mirga, chingi. She started photocopy service with the help of Udyogini. After the photocopy service the students got benefitted through this because earlier they faced problems such as in town they have to pay Rs. 5 per copy and had to travel 5-10 km for this. To add more services, she started nursery development of banana and papaya. Annually she is earning 1 lakh to 1.5 lakh INR.

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

1.1 Lead Centre: ICAR-IINRG, Ranchi

Preparation and characterization of modified guar gum nanocomposite films reinforced with piyar AgNPs for diversified applications

A number of nanocomposite films reinforced with piyar-AgNPs were developed (Fig. 7.1) for diversified applications through solution casting method, by varying reactants i.e. modified guar gum (MGG), plasticizer, piyar-AgNPs etc., to study the effect on the physical, mechanical, thermal, barrier and antimicrobial properties of the resulting nanocomposite films. The syntheses were monitored by recording UV-Vis spectra at 200-600 nm. Films were dried in an oven at 40 ℃ for 24 hr., peeled off and kept at 25 ℃ and 58% relative humidity (RH) for further analysis. Control films were similarly prepared, but without the addition of nanoparticles.

UV-Vis absorbance spectroscopy: To determine the optical properties, the absorbance spectra of MGG-piyar-AgNPs nanocomposite films were obtained using a UV-visible spectrophotometer (CECIL CE 7200, UK) in absorbance mode. A piece of nanocomposite film was placed in the attachment for recording of film absorbance at different wavelengths (200 to 600 nm). The control film did not show any absorption peak but nanocomposite films indicated good absorbance in the UV range (290 to 430 nm) indicating the presence of Surface Plasmon Resonance (SPR) and incorporation of silver nanoparticles therein.

Fourier-transform Infrared Spectroscopy (FTIR): The FTIR spectra of the MGG-piyar-AgNPs nanocomposite films were measured by Nocolet iS 5 FTIR Spectrophotometer (Thermo Fischer Scientific, USA). For each spectrum, 64 consecutive scans at 4 cm−1 resolutions were averaged to reduce spectral noise. The spectra exhibited the desired characteristic peaks.

Determination of film thickness: Film thickness of the developed nanocomposite films was determined using Screw Gauze. Thickness was measured at four random spots on the film. On increasing the MGG concentration, film thickness also increased. Treatment T33-2 has exhibited highest thickness possibly due to the combined effect of MGG and incorporated piyar-AgNPs.

Determination of opacity: The opacity of the MGG-piyar-AgNPs nanocomposite films was determined following standard formula (Opacity = Absorbance at 600nm/Thickness in mm) and found that treatment T33-1 exhibited maximum opacity.

Exploration and preparation of field guide for minor gum and resin producing plants in India

Fig. 7.1: Modified guar gum - piyar-AgNPs nanocomposite films

Under this project, different field visits were conducted for collecting photographs and information regarding minor resin and gum producing trees. In the year 2020, visits were made to Navsari, Gujarat and surrounding forest areas in February and after lock down photographs were taken identifying some gum-resin trees from Ranchi, Jharkhand and nearby area.

In the year 2020, before lockdown, survey visits were made to Navsari, arboretum maintained by Navsari Agricultural University, Waghai Botanical Garden, Ambapada, and surrounding forest areas of Gujarat in Feb-March, 2020. During the survey photographs of season specific plant parts including flowers, fruits, leaves, whole plants and gum exudation of different plant species were taken. The trees covered were *Calophyllum inophyllum, Ceiba pentandra, Chukrasia tabularis, Cochlospermum religiosum, Enterolobium cyclocarpum, Garcinia spp, Garuga pinnata, Limonia acidissima, Macaranga indica, Moringa concanensis, Pterocarpus marsupium, Sapindus trifoliatus, Semecarpus anacardium* and *Spondias pinnata.*

In order to increase the scope of this study, two centres namely KAU, Thrissur, Kerala, for photographing different plant parts of gum and resin plants of western ghat of Kerala and CAZRI, Jodhpur, Rajasthan, for arranging photographs of different plant parts of the gum- resin producing trees from the arid regions of Rajasthan, were involved in the project.

Kerala Agricultural University, Thrissur, Kerala centre has surveyed local western ghat areas to cover biodiversity of resin and gum producing plants available there. Amidst restriction of covid-19 situations they could manage to get photographs of the flowers, fruits, leaves, gum/resin exudations of trees including *C. inophyllum*, *C. tabularis*, *Commiphora berryi*, *Commiphora caudata*, *G. pinnata*, *Macaranga peltata*, *Myristica beddomei*, *Vatica chinensis*, etc. ICAR-CAZRI, Jodhpur Centre also explored the gum-resin producing trees in the vicinity of Jodhpur and photographed various plant parts of the trees including *Balanites aegyptiaca*, *Anogeissus rotundifolia*, *Prosopis cineraria*, etc.

Effect of tapping techniques on gum yield from *Moringa oleifera* trees

Development of conceptual/line diagram: Conceptual/ line diagram of the gum tapping tool/die developed considering semi- circular method of *karaya* gum tapping developed by Koval Foundation, Visakhapatnam in collaboration with Girijan Co-operative Corporation, Visakhapatnam so that the shape and size of blaze/ incision made on the tree trunk for gum tapping may be uniform for each blaze/incision per tree. Conceptual/line diagram of the gum tapping die prepared on the basis of semi-circular method of *karaya* gum tapping.

Development of detailed manufacturing design drawing: On the basis of prepared conceptual/line diagram of gum tapping die, detailed manufacturing design drawing of proposed gum tapping die developed alongwith different components and assembly using Pro Engineer CAD software in collaboration with ICAR – Central Institute of Agricultural Engineering, Bhopal for fabrication. The developed detailed manufacturing design of gum tapping die mainly consists working blade, stopper mechanism and handle. The developed detailed manufacturing design drawing of gum tapping die modified as per the requirement considering ease in fabrication and its handling. During improvement stopper mechanism with adjusting system was included in the design of gum tapping die to maintain uniform depth of blaze/incision during tapping work.

Fabrication of gum tapping tool: On the basis of detailed manufacturing design drawing developed in Pro Engineer CAD Software, gum tapping die fabricated/ developed in collaboration with M/s. National Enterprises, Hatia, Ranchi (Fig. 7.2).

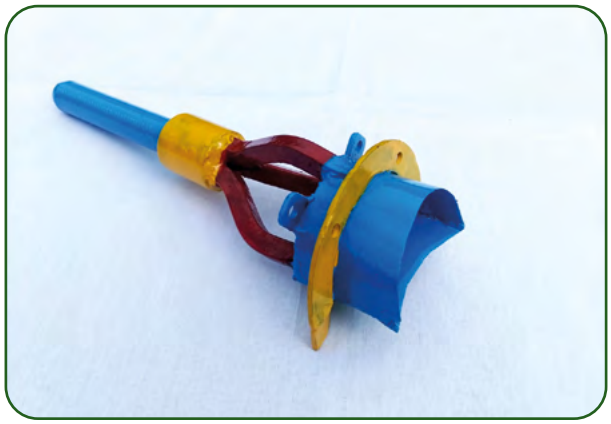


Fig. 7.2: Gum tapping tool/die

Experimentation on moringa gum tapping from *Moringa oleifera* trees

The gum tapping experiment from *Moringa oleifera* trees initiated under the project in the last week of February, 2020 at Kumhardih village of Murhu block, Khunti district. During initiation of the above experiment, blaze/incisions were made on the tree trunk using battery operated drilling machine with ½ inch drill bit, hand operated drilling machine with ½ and 1 inch drill, hand operated chisel for semi- circular incision and gum tapping die, respectively.

To develop blaze/incision on the tree trunk of *M. oleifera* trees under different treatments and using developed gum tapping die, the die was placed on the tree trunk 1.0 m above the ground level and hammered thoroughly up to the bark thickness and depth of blaze/incision maintained utilizing stopper mechanism provided in the die. During operation of the developed die for gum tapping from *M. oleifera* trees, it was observed that blaze/incisions developed easily with sharp edges of the blaze/incision on the tree trunk utilizing developed die (Fig. 7.3 & 7.4).

Fig. 7.3: Blaze development using gum tapping die

Fig. 7.4: Developed blaze

Network Co-operating Centres

1.2 Project on gum arabic at ICAR-CAZRI, Jodhpur

Study on gum production from known and lesser-known gum producing tree species of arid zone of Rajasthan

Along with *Acacia senegal* (Fig. 7.5a & 7.5b) other edible gum producing tree species such as *Acacia nilotica, Acacia tortilis* (Fig. 7.5c), *Prosopis cineraria* (Fig. 7.5d), *Anogeissus pendula* and *Anogeissus rotundifolia* also produce more or less same quality of edible gum and rural folk use them as a traditional medicine and in many other food items. Gum of these tree species can be used for industrial purpose and its production will help rural folk in additional income and employment source during summer season (where farmers only partially employed because cultivation of crops are only in rainy season).

Standardization process of gum production in *A. rotundifolia* and *A. tortilis* tree species was done which are another well known source of edible gum. Gum exudation trials on larger scale from lesser known gum producing tree species at farmers' fields are continuing this year. Resin extraction trials from *Acacia excelsa, Colophospermum mopane* and *Hardwickia binata* is continuing this year.

a

b

c

d

Fig. 7.5: Gum exudation from (a) *Acacia senegal* (indigenous), (b) *Acacia senegal* (Nigerian exotic), (c) *Acacia tortilis* and (d) *Prosopis cineraria* tree species

Study on factors affecting gum yield in *Acacia senegal* and *Acacia tortilis*

During this year, experiments were conducted to understand gum exudation in relation to different diameter classes in *A. senegal* (Fig. 7.6) and *A. tortilis* in semi-rocky lands (Jodhpur). Experiments were conducted at ICAR- CAZRI, Jodhpur research farm.

In case of *A. senegal*, trees were grouped into five DBH classes and diameter class ranged from 6.6-9.5 cm DBH to 21.5 cm DBH. All the trees were treated with standardized dose of CAZRI gum inducer. After treatment, maximum average gum yield in DBH classes (15.6-18.5 cm) has recorded followed by DBH classes (18.6-21.5 cm) 202.0 g/tree respectively. In case of DBH classes (6.6-9.5 cm) average gum yield has found minimum as 34.0 g/tree. It appeared that in general, gum yields increase from lower DBH to higher DBH.

Fig. 7.6: Gum exuded from *Acacia senegal* by using CAZRI gum inducer

During this year, gum exudation trials were carried out on Nigerian exotic plant type (Fig. 7.7) at natural resins and gums garden at ICAR-Research farm. Ten years old plantation stand has been ready for gum exudation trials

and this year, DBH range of 40.0 cm treated with CAZRI gum inducer has resulted in yielding 357 g gum Arabic.

Fig. 7.7: *Acacia senegal* (Nigerian exotic plant type) at 10 years old plantation stand located at ICAR-CAZRI research farm

In this year, studies were continued to find relation between diameter and yield of gum from *A. tortilis*. Results indicated that gum yield gradually increased with DBH in semi- rocky land forms. Maximum yields were found in DBH range between 18.6-21.5 cm in both land forms.

In semi-rocky land form gum yield increased gardually up to diameter class 18.6-21.5 cm. Maximum average gum yield was 478.3 g/tree obtained from 18.6- 21.5 cm followed by DBH classes 15.6-18.5 diameter classes which was 213.0 g/tree average gum yield (Fig. 7.8). Gum exudation pattern significianty increased from lower to higher DBH classes. The experiments showed that the optimum gum yield potential was observed only in trees having more than 18.6 cm diameter in semi-rocky land form.

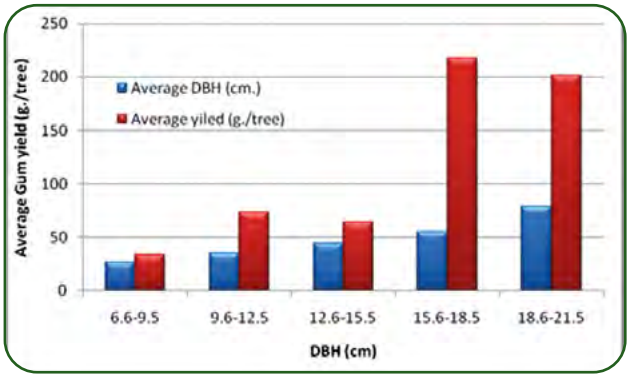


Fig. 7.8: DBH (cm) vs gum yields of *Acacia senegal* in semi-rocky lands (Jodhpur)

Standardization of gum inducer technique for *Commiphora wightii*

During 2019-20, *guggul* production trials were conducted in farmers' fields at village: Javroll, Tehsil: Sabalgarh, district : Morena (MP). Comparative studies of traditional methods Vs CAZRI's technology was continued to understand production patterns including plant health.

The experimental plant were randomly selected at field boundaries. Fifty trees were treated with CGI inducer. Moreover, farmers' practices i.e. conventional method of *guggul* treatment was also done at the same time. Average plant height in treatment group was 265.0 cm with average canopy of 255.0 cm and 35.0 cm average girth. In conventional method group plants had average height 270.0 cm with average canopy 245.0 cm and 36.0 cm average girth.

Maximum average oleo-resin yield of *guggul* 142.0 g/ plant was obtained from plants treated with CGI. In case of conventional method i.e. 119.0 g/plant yield was recorded. Results indicated that oleo-resin yield of guggul was 23.0 g/plant more in CGI inducer method compared to conventional method. No mortality was reported from farmers after the treatment.

In farmers' trials, it was observed that yields were diverse with girth of the treated plants and climatic conditions. Earlier studied indicated that *guggul* yield gradually increased with girth. However, some other climatic attribute and tree structural traits also affected *guggul* production. More field trials are required to discover scientific analysis in relation to conventional methods which are applied by farmers. Initial results clearly indicated that CAZRI methodology gave better results at farmers' fields.

Standardization of gum production in *Acacia nilotica*, *Acacia tortilis* and *Moringa oleifera* in Bikaner, Jodhpur and Pali districts

A. tortilis gum exudation trials were conducted during the month of February, 2020 (winter) at RRS, Bikaner and RRS, Pali. Gum yield were recorded from trees that were applied with different doses i.e. T-1 (97.5 mg/ ml), T-2 (195 mg/ml) and T-3 (390 mg/ ml). Four ml of each dose were applied for gum production trials.

In T-1 treatment, maximum yields were obtained in all landforms. It ranged from 17.08 g/tree at sandy loam (Pali) to 39.0 g.tree at sandy plain (Bikaner). The analysis of *A. tortilis* gum production in different land forms showed that in rocky and sandy land form T-1 treatment has significant yield compared to other treatments. In Moringa gum exudation trials results were not found in

order. However, maximum gum exudation (522 g/tree) was found with T-1 treatment.

In case of *A. nilotica* sub sp. *cupressiformis* experiment was conducted at CAZRI, RRS, Pali during winter season. Even trees at the age of 3 were selected for each and every groups for treatment. Maximum yields (15.5 g/tree) was found in T-2 group. The T-3 group had no response during treatment.

Study on refining gum Arabic

The experiment was carried out for the household purification of *A. tortilis* gum. The gum solutions were prepared in different concentrations (1:1; 1:2 & 1:3), filtered and dried in shade. Highest recovery (94.7%) of gum was seen in 1:3 ratios of gum and solvent and drying of gum took 14 days.

The experiments were also carried out for purification of gum Arabic in cold and hot distilled water in different concentrations, filtered and dried in shade. Pooled data of gum Arabic refining indicated highest gum yield (92.4%) in room temperature distilled water for 1:3 ratios. In case of drying period, it has been almost same day with range of 13-15 days.

In case of warm water methodology, pooled data indicated that pure gum obtained ranged between 72 and 90 percent and loss was in range between 4.8 g and 15.29 g. Maximum pure gum (85%) was obtained from concentration of solvent 1:2. Gum drying duration was almost similar (12-15 days) but dissolving time gradually decreased with reduction in concentration.

Value addition of gum Arabic through convenient technology

Acacia gum is well known in arid region. The gums are collected in the form of natural ooze from trees which are then dried and stored for further use. Acacia gums are used as thickeners, emulsifiers, stabilizers in food industry. It is also used in chewy candies (Fig. 7.9a), ice-creams, beverages and other confectionary (Fig. 7.9b & 7.9c).

Particularly in arid western Rajasthan gum Arabic is used as a principle ingredient for making folk medicine during winter season. In some other cases rural folk use it in medicinal diet of lactating women.

Gum Mouth freshener (Fig. 7.9d) have been formulated by coating small pieces of Gum Arabic with flavor, colour and fragrance. Butea Gum has been utilized to develop value added product i.e. Butea Crack Healing Cream (Fig. 7.9e). Gum Mouth Freshener and Butea cream have been under trials and standardization process.

Butea cream trial batches have been prepared using the finely powdered Butea Gum from *Butea monosperma* along with base material such as petroleum wax, fragrance etc. The cream was prepared to alleviate the problems of cracked heels, ring worm and fungal infection. The standardization of method is in progress.

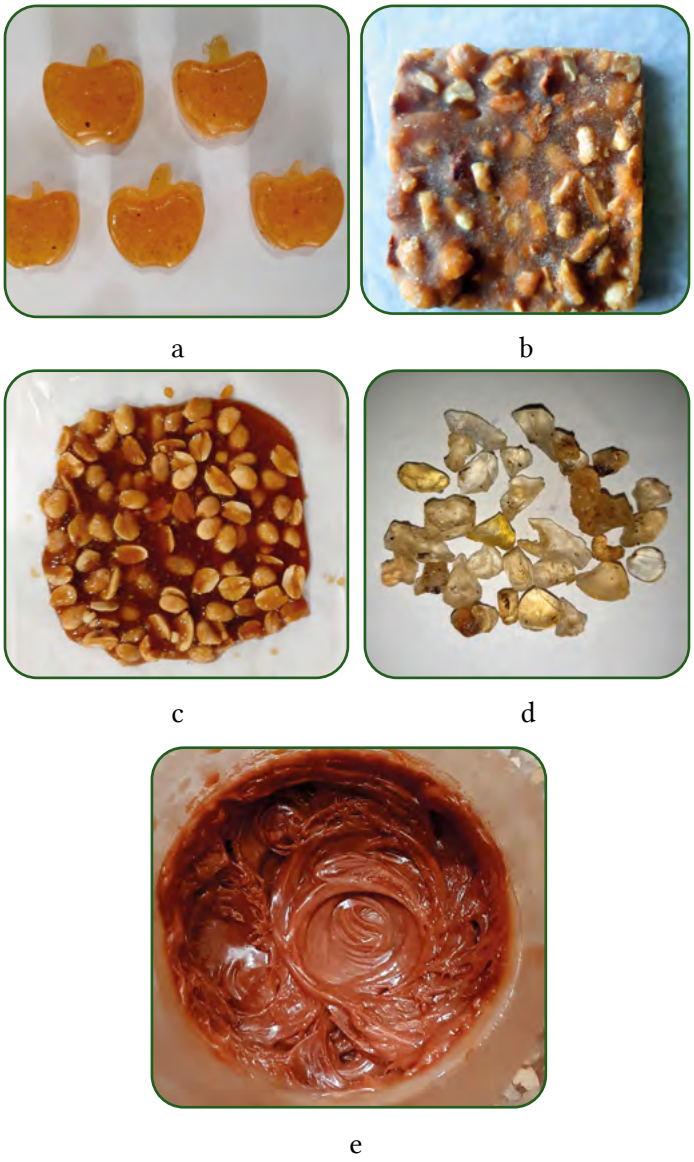


Fig. 7.9: Standardizing process technology
(a) gum candy, (b) gum-pea-nut Chikki, (c) milk gum confectionary, (d) gum Arabic based mouth freshener and (e) *Butea monosperma* gum based crack heels cream " Butea crack heals cream"

Extension of gum inducing technique in arid regions of Rajasthan

The CAZRI gum exudation technology not only spread in Western Rajasthan but also in other arid/ semi arid parts of Madhay Pradesh and Gujarat. In this connection, stakeholders from other states have also shown keen interest in CAZRI gum exudation technology. Farmers/ other stakeholders are earning good amount of revenue by sale of gum Arabic in local markets.

During the period (2018-19), 6465 trees of *A. senegal* were treated by CAZRI gum inducer, resulting in production of approximately 2.90 tons of gum Arabic. In more than 48 villages, farmers of Chauhatan and Baytu tehsils of Barmer district; Shergarh and Phalodi tehsils of Jodhpur district; and some villages of Nagaur, Jhunjanu and Pali districts adopted the gum inducer technology on large scale. This year the average rate of gum Arabic was Rs. 800/- per kg in local market. Thus, farmers registered at CAZRI, Jodhpur of said villages earned revenue of Rs. 23.20 lakhs.

Besides *A. senegal*, other gum yielding trees like *A. tortilis, A. nilotica, A. leucophloea, P. cineraria, P. juliflora, A. rotundifolia, etc.* were also treated in villages by using this technique effectively for gum production.

Training/demonstration of CAZRI gum exudation technology during 2019- 2020

On campus training

Fig. 7.10: One day *On-Campus* hand on training programme of CAZRI gum exudation technology

1. On 20th January, 2020: Five days training course for progressive farmers on "Advance in arid horticulture" sponsored by Department of Horticulture, Ahmedabad, Govt. of Gujarat from 20 to 24 January, 2020. Thirty farmers and two officers participated. (Demonstration of CAZRI gum exudation technology and nursery visit). (fig. 7.10)
2. On 24th January, 2020: One day programme for 36 officer trainees (02: Chhattisgarh, 13: Karnataka, 01: Madhya Pradesh and 20 from Odisha including 10 lady officer trainee). Both Shri Pradeep Wahule and Ms Sarita Kumari IFS were lecturers of "West tour of the officer trainees of 2018-20 SFS batch of CASFOS, Dehra dun". (Demonstration of CAZRI gum exudation technology and nursery visit). (fig. 7.11)
3. Five days training course for progressive farmers on "Current trends in production techniques of horticulture in arid region" sponsored by ATMA, Nagaur of Govt. of Rajasthan from 27th to 31st January, 2020. Thirty farmers with one officer from ATMA, Nagaur participated. Demonstration of CAZRI gum exudation technology and nursery visit was held on 29th January, 2020.

Fig. 7.11 Five days training course for progressive farmers

4. On 29th January, 2020. Demonstration of CAZRI gum exudation technology and silva and AF nursery visit of trainees from Central Academy of Forest Education, Kurseong, Darjeeling.
5. Farmer groups from Balesar and nearby area under SCSP-2020 scheme on 4th Feb., 2020 (Demonstration CAZRI gum exudation technology and nursery visit).
6. Farmer groups from village Purkhawas under SCSP-2020 scheme on 10th Feb., 2020 (Demonstration CAZRI gum exudation technology and nursery visit).
7. Farmer groups from Dantiwada area under SCSP-2020 scheme on dated 17th Feb., 2020 (Demonstration CAZRI gum exudation technology and nursery visit).

8. On 19th Feb., 2020 educational tour of under graduate students from College of Horticulture and Forestry, Jhalrapatan under University of Kota. CAZRI gum inducer technology was demonstrated to students and they were also given hands on training of the same. (fig. 7.12)

Fig. 7.12: Educational tour of under graduate students from College of Horticulture and Forestry, Jhalrapatan

Off campus training

9. One day Off campus hands on training cum farmer's interaction meeting held at tehsil, Balotra district of Barmer on 11 Feb., 2020. Farmers know about this technology and trained about technology. (fig. 7.13)

Fig. 7.13: Off- Campus hands on training at village Siyanda, Tehsils of Shergarh, Jodhpur on CAZRI gum exudation technology

Fig. 7.14: Off- Campus hands on training at tehsil, Balotra district of Barmer on CAZRI gum exudation technology

10. One Day on Off campus hands on training conducted at Village Bhuniya, Tehsil, Dhorimanna, District, Barmer on 7th March, 2020, during the training farmers were trained to treat CAZRI gum inducer. (fig. 7.14)

1.3 Project centre at ICAR-CAFRI, Jhansi

A. Growth and productivity of agroforestry models

A.1. On-farm Agroforestry models

Data on survival and growth of trees planted in various agroforestry models established at central research farm of the institute were recorded (Fig. 7.15). In agri-horti-silviculture model, maximum GBH (cm), plant height (cm) and canopy spread (m^2) were recorded in *Aegle marmelos* (bael), followed by *A. senegal* (kumat), *Citrus limon* (lemon) and *Carissa carandas* (karonda). Since, casualty replacement was done during 2018-19; maximum survival (%) was recorded in *C. carandas*, followed by *A. senegal*, *C. limon* and *A. marmelos*. Pruning of tree's crown was carried out in the month of October i.e. before sowing of winter crops. In this model, fruit yields were recorded from 14 plants of *C. limon*, 19 plants of *A. marmelos* and 16 plants of *C. carandas*. A total of 71.00 kg lemon, 70.40 kg karanda and 1018.00 kg bael fruits were harvested. The average weight of bael variety CISH B1 was 0.70 kg and variety CISH B2 was 1.40 kg. During *rabi* (2018-19) and *kharif* (2019), wheat (variety HD 2967) and moong (variety IPM 0214), respectively were cultivated as intercrops in the model. This year i.e. 2019-20 (*rabi* season), wheat (variety HD 2967) was sown. During 2018-19, natural oozing of gum (average 16.37 g/tree from 5 trees) from *A. senegal* was recorded.

In horti-silviculture model I, *Terminalia arjuna* (arjun) showed maximum survival (100%), followed by *A. senegal* and *A. nilotica* (babool). Growth parameters i.e. GBH (cm) and plant height (cm) were recorded maximum in *A. senegal*. In horti-silviculture model II, *T. arjuna* showed maximum survival (100%), followed by *A. nilotica* and *A. senegal*. Highest GBH, plant height and canopy spread were recorded in *A. nilotica*. Survival of *A. senegal* in block plantation on rocky site was found to be 100% and plants attained mean height of 479.7 cm with GBH of 23.7 cm.

In *rainfed* agri-silviculture model, wherein *A. senegal* and *A. nilotica* were planted in three different spacings; maximum survival was recorded in *A. senegal* planted in

10 m × 10 m spacing while in case of *A. nilotica,* it was recorded highest in 5 m × 5 m spacing. After seven years of plantation, higher GBH and plant height were recorded in *A. nilotica* than *A. senegal* in all spacings, barring few exceptions.

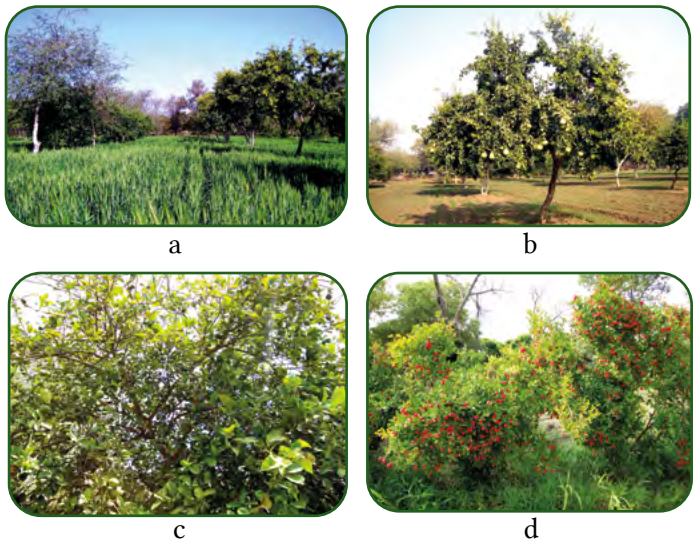


Fig. 7.15: *Acacia senegal* based agri-horti-silviculture model at research farm of ICAR-CAFRI, Jhansi including (a) Wheat, (b) *Aegle marmelos*, (c) *Citrus limon,* and (d) *Carissa carandas*

A.2. Agroforestry models at farmers' fields

After ten years of planting, *A. senegal* recorded relatively more survival (up to 59.5%) than *A. nilotica* (up to 50%) at Garhkundar watershed area. At the farm of Shri Thakur Das, among planted species, *A. nilotica* recorded higher growth as well as survival, followed by *Psidium guajava* (guava) and *C. carandas*. In this field, many plants have been damaged by mechanized operations with tractor, as the farmer did not pay attention. On the farm of Shri Himmat, maximum growth was recorded in *Emblica officinalis* (aonla); however, survival (%) was recorded comparatively higher in *A. senegal*. At the farm of Shri Ghanshyam, *A. senegal* planted during 2012 showed poor performance in terms of growth; however, survival (%) was comparatively higher than the values recorded from other two fields. At village Ambabai, 37% survival of *A. senegal* with average height of 280.5 cm and average collar diameter of 13.0 cm was recorded.

Gum garden

The survival and annual growth data of gum-yielding tree species planted in gum gardens were recorded. Survival (%) was higher in *A. senegal* than *B. monosperma* in both the gardens. The planted saplings of *B. monosperma* showed very poor performance. *A. senegal*, planted in new gum garden i.e. during 2015, attained good girth and showing relatively higher survival (%) than the seedlings planted during 2014. Out of 190 plants of *A. senegal* raised in old gum garden (2014 plantation), 31 plants yielded *gum-arabic*. Similarly, out of 268 *A. senegal* planted in new gum garden (2015 plantation), natural exudation of *gum-arabic* was observed from 23 plants.

B. Demonstration and development of gum-yielding tree-based agroforestry models

B1. At institute research farm

During rainy season of 2018, four bio-fence models were planted at institute research farm. Casualty replacement was done during rainy season of 2019 in all models. Bio-fence model-1, aiming to optimize the distance apart *A. senegal* and *C. carandas* (1.0, 1.5 and 2.0 m apart), was maintained and observation on growth and survival was recorded. After 1.5 years of planting, survival of *A. senegal* and *C. carandas* was 95.5 and 84.1%, respectively.

Bio-fence model-2 aimed to assess effectiveness of double row fence consisting of *A. senegal* as outer row and *C. carandas* as inner row on field bunds. Distance between two rows was 1.0 m and within the row, plant to plant distance was 2.0 m. Planting of both species in two rows was done in staggered manner. After 1.5 years of planting, 86.7 and 92.6% survival of *A. senegal* and *C. carandas*, respectively were observed.

Bio-fence model-3 aimed to assess the effectiveness of double row fence of *A. senegal* at different spacing. This model was planted on three sides of field boundary of a well-established *E. officinalis* orchard. Plant to plant distance was kept uniform at 1.5 m in both tree rows, while the distance between two rows varied at all three sides of the field i.e. 1.0, 1.5 and 2.0 m. Planting was done in staggered manner in two rows. After 1.5 years of planting, 90.9, 95.3 and 84.0% survival in 1.0, 1.5 and 2.0 m distance, respectively were recorded in outer row. Similarly, 100.0, 88.4 and 88.0% survival in 1.0, 1.5 and 2.0 m distance, respectively were recorded in inner row.

Bio-fence model-4 consisted of two rows of *A. senegal* (inner and outer) kept at 1.5 m apart wherein plant to plant distance was also 1.5 m. This model was planted along two sides of a well-established *Punica granatum* (pomegranate) orchard. Planting was done in staggered manner in two rows. After 1.5 years of planting, survival

of 69.6 and 44.2% were recorded from inner and outer rows, respectively.

B2. At farmers' fields

During rainy season of 2019, more than 22000 seedlings of *A. senegal* were raised in nursery at ICAR-CAFRI, Jhansi, and provided on payment basis for planting in seven districts (Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakut) of Bundelkhand, Uttar Pradesh under the scheme of Doubling Farmers' Income. At each site, 4-5 farmers were identified for developing horticulture/agri-horticulture/agri-horti-silviculture model under the Doubling Farmers' Income project of Government of Uttar Pradesh in collaboration with ICRISAT, Hyderabad and ICAR-CAFRI, Jhansi. *A. senegal* has been planted on field boundaries, as it acts as bio-fence. The survival (%) of *A. senegal* planted on different farmers' field could not be assessed.

Survival (%) of seedlings planted in various villages/sites during rainy season of 2018 was recorded, which varied from 44.6 (Garhkundar) to 72.7% (Indragarh) in *A. senegal*, from 33.9 (Parasai) to 60.0% (Dhikoli) in *C. carandas*, from 37.7 (Parasai) to 54.0% (Binwara) in *C. limon*, from 35.0 (Garhkundar) to 40.0% (Dhikoli) in *D. strictus*, and 64.0% in *P. guajava*.

Observation on survival (%) of *A. senegal* along with *C. limon*, *P. guajava* and *P. granatum*, planted in the field of 14 farmers of village Parasai during 2017, was also recorded which varied from 55.1 to 88.0% in *A. senegal*, from 35.0 to 78.0% in *C. limon*, and from 40.0 to 67.3% in *P. guajava*. Out of 22 plants of *P. granatum* planted in the field of Shri Komal Singh, only 9 plants are surviving (40.9% survival).

C. Studies on biomass and carbon stock in *Acacia senegal* and *Acacia nilotica*

Studies on estimation of above-ground biomass (AGB; kg/tree) and below-ground biomass (BGB; kg/tree), and carbon (C) stock (tonnes/ha) and C sequestration rate (tonnes/ha/year) of *A. senegal* and *A. nilotica* planted in *rainfed* agri-silviculture model was carried out. This model comprising of *A. senegal* and *A. nilotica* planted in three spacing *viz*., 10 m × 10 m (100 trees/ha), 10 m × 5 m (200 trees/ha) and 5 m × 5 m (400 trees/ha) was established during July, 2013 at ICAR-CAFRI research farm. Annual data on growth i.e. plant height (cm) and DBH (cm) are being recorded since its plantation. They were used to calculate the AGB, BGB, C stock and C sequestration rate. The allometric equation ($Y=0.904(DBH)^{1.760}$) developed by ICAR-CAFRI, Jhansi for *A. nilotica* was used to compute AGB; however, for *A. senegal*, no equation was found for our region. Hence, considering the growth habit and characteristics of both the plant species, the same equation ($Y=0.904(DBH)^{1.760}$) was also used for *A. senegal*. With regard to BGB, a factor of 0.26 of the AGB was used to estimate the BGB. Total biomass (TB = AGB+BGB) was used to calculate C stock (tonnes/ha). The C stock was estimated as 47.5% of TB which was further used for calculating C sequestration rate (tonnes/ha/year).

Study recorded maximum AGB, BGB and TB in *A. senegal* and *A. nilotica* planted in 5 m × 5 m, followed by 10 m × 5 m and 10 m × 10 m spacing throughout the study period, barring few exceptions. The TB varied from 1259 to 4475 kg/ha after three years, from 2045 to 7228 kg/ha after four years, 3256 to 10333 kg/ha after five years, 4766 to 14927 kg/ha after six years and 7002 to 20760 kg/ha after seven years of planting of *A. senegal* in various spacing regimes. Similarly, for *A. nilotica*, it varied from 1484 to 8180 kg/ha after three years, 2067 to 14242 kg/ha after four years, 3393 to 14927 kg/ha after five years, 6263 to 20627 kg/ha after six years and 6591 to 24766 kg/ha after seven years of planting in different spacing. Comparatively higher AGB, BGB and TB were recorded in *A. nilotica* when compared with *A. senegal*, irrespective of planting spacing. Per cent annual increment in TB of *A. senegal* was recorded in following manner: 75% (4^{th} year), 32% (5^{th} year), 56. (6^{th} year) and 35% (7^{th} year). Similarly, in *A. nilotica*, the per cent increase in TB was 69% (4^{th} year), 10% (5^{th} year), 52% (6^{th} year) and 18% (7^{th} year).

Among spacing regimes, maximum C stock was recorded in 5 m × 5 m, followed by 10 m × 5 m and 10 m × 10 m in both the plant species during entire study. The average estimated C stock in *A. senegal* was 1.13 (3^{rd} year), 1.99 (4^{th} year), 2.63 (5^{th} year), 4.11 (6^{th} year) and 5.56 tonnes/ha (6^{th} year) irrespective of planting spacing. Similarly, the average estimated C stock in *A. nilotica* was 1.98, 3.35, 3.68, 5.60 and 6.58 tonnes/ha during 3^{rd}, 4^{th}, 5^{th}, 6^{th} and 7^{th} years, respectively. Increase in C stock in *A. senegal* and *A. nilotica* with increase in their age was recorded. Comparatively, higher C stock was recorded in *A. nilotica* than *A. senegal*.

Maximum rate of C sequestration (tonnes/ha/year) was recorded in 5 m × 5 m, followed by 10 m × 5 m and 10

m × 10 m spacing in both the plant species every year, barring few exceptions. The average estimated rate of C sequestration in *A. senegal* was found in respective order as 0.38, 0.50, 0.53, 0.69 and 0.79 tonnes/ha/year during 3rd, 4th, 5th, 6th and 7th years, respectively irrespective of planting spacing. Similarly, the average estimated rate of C sequestration in *A. nilotica* was 0.66, 0.84, 0.74, 0.93 and 0.94 tonnes/ha/year during 3rd, 4th, 5th, 6th and 7th years, respectively. Increase in the rate of C sequestration with increase in the age of both plant species was recorded, barring few exceptions. Relatively higher rate of C sequestration rate was noticed in *A. nilotica* than *A. senegal.*

D. Economic analysis of an agri-horti-silviculture model

Economic analysis of a ten years old agri-horti-silviculture model was done on the basis of the opportunity costs of different inputs.

The total expenditure incurred during 1st year was Rs. 42280/ha which declined during 2nd year (Rs. 25863/ha). Comparatively, higher input cost during 1st year was due to establishment cost of the model (Rs. 10950/ha). Total expenditure included only maintenance cost of the model as well as cost of cultivation of intercrops 2nd year onwards. During subsequent years, increase in the cost of cultivation or working capital, owing to inflation on year to year basis, with increase in the age of the model was noticed. During entire study, the maintenance cost of the model varied from Rs. 1380 to 1980/ha/year, and cost of cultivation of intercrops from Rs. 21463 to 59125/ha/year. This variation was due to the type of crops grown and variation in cost of their cultivation. The returns from intercrops varied from Rs. 18800 to 101232/ha/year during a period of ten years, and this variation was due to the success or poor yield or failure of crop particularly in summer season. Study also showed that out of ten seasons, summer crops either failed or performed poorly during five seasons (2012-13 to 2016-17) that affected value of total returns from the model. The returns from trees/woody components varied from Rs. 96 to 26052/ha/year. Thus, results signify that total returns from the model depend on the success of intercrops and yield from woody perennial components which varied from Rs. 21532 to 127284/ha/year. During 1st year, the annual B: C ratio was 0.74 implying that there was net loss against investment in the model, and this was due to inclusion of establishment cost of the model. In 2nd year also the annual B: C ratio remained less than 1.0, and during 3rd to 5th year, it remained almost static around 1.0; thereafter, it increased considerably and reached up to 2.15 in 10th year.

1.4 Project on guar gum at VNMKV, Parbhani

Preparation of high quality protein rich biscuits using detoxified guar meal

Detoxification of anti-nutritional factors such as trypsin inhibitor and phytic acid were done by autoclaving the guar meal at 121°C for 15 min. Microbial study of biscuits prepared using wheat flour and guar meal flour mix (Fig. 7.16) revealed that the microbial counts (TPC and YMC) were within the acceptable range and biscuits made were safe to consume. The estimation of cost of production was done by using standard calculation method i.e. by considering the raw material cost, processing and packaging cost (at 30% of raw material cost). The total raw material cost for production of 1 kg biscuit was Rs. 34.63/-. The processing and packaging cost which was applied at the rate of 30 per cent of raw material cost was found to be Rs. 10.38/-. Hence, the total production cost of 1 kg of biscuit was Rs. 45.01/-.

Fig. 7.16: Biscuits prepared using wheat flour and guar meal flour mix

Utilization of guar hull and its value addition

Nutritional and sensory qualities of biscuit were improved with supplementation of guar meal flour; showing that wheat flour and guar meal flour mixes had higher protein content than the whole wheat flour alone. Sensory analysis showed high acceptability for the biscuits up to 10% substitution of guar meal. The guar meal flour fortified biscuits can be stored at ambient temperature up to 6 months. The use of guar meal flour this way would improve on the utilization of guar meal as well as the quality of biscuit for growing children. 3% guar seed hull incorporated cookies (Fig. 7.17) were found to be overall acceptable which caused significant increase in fiber and minerals.

Fig. 7.17: Biscuits prepared using wheat flour and guar seed hull mix

Modification of native guar gum by enzymatic method and its utilization in pizza sauce

To increase the commercial potential of guar gum it was hydrolyzed by enzyme, the hydrolyzed guar gum thus obtained showed a remarkable decrease in viscosity and swelling behavior. Its solubility was significantly improved. Enzymatic hydrolysis reduced viscosity of guar gum via molecular weight and chain length reduction. Depolymerized guar gum is a source of fiber, used in development of nutraceuticals and functional foods. It was concluded that PHGG (Partially hydrolyzed guar gum), thus obtained had low viscosity and it was water soluble with many physiological health benefits. Proximate analysis of PHGG indicated that it had high amount of fiber.

Pizza sauce containing 7% PHGG was prepared (Fig. 7.18). Sensory analysis of pizza sauce revealed that, sauce containing 7% PHGG had high overall acceptability. Also storage studies had shown that the pizza sauce was self-stable for a period of 56 days when stored at ambient temperature and also it was found to be microbially safe. Incorporation of PHGG in sauce had resulted in significant increase in fiber, also it had not affected the acceptability of the product. Thus it can be concluded that 7% PHGG can be added in pizza sauce as a thickener which will provide benefit of fiber.

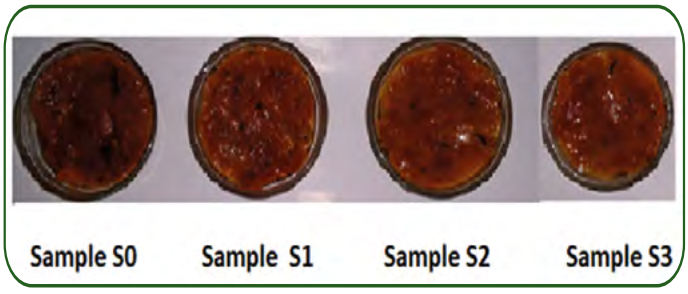


Fig. 7.18: Pizza sauce prepared using Partially hydrolyzed guar gum

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

Standardization of borehole height for oleoresin tapping in *Pinus roxburghii* Sargent

Experiments were carried out to study effect of borehole height on oleoresin yield (Fig. 7.19). The highest oleoresin yield in Nauni Campus (3,900.89 g/season) was recorded at borehole made at a height of 150 cm (H3) and in Bhota, the highest oleoresin yield of 1,923.34 g/season was also recorded at borehole made at a height of 150 cm (H3). The maximum oleoresin yield was obtained from the diameter class >60 cm from both Nauni Campus and Bhota (Hamirpur). The highest oleoresin yield was obtained from the borehole drilled in the month of May and June at Nauni Campus (UHF) and Bhota (Hamirpur), respectively. In Rill method, the highest oleoresin yield (6.73 kg/season) was recorded in diameter class of >55 cm (D6) and lowest (5.18 kg/season) was observed in diameter class 30-35 cm (D2).

a b

Fig. 7.19: Boreholes at Different Heights viz., (a) 50 cm, and (b) 100 cm

Trainings organized

One-day training-cum-demonstration on borehole method of oleoresin tapping at Dr YS Parmar University of Horticulture and Forestry, Nauni – Solan to the officers/ stakeholders and contractors of Himachal Pradesh State Forest Corporation Ltd on 20th January-2020 in which 35 trainees participated.

Identification and evaluation of high resin yielders of *Pinus roxburghii* Sargent from different sites in Himachal Pradesh

The maximum oleoresin yield (449.73 g/season) was recorded in 37 Kopra P-5. The maximum percentage of

turpentine (21.30%) was recorded at Nauni (Main Campus) whereas the highest (80.08%) rosin per cent was found at Nauni (Progeny).

Effect of wood characteristics on oleoresin yield

The maximum specific gravity, tracheid length and resin ducts per mm^2 were noticed in HRY 134, HRY 145 and HRY 24, respectively. The maximum and cold water soluble extractives, hot water soluble extractives and alcohol benzene soluble extractives were observed LRY 68, P8 and MRY 54, respectively. The maximum holocellulose and minimum lignin content was noticed in HRY 8 and HRY 150, respectively. The oleoresin yield exhibited positive significant correlation coefficient with specific gravity (0.909), tracheid length (0.882) and resin ducts (0.987). The oleoresin yield exhibited positive significant correlation with holocellulose content (0.561) and strongly negatively correlated with lignin content (-0.584).

Demonstration of borehole technology of oleoresin tapping

The borehole method of oleo-resin tapping was demonstrated to the Forest Guards and Range Forest Officers, ACFs and DFOs trainees of State Forest Department of Himachal Pradesh and also from other states.

1.6 Project on Babul Gum at IGKVV, Raipur

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

In *dhawra*, particularly in summer the quantity of gum exudation increased with increase in concentration of ethephon during in April to October. When plant was treated in the month of Oct. with low concentration of ethephon (@ 3.90%), treatment was significantly effective for higher production of gum obtained in Nov. 2018. Whereas in winter season combined effect of higher level of ethephon @5.5 + H_2SO_4 10% (4 ml) was quite effective to induce the maximum quantity of gum over traditional and other gum enhancer (from Dec.to Jan). From the plant treated in the month of February, the maximum exudation was obtained with application of ethephon @ 4.8%. As compared to mechanical and traditional methods of tapping, use of gum enhancer (Fig. 7.20, 7.21 and 7.22) was found better in terms of gum production.

Fig. 7.20: Manual drilling in *dhawara* plant

Fig. 7.21: Injecting chemical and seal the hole with mud

Fig. 7.22: Gum exudation from *Dhawra* plant

Development of tapping techniques for sustainable extraction of biopolymer in Rohini (*Soymida febrifuga* Roxb.), Chironji (*Buchanania lanzan Spreng*) and Saja (*Terminalia tomentosa* Roxb.)

Rohini (*Soymida febrifuga*): As compared to mechanical or traditional method of tapping, use of gum inducer was found to be significantly effective in gum production in Rohini. The quantity of gum exudates in gum inducer method at half DBH (50 cm) was significantly lower than obtained at 1 DBH. Higher concentration of ethephon @5% was quite effective when applied in single place of tree as compare to three places.

Saja (*Terminalia tomentosa*): No exudation was seen in Saja in mechanical method of tapping gum in month of March to June. Use of gum inducer was found to be effective when applied in lower concentration @ 3.9% ethephon at single place using hand *girmit* for making hole. As compared to 4 mm, 10 mm diameter was better for gum exudation in all the experimental trees. Hand *girmit* was quite effective for making hole.

Chironji (*Buchanania lanzan*): The use of ethephon is significantly effective to induce gum production in Chironji during April to June and as compared to mechanical and traditional method of tapping. Mechanical and traditional methods of tapping were not effective for the production of Chironji gum. The higher concentration of gum inducer @5.5% ethephon was significantly superior for the production of Chironji gum in the month of June as compared to other gum inducer, mechanical and traditional methods**.** Thus, the appropriate time of tapping in Chironji is June. Methionine, Jasmonic acid, Maleic Hydrazide and NAA were not effective as gum inducer in Chironji. Winter tapping can be enhanced by using H_2SO_4 @ 10%

Rheological studies on different gums

The viscosity of gum increases with the increased in the concentration (5 to 10%) in all the gum samples (*A. latifolia, A. nilotica* and Nigerian gum). In all the three gums (*Babool, Dhawra* & Nigerian) viscosity (cP) of solutions increased with the increase in the shear rate (ɣ) but variation in viscosity with shear rate was very less i.e. nearly constant and exhibited a Newtonian behaviour. In all the three gums, viscosity (cP) of solutions decreased with the increase in the temperature for all the solution concentrations. In karaya gum, viscosity decreased with the increase in shear rate and exhibited pseudoplastic (shear thinning) behaviour. Karaya gum has higher capacity to form viscous solutions and gels at low concentration as compared to *A. senegal, A. latifolia, A. nilotica* gums.

Studies on extraction of gum from Charota (*Cassia tora*) seeds and its characterization

The value to bulk, tapped and true density of *C. tora* seed (Fig. 7.23) was found to be 0.87±0.03 g/ml, 0.89±0.012 g/ml and 1.3±0.143 g/ml, respectively. The porosity of *C. tora* seed was found to range from 15.21 to 41.25%. The geometric mean dimensions (GMD) were in ranges between 2.86 and 6.88 with mean value of 4.56±1.10 mm. The length, width and thickness of *C. tora* seed were found to be 4.43±0.59 mm, 2.21±0.44 mm and 2.11±0.42 mm, respectively.

Fig. 7.23: Seeds of *Cassia tora*

The value of sphericity of *C. tora* seed was obtained as 61.93±7.37. The test weight and volume (1000 kernel weight and volume) were 13.794 g and 14 ml, respectively. The color of *C. tora* seed was found brown. The endosperm and husk & germ obtained from per 100 g sample of *C. tora* seed roasted at temperature between 100 °C and 140 °C were 29.74±3.30 g and 64.41±2.91 g, respectively. The endosperm and husk & germ obtained from 100 g sample of *C. tora* seed roasted at temperature between 150 °C to 200 °C were found to be 29.34±2.87 g and 7.52±2.94 g, respectively.

Development of scientific harvesting and collection of *palas* (*Butea monosperma)* gum / *kamarkas*

The research work on scientific tapping and collection of *palas* (*Butea monosperma*) gum is continued. The major problem faced during last year was the high flow rate and less viscosity of exudation. Therefore, the gum was slicked on tree bark and was difficult to separate out in chemical method of using gum inducer.

Training and Demonstration Activities

Eight training programmes (Table 7.1) were organized during the year at different places (Fig. 7.24) and on following topic trainings were imparted to farmers.

Topic covered during trainings

- Scope of gum harvesting/tapping in the region
- Different chemical tapping methods used in gum harvesting

- ❖ Different mechanical tapping methods used in gum harvesting
- ❖ Field visit and demonstration of tapping methods on plant

Table 7.1: Detail of training programmes organized

S. No.	Place	Date	Duration	Participants
1	Krishi Vigyan Kendra, Dhamtari	Feb 22, 2020	1	39
2	College of Agriculture & RS, Saja, Bemetara	Feb 22, 2020	1	36
3	Krishi Vigyan Kendra, Kabirdham	Feb 22, 2020	1	41
4	Krishi Vigyan Kendra, Ambikapur	March 03, 2020	1	34
5	Krishi Vigyan Kendra, Mainpat	March 04, 2020	1	70
6	Krishi Vigyan Kendra, Jashpur	March 05, 2020	1	40
7	Krishi Vigyan Kendra, Korea	March 06, 2020	1	38
8	Krishi Vigyan Kendra, Mahasamund	March 16, 2020	1	26

Fig. 7.24: Photos of training programmes organized at different KVKs in Chattishgarh on scientific method of gum tapping

1.7 Project on guggul at JNKVV, Jabalpur

Physio-chemical analysis of *guggul* gum in storage

Fresh *guggul* sample was analyzed for CHNS contents and it had N (3.75%), C (59.54%), H (12.84%) and S (0.88%). *Guggul* samples stored in different packing/ containers (Fig. 7.25 & 7.26) were evaluated for their physio-chemical properties. Twenty four months after the storage, samples stored in the Jute bags had highest N (2.34%) and H (9.04%). The decline was 1.25, 1.56 and 0.75 percent respectively. Sulphur content was highest (0.13%) in the *guggul* samples in Earthen pots and lowest (0.001%) in Jute bags. The decline was 6.38 and 0.079 percent, respectively. The data obtained after FT-IR analysis also revealed the superiority of earthen pots as a storage container among all storage containers used in the present study. Irrespective of the storage containers, the duration of storage results in qualitative loss of active groups in *guggul*.

Shelf life study of Jawahar *Guggul* laddu

Shelf life of Jawahar *Guggul* Laddu (JGL) (Fig. 7.27) was analyzed for its 13 below mentioned qualitative parameters (Table 7.2). Fresh sample of JGL was compared with those stored in room temperature for 30 and 60 days in the laboratory. The analysis was done in the NABL

accredited laboratory in Jabalpur. Fresh JGL had calorific value of 482.23 K cal/100g. After 30 days and 60 days a reduction of 1.73 and 5.44 percent, observed respectively. Similarly, the total carbohydrate content reduced by 14.15 and 28.3 percent, respectively. The loss of fat (6.46%) and protein (7.5%) was less after 30 days over than in fresh JGL but more loss by 23.1 and 24.17 percent, respectively after 60 days. Rapid loss of minerals was observed during storage.

Fig. 7.25: Packing/containers used to store fresh *guggul* gum

Fig. 7.26: Earthen pots of different thicknesses used to store fresh *guggul* gum

Fig. 7.27: Jawahar *Guggul* Laddu

Table 7.2: Nutritional analysis of fresh Jawahar Guggul Laddu (100 g)

S. No.	Parameter	Method	Fresh	30 days	60 days
1	Calorific value	By calculation	484.23 K cal/100g	480.74 K cal/100g	462.77 K cal/100g
2	Total Carbohydrate	By calculation	58.23 g/100g	50.05 g/100g	41.76 g/100g
3	Moisture	IS IS 1155:1968 RA 2010	9.10 g/100g	8.03 g/100g	7.02 g/100g
4	Fat	IS12711:1989 RA 2010	25.87 g/100g	24.46 g/100g	20.16 g/100g
5	Protein (N X 5.70)	IS 7219:1973 RA 2010	4.62 g/100g	4.32 g/100g	3.55 g/100g
6	Crude Fibre	IS IS 1155:1968 RA 2010	9.45 g/100g	7.38 g/100g	7.11 g/100g
7	Total Ash	IS IS 1155:1968 RA 2010	2.18 g/100g	2.06 g/100g	1.88 g/100g
8	Calcium	IS 3025 (P40):1991 RA 2014	36.43 mg/L	26.44 mg/L	26.19 mg/L
9	Magnesium	IS 3025 (P46):1994 RA 2014	2.68 mg/L	2.13 mg/L	2.04 mg/L
10	Iron	IS 3025 (P53):2003 RA 2014	0.08 mg/L	0.07 mg/L	0.04 mg/L
11	Phosphorus	IS 3025 (P31):1988 RA 2003 (2017)	11.00 mg/L	9.03 mg/L	8.98 mg/L
12	Sodium	IS 3025 (P45):2003	18.2 mg/L	14.2 mg/L	12.24 mg/L
13	Potassium	IS 3025 (P45):2003	118.1 mg/L	109.8 mg/L	101.3 mg/L

1.8 Project on Tamarind Seed Gum at TNAU, Coimbatore

Flower and fruiting in florigen applied tamarind germplasm_

In 5 tamarind germplasm planted, Hasanur 06 sprayed with foliar application of cycocel (Fig. 7.28) with 1000 ppm concentrations which has showed maximum flowering in tamarind (Fig. 7.29). In Hasanur 09 and PKM 01, the tamarind fruiting was recorded.

Fig. 7.28: Spraying of florigen (growth regulator) in different tamarind germplasm

Fig. 7.29: Flowering in different tamarind germplasm

Value addition of tamarind seed gum for edible purpose

The value added edible products namely biscuits (Fig. 7.30) and tea cake (Fig. 7.31) were prepared by blending 10 per cent tamarind kernel powder. The sensory analysis was carried out and observed that the TKP blended biscuits was overall accepted by customers in all sensory characters (Appearance, colour, texture, aroma and taste). Whereas, the TKP blended tea cake is accepted for its appearance and aroma and the remaining sensory character namely texture, taste and color need to be improved.

Fig. 7.30: Biscuits (10% TKP blended)

Fig. 7.31: Cup cake (10% TKP blended)

Entomological studies on tamarind pod and seed storage

Laboratory experiments were conducted to test the efficacy of leaf extracts of selected tree species on storage pests of tamarind seeds namely tamarind seed weevil (*Sitophilus linearis*) (Fig. 7.32, 7.33 & 7.34) at Forest College and Research Institute, Mettupalayam. The results of the studies are summarized hereunder.

Ethanol extracts of *Strychnos nux-vomica* 10,000 ppm @ 1 per cent registered cent per cent cumulative mortality of tamarind seed weevil at 7 days after treatment (DAT) followed by ethanol extract of 10,000 ppm *Cleistanthus collinus* (98.33) and *Vitex negundo* (95.00) @ 1 per cent concentration. Methanol extract of *C. collinus* 10,000 ppm @ 1 per cent concentration registered cent per cent cumulative mortality of tamarind seed weevil at 7 DAT. At 14 DAT, all the tree leaf extracts (10,000 ppm) @ 1 per cent registered cent per cent cumulative mortality of tamarind seed weevil.

Fig. 7.32: Tamarind seed weevil (*Sitophilus linearis*)

Fig. 7.33: Tamarind seed weevil infested on seed

Fig. 7.34: Tamarind seed weevil infested on decorticated seeds (endosperm)

Hexane extracts of *S. nux-vomica* and *C. collinus* 10,000 ppm @ 1 per cent concentration registered cent per cent cumulative mortality of tamarind seed weevil at 7 DAT. Extracts of *V. negundo* (93.33) and *Ailanthus excelsa* (91.67) (10,000 ppm) @ 1 per cent level were next in the order of efficacy. Leaf powder of *C. collinus* @ 1 per cent level registered cent per cent cumulative mortality of tamarind seed weevil even at 7 DAT, followed by *S. nux-vomica* (96.67) and *V. negundo* (93.33) powders @ 1 per cent concentration.

Ethanol extracts of *S. nux-vomica* and *C. collinus* 10,000 ppm @ 1 per cent concentration were recorded to be superior with more than 95 per cent mortality of tamarind bruchid even at 5 DAT. At 7 DAT, ethanol extracts of *S. nux-vomica, C. collinus* and *V. negundo* (10,000 ppm) @ 1 per cent concentration registered cent per cent cumulative mortality. Methanol extracts of *C. collinus* and *S. nux-vomica* 10,000 ppm @ 1 per cent concentration recorded superiority with 96.67 per cent and 95.00 per cent cumulative mortality of tamarind bruchid, respectively even at 5 DAT. While, at 7 DAT, *C. collinus* and *V. negundo* extracts (10,000 ppm) @ 1 per cent level registered cent per cent cumulative mortality.

Hexane extract of *C. collinus* 10,000 ppm @ 1 per cent concentration recorded cent per cent mortality of tamarind bruchid even at 3 DAT. At 5 DAT, hexane extract of *S. nux-vomica* (10,000 ppm) @ 1 per cent level registered 98.33 per cent cumulative mortality. While, at 7 DAT, hexane extracts of *S. nux-vomica, C. collinus,*

Melia dubia and *V. negundo* (10,000 ppm) @ 1 per cent concentration registered cent per cent cumulative mortality of tamarind bruchid. Leaf powder *S. nux-vomica* @ 1 per cent concentration registered cent per cent cumulative mortality of tamarind bruchid at 7 DAT. Cent per cent cumulative mortality of tamarind bruchid was recorded in all the tree leaf powder treatments @ 1 per cent concentration at 14 DAT. Cumulative mortality of tamarind seed weevil and groundnut bruchid were recorded as cent per cent in all the three tree leaf extracts *viz*., ethanol, methanol and hexane (10,000 ppm) and leaf powders @ 1 per cent concentration at 14 DAT.

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

Azadirachta indica trees of 60-90 cm diameter class were found to be superior over other diameter class in terms of gum production. Minimum gum production was observed in 30-60 cm diameter class trees. The gum booster dosage of 400mg/ml of ethephon concentration was found to be significantly improved the gum yield over other levels. The treatment 400 mg/ml of ethephon concentration was found to be significantly superior over other levels in *Lannea coromandelica*, *Vachellia nilotica, Pterocarpus marsupium* and *Acacia leucophloea.*

Augmenting existing tamarind germplasm

During April 2019 – March 2020, 4 new tamarind germplasm (Urigam, Red tamarind 1, Red tamarind 2, Red tamarind 3 and Red tamarind 4) was collected and planted in tamarind gum garden. In already established tamarind germplasm, the varieties namely Hasanur 06, Hasanur 09, PKM 01, Javathu Hills and Amirthi 1 had shown the maximum biometric attributes.

Assemblage of gum yielding tree species of regional importance

Gum yielding tree species of regional importance have been planted in the gum garden developed in the research farm (Fig. 7.35 & 7.36). *Acrocarpus fraxinifolius, Vachellia nilotica* and *Pterocarpus marsupium* were found superior in biometric observation. The tree species planted during the current year (April, 2019 – March, 2020) was *Prosopis cineraria, Acacia ferruginea, Acacia senegal, Lannea coromandelica, Vachellia nilotica, Anogeissus pendula, Azadirachta indica, Flemingia semialata* and *Butea monosperma.*

Fig. 7.35: Experimental site of gum yielding trees

Fig. 7.36: *Acrocarpus fraxinifolius* and *Vachellia nilotica* plants in experimental plot

1.9 Project on natural dammars at KAU, Thrissur

Preparation of black dammar dhoop sticks

Dhoop sticks were prepared from black dammar powder (Fig. 7.37). In dhoop stick preparation, finely powdered black dammar (75 g) was mixed with premix powder (75 g) and 85 ml of water was added to this mixture. It was thoroughly mixed by hand and made into more pasty. Added 5-10 ml vegetable oil to this paste (coconut oil or gingelly oil) and repeated the mixing. Different molds (Fig. 7.38) were used to prepare the dhoop. Pellet type mold was prepared with an average length of 2.5 cm. and 0.5 cm diameter. The size of the dhoop stick is very important as the diameter increases, it becomes very difficult to burn and produce smoke. The cone shaped molds were used for making cone shaped dhoop stick.

Viscosity studies on dammar

The viscosity of black dammar was measured by using Brookfield viscometer at 5 rpm per minute by using spindle number 62 and viscosity values ranged from 560-687 cps at room temperature. Similarly, white dammar viscosity ranges from 323-900 cps at the speed of 5 rpm and in spindle number 62 at room temperature.

Fig. 7.37: Black dammar dhoop sticks prepared from paper mold and mild steel mold

Fig. 7.38: Cone shaped dhoop mold prepared from mild steel

Design and fabrication of Manual type agarbatti making machine

A manual type agarbatti making machine was designed with the support of Agricultural engineering college, Thavanoor, KAU. Now they have started fabricating a low cost manual type agarbatti making machine. This is mostly designed for the tribals who are residing in the settlements wherein electricity connection is a major issue.

Effect of ethephon on gum oleoresin yield in *Ailanthus triphysa*

The effect of ethephon on gum-oleo resin production in ailanthus was studied and it is noticed that inject method was found to be best method as it yielded maximum resin than that in brush method. It was also observed that the post monsoon period is the best season for resin extraction. Value addition experiments of ailanthus resin is in progress and it is planned to produce cost effective and non-hazardous adhesives from this resin.

Extension activities under network project

College of Forestry had conducted several extension programmes on sustainable harvesting and value addition of black dammar including black dammar incense sticks making at different tribal settlements of Kerala. Tribals were also imparted training on scientific harvesting of dammars and agarbati making. The centre had started an Agarbatti making unit in the main campus, where tribals were brought from different settlements and trained in incense stick production by manual and mechanical ways. Now the agarbatti making unit in the centre has been elevated to *Agarbatti Production and Training centre.* Besides theses training programmes, black dammar incense sticks were produced in the unit and sold through various outlets of KAU. Now more than thousand black dammar incense sticks packets were sold through these outlets and as a mosquito repellent, it has become more popular among common people.

- One day training programme on sustainable harvesting of Black dammar and Incense stick making at Attapady, Mannarkkad forest division was conducted on Nov. 21, 2019 in which 30 participants attended (Fig. 7.39).

Fig. 7.39: Training on sustainable harvesting and value addition of Black dammar at Attapady

- One day training programme on Black dammar Incense stick making at Vellikulnagara, Chalakudy forest division on March 8, 2020 in which 50 participants attended (Fig. 7.40)
- One day training programme on Black dammar Incense stick making at Randukai, Chalakudy forest division on March 10, 2020 in which 40 participants attended (Fig. 7.41).

Fig. 7.40: Training on sustainable harvesting and value addition of Black dammar at Vellikulangara

Fig. 7.41: Training on sustainable harvesting and value addition of Black dammar at Randukai, Chalakudy

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

Standardization of resin tapping technique in *Pinus kesiya* for sustainability and conservation of natural resources

Borehole method was used for resin tapping in *Pinus kesiya*. In this method holes of 2.5 cm in diameter were drilled to a depth of 10 cm depth. The holes were drilled with slight slope towards opening to allow the flow of oleoresin. Three bole-holes were made around the tree circumference. Chemical spray of 1:1 mixture of 10 percent 2-chloroethyl-phosphonic acid (CEPA commercially known as Ethephon) and 20 percent sulphuric acid were applied inside boreholes with spray bottle. Spout was used to connect boreholes with polythene bags. Polythene bags were attached to the spout with the help of tie for collection of oleoresin and replaced when filled with oleoresin during the period of tapping. It was a closed system having the advantages of capturing volatile monoterpenes and prevents premature solidification of the resin acid.

Resin tapping from *Pinus kesiya* trees of three different diameter classes from one provenance i.e. Nongstoin from West Khasi Hills District of Meghalaya revealed effect of season on resin yield. Among the 30-35cm diameter class trees, mean total resin yield varied from 89.45 gm to 354.13 in the ascending order i August > October > September > November. The percentage of oil was found in the order of ascending order of August > November > October > September. Among the trees of diameter class 35-40cm, the mean yield of total resin was found to be highest in the month of September with 340.46 g and lowest in the November with 244.53 g. The oil percentage extracted from the resin showed that highest oil percentage was found in the month of September and lowest in August with the 28.27%. In the trees of > 40cm diameter class, the total resin extracted was found highest during the month of November (458.89 g) followed by September (453.31 g), October (364.32 g) and August (191.56 g). The percentage of oil extracted from resin was highest (37.3%) during November and lowest in August (24.89%) respectively

Assessment on effect of tapping on yield in different provenances in Meghalaya:

Resins were extracted from six provenances in four districts of Meghalaya namely East Khasi Hills, West Khasi Hills, Jaintia Hills and Ri-Bhoi districts. The bore hole method was followed for tapping the resins for one month (September 2019) for all the provenances. The yield of pine resin, rosin and turpentine from different provenances was recorded. Among the provenances in 30-35 cm diameter class trees, the mean yield of resin varied from 45.19 to 167.06 g per tree whereas in 35-40cm diameter class, the highest resin yield was observed in trees from ICAR-NEH farm (Ri-Bhoi district) with 165.66 g per tree and lowest in Kyrdem provenance at 50.39 g. In the diameter class of >40cm, the resin yield was highest in ICAR-NEH farm and lowest in Kyrdem.

The oleoresin was distilled through steam distillation process to separate turpentine oil and rosin from the

oleo-rosin. The percentage of oil was found highest in provenance NEHU & NEPA in 30-35cm girth class, Nongstoin in 35-40 cm class and Shangpung in > 40cm diameter class category of trees respectively. The lowest percentage of oil was detected from provenances of Kyrdem in 30-35cm diameter class, ICAR_NEH farm in 35-40 cm class and Kyrdem in > 40cm diameter class category of trees respectively

The resin yield in six provenances indicated that the yield is increasing along the altitudes. Effect of seasons (Month-wise) revealed that resin yield is variable among the trees. Nevertheless, it is observed that there is increase in resin yield in the trees of diameter class more than 40cm diameter. Resin yield was higher in November followed by September-October months.

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Network Project on Conservation of Lac Insect Genetic Resources

I. Lead Centre: Indian Institute of Natural Resins and Gums (IINRG), Ranchi

Evaluation of lac insects on grafted *semialata* for host suitability

Three lac hosts *viz.* Grafted, (*F. semialata* on *F. macrophylla*), *F. semialata* and *F. macrophylla* were evaluated for host suitability during summer season (*Jethwi*) crop of *Kusmi* and rainy season (*Katki)* crop of *Rangeeni* lac crop 2020. Average initial density of settlement was more in *F. semialata* (47/cm^2) followed by Grafted plant (44/cm^2) and *F. macrophylla* (43/cm2) during *jethwi* crop but, the average initial mortality was comparatively less in *F. macrophylla* (30%) followed by *F. semialata* (40%) and grafted plant (41%). Male sex ratio ranged from 47 to 56% in all three host plants. Survival at maturity was more in *F. semialata* (3.1 per sq cm) followed by *F. macrophylla* (2.7/cm^2) and Grafted plant (2.1/cm^2). Average fecundity (398 nos) was more in *F. semialata* followed by Grafted plant and *F. macrophylla* (Fig. 8.1). Cell weight and resin weight were more in grafted plants (20.54 and 16.69 mg) followed by *F. semialata* and *F. macrophylla* (Fig. 8.2). Host suitability and Relative Index in ascending order is of *F. semialata* <*F. macrophylla*<Grafted.

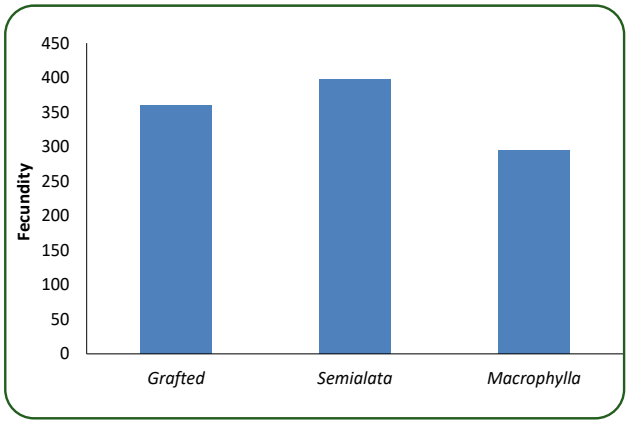


Fig. 8.1: Fecundity on different hosts during summer season (*jethwi*) crop 2020

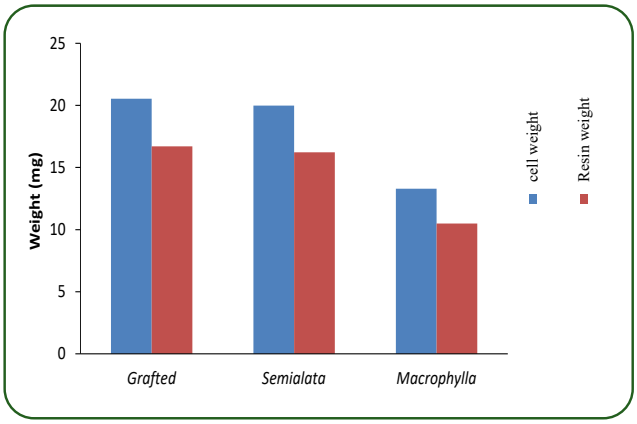


Fig. 8.2: Cell and resin weight on different hosts during *jethwi* crop 2020

In *Katki* 2020, the average density of settlement ranged from 32 to 43 per sq cm on Grafted plant, *F. macrophylla* and *F. semialata*. Initial mortality was more on Grafted plant (41 per cent) followed by *F. semialata* (40 per cent) and *F. macrophylla* (37 per cent). Male sex ratio was less than optimum on *F. semialata* (24 per cent) and grafted plant (23 per cent) and *F. macrophylla* (23 per cent) (Fig. 8.3). The survival at crop maturity was comparatively less in all three hosts *F. semialata* (1.56 per sq cm), *F. macrophylla* (1.51 per sq cm) and grafted (0.38 per sq cm).

Pruning response of *Calliandra calothyrsus* and evaluation of lac insect (*kusmi*) on pruned plants

Pruning was done in fourth week of every month from September 2019 to September 2020. Observations *viz.*, time of initial sprouting, collar diameter, main and sub branch diameter, number of shoots, shoot length, shoot diameter were recorded at monthly intervals per plant in each month of pruning (Fig. 8.4).

Evaluation of lac insect (*kusmi*) on pruned plants during *aghani* (winter) crop 2020

Number of shoots, shoot length and shoot diameter were recorded on pruned plants in the month of September, October, November, December 2019 and January, February, March 2020. February and January 2020 month of pruning recorded longest shoot with more diameter as compared to other months pruning. *Kusmi* broodlac was inoculated on pruned plants on 21st, July, 2020 during winter (*aghani*) crop (Fig. 8.5).

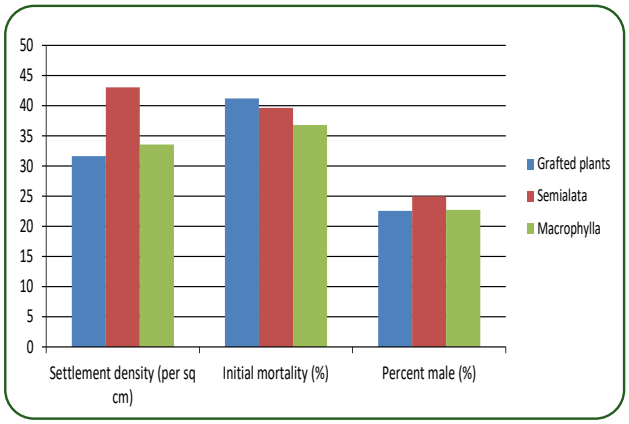


Fig. 8.3: Pre-harvest parameters of different lac host plants during rainy crop 2020

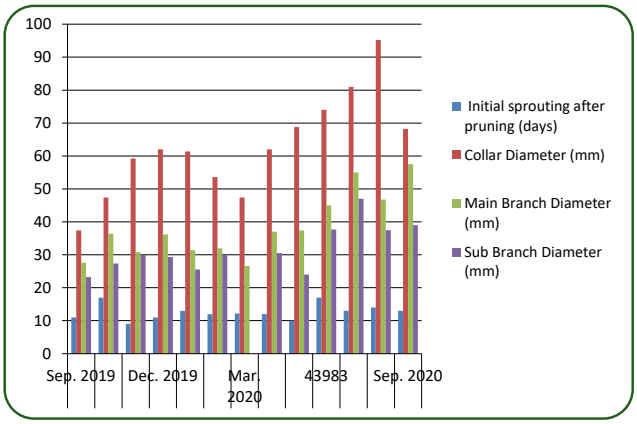


Fig. 8.4: Characteristics of selected plants during different months of pruning

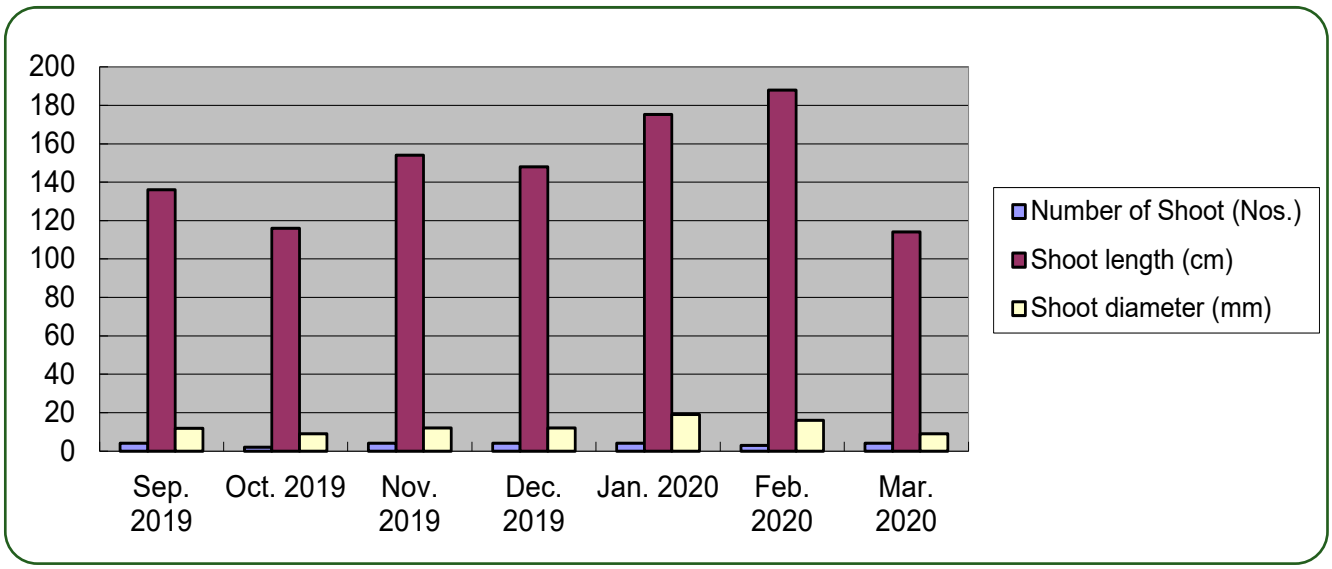


Fig. 8.5: Characteristics of plants selected during different months of pruning

Molecular identification of newly collected lac insects and lac associated fauna

Cytochrome oxidase barcoding PCRs were carried out for newly collected lac insects from different regions of the country and a sample from Taiwan on *Adansonia digitata* and a white fly sample collected on *F. semialata* at IINRG research farm. Sequences were generated and used for NCBI database search. The results showed that the lac insect population from Karnataka and Andhra Pradesh to be *K. lacca* and from Taiwan to be *K. chinensis*. The whitefly sample was found to be *Aleurodicus dispersus* (Table 8.1).

Table 8.1: Results of barcoding PCRs

Place of Collection	Host	Name	Product length	Identity	GenBank Accession no.
Kurnool, AP	*S. saman*	*Kerria lacca*	661 bp	99.85%	MW633487
Guntur, AP	*S. saman*	*Kerria lacca*	654 bp	99.85%	MW633486
Vijaypur, Karnataka	*F. benghalensis*	*Kerria lacca*	659 bp	99.5%	MW630122
Yadgir, Karnataka	*F. lacar*	*Kerria lacca*	499 bp	99.38%	MW630123

Place of Collection	Host	Name	Product length	Identity	GenBank Accession no.
Shanhua, Taiwan	*Adansonia digitata*	*Kerria chinensis*	641 bp	99.85%	
IINRG, Ranchi	*F. semialata*	*Aleurodicus dispersus*	686 bp	100%	MZ356499

Field guide for identification of major lac host plants

With the objective of creating a photographic guide for identification of major lac host plants, the photographs of different parts of lac host plants such as leaves, flowers, fruits, seeds, bark, lac, exudating gum if any, and their botanical details were compiled for 52 lac host plants (Table 8.2) in the form of a book.

Table 8.2: List of lac host plants covered for preparing field guide

Sl. No.	Common name	Host plants	Family
1	Kusum	*Schleichera oleosa*	Sapindaceae
2	Palas	*Butea monosperma*	Fabaceae
3	Ber	*Ziziphus mauritiana*	Rhamnaceae
4	Semialata	*Flemingia semialata*	Leguminosae
5	Bhalia	*Flemingia macrophylla*	Leguminosae
6	Rain tree	*Albizia saman*	Mimosaceae
7	Galwang	*Albizia lucida*	Mimosaceae
8	Arhar	*Cajanus cajan*	Fabaceae
9	Copper pod	*Peltophorum ferrugineum*	Caesalpinioideae
10	Khair	*Acacia catechu*	Mimosaceae
11	Pipal	*Ficus religiosa*	Moraceae
12	Sandan	*Dalbergia oojeinensis*	Fabaceae
13	Banayan tree	*Ficus bengalensis*	Moraceae
14	Mimosa bush	*Acacia farnesiana*	Mimosaceae
15	Lata palas	*B. superba*	Fabaceae
16	Putri	*Croton oblongifolius*	Euphorbiaceae
17	Gursikhi	*Grewia hirsuta*	Tiliaceae
18	Babool	*Acacia nilotica*	Mimosaceae
19	Ghont	*Z. rotundifolia*	Rhamnaceae
20	Red calliandra	*Calliandra calothyrsus*	Mimosoideae
21	Turk's cap mallow	*Malvaviscus penduliflorus*	Malvaceae
22	Surinam	*Calliandra surinamensis*	Mimosoideae
23	Red Powder Puff	*Calliandra haematocephala*	Mimosoideae
24	White Powder Puff	*Calliandra haematocephala Alba*	Mimosoideae
25		*Eriolaena spectabilis*	Malvaceae

Sl. No.	Common name	Host plants	Family
26	Jatsalpan	*Desmodium pulchellum*	Fabaceae
27	Galphuli	*Flemingia chappar*	Fabaceae
28	Madipata	*Flemingia bracteata*	Leguminosae
29	Talura	*Shorea talura*	Dipterocarpaceae
30	Ganj, Gonj	*Milletia extensa*	Papilionaceae
31	Custard apple	*Annona squamosa*	Annonaceae
32	Baobab	*Adansonia digitata*	Bombacaceae
33	Leea	*Leea crispa*	Leeaceae
34	Litchi	*Litchi chinensis*	Sapindaceae
35	Mango	*Mangifera indica*	Anacardiaceae
36	Swadi Palas	*Butea monosperma Var swadi*	Fabaceae
37	Black fig	*Ficus benjamina*	Moraceae
38	Gular	*Ficus glomerata*	Moraceae
39	Pilkhan	*Ficus rumphii*	Moraceae
40	Anjeer	*Ficus carica*	Moraceae
41	Soft fig	*Ficus mollis*	Moraceae
42		*Ficus tsiela*	Moraceae
43		*Ficus tsjakela*	Moraceae
44		*Ficus microcarpa*	Moraceae
45		*Ficus semicordata*	Moraceae
46	Kondeyore	*Garuga pinnata*	Burseraceae
47	Akashmani	*Acacia auriculiformis*	Mimosaceae
48	Kikar	*Acacia tortulis*	Mimosaceae
49	Black Siris	*Albizia lebbeck*	Mimosaceae
50	Jungle jilebi	*Pithecellobium dulce*	Fabaceae
51	Paras peepal	*Thespesia populnea L*	Malvaceae
52	Khejadi	*Prosopis cineraria*	Mimosaceae

Sub Project 1: Diversity analysis of aleuritic acid content in major lac insect species/ strains and its use for better isolation strategies

Variation in Aleuritic acid content in lac insects from different host plants, different strains *viz.*, *Kusmi* and *Rangeeni* as well as lac insect colour variants *viz.*, yellow and crimson were evaluated at different time intervals. The results show variation in aleuritic acid content in different lac insect species, strain, colour, season and lac host. Per cent aleuritic acid is in decreasing trend at different time interval. Aleuritic acid content found in *Kerria chinensis* was 19.81, 13.73 and 9.01 per cent at harvesting, six and 12 months after harvesting, respectively. Aleuritic Acid content in lac resin from different host plants and insect species are given in the Table 8.3.

Table 8.3: Estimation of aleuritic acid content in lac resins of different host plant and insect species at different time interval

Host	Species /Strain	Season	Colour	Acid (Per cent)	Melting Point (°C)	% Purity	Acid (Per cent)	Melting Point (°C)	% Purity	Acid (Per cent)	Melting Point (°C)	% Purity	Aleuratic Acid (Per cent)	Melting Point (°C)	Purity from acid value
				After harvesting			6 month after harvesting			12 month after harvesting			18month after harvesting		
Kusum	*K. lacca Kusmi*	Summer (*Jethwi*)	Yellow	10.95	92.6	96.32	13.13	95.15	96.35	12.76	94.5	92.81	11.375	94	95.715
Kusum	*K. lacca Kusmi*	Summer (*Jethwi*)	Crimson	12.37	92.6	93.83	No yield Sample taken Aug 2020			12.48	94.5	87.025	6.69	QEL	QEL
Ber	*K. lacca Kusmi*	Winter (*Aghani*)	Crimson	15.18	92.6	95.86	16.34	91.1	96.5	No yield Sample taken Aug 2020			10.04	96	91.36
Ber	*K. lacca Kusmi*	Winter (*Aghani*)	Yellow	17.07	92.5	93.71	16.84	92.2	98.63	13.06	94.5	92.78	8.31	93.5	92.785
Palas (SEL)	*K. lacca Rangeeni*	Summer (*Baisakhi*)	Crimson+ Yellow	16.60	94.5	92.05	12.22	91.5	97.14	12.079	QEL	QEL	Sample to be analyzed during May 2021		
Palas (SEL)	*K. lacca Rangeeni*	Rainy (*Katki*)	Crimson+ Yellow	16.46	QEL		11.84	91.5	97.09	9.85	QEL	QEL	Sample to be analyzed during May 2021		
Ber (SEL)	*K. lacca Rangeeni*	Rainy (*Katki*)	Crimson+ Yellow	12.84	QEL		10.69	91.5	97.10	8.3	QEL	QEL	Sample to be analyzed during May 2021		
Ber	*K. sharda*	-	Crimson	9.23	92.5	93.90	7.72	91.5	90.615	6.56	91.5	98.55	Samples not available for 18 months analysis		
F. macrophylla	*K. chinensis*	Rainy	Crimson	19.81	92.5	98.78	13.73	89.5	98.74	9.01	89.5	98.55	Sample to be analyzed during January 2021		

SCL – Scarped lac; SEL – Seed lac
QEl - Quality evalution Lab

Sub Project 2: Taxonomic studies of lac insects (Hemiptera: Coccoidea: Tachardiidae) from different Agro climatic zones of India

a. Collection and preservation of lac insects for taxonomic studies: The survey for lac biodiversity by different network centers resulted in collection of natural lac insect populations from different locations of the country on different host plants (Table 8.4). Matured female samples were collected in to alcohol for taxonomic studies.

Table 8.4: Lac samples collected from different locations with host details

Sl. no.	Location	Host plants	Collected Centre
1	Madurai, Tamil Nadu	*Samanea saman*	IINRG, Ranchi
2	Imphal, Manipur	*Jacaranda mimosifolia* and *Calliandra* spp.	IINRG, Ranchi and CAU, Imphal
3	Guntur, Andhra Pradesh	Dubai teak and *S. saman*	ANGRAU, Guntur
4	Kurnool, Andhra Pradesh	-	ANGRAU, Guntur
5	Bengaluru, Karnataka	*Ficus* spp. and *Pterospermum* spp.	IINRG, Ranchi
6	Vijaypur, Karnataka	*Ficus benghalensis, F. religiosa, F. lacar*	KVK, Sirsi

Sl. no.	Location	Host plants	Collected Centre
7	Bidar, Karnataka	*S. saman*	KVK, Sirsi
8	Yadgir, Karnataka	*F. lacar*	KVK, Sirsi
9	Chikamagalur, Karnataka	*S. saman*	KVK, Sirsi

Taxonomic identification, illustration and description: Identification and descriptions were done based on the slide mounted adult female specimens. All 14 populations / samples collected in the study are preserved and processed for taxonomic studies. The Madurai (Tamil Nadu) sample from *Samanea saman* are described as a new lac insect species, *Kerria canalis* Rajgopal in detail with all taxonomic illustrations and got published. Samples from Imphal (Manipur) on *Jacaranda mimosifolia* and *Callindra* spp. (Fig. 8.6) and Guntur (Andhra Pradesh) on Dubai teak and *S. saman* were identified as *Kerria chinensis* (Mahdihassan) and *Kerria thrissurensis* Ahmad & Ramamurthy, respectively.

Establishment of systematic repository for lac and other insects associated with lac ecosystems from different agro climatic zones

Lac samples collected from different locations are preserved in insect repository established in Quality & Productivity Improvement Division, in mount and alcohol preserved specimens for future reference. Along with lac insects other lac host plant insect/mite pests (Fig. 8.7 & 8.8) from the orders Lepidoptera, Hemiptera, Orthoptera, Coleoptera and Trombidiformes are collected and deposited in the repository. Some of the insect and mite pests are identified by the help of experts as given in Table 8.5.

Table 8.5: List of Insect/mite pests identified from different lac host plants deposited in insect repository

Sl. No.	Host plant	Insect/ mite pest	Family
1	*Kusum*	*Maconellicoccus hirsutus*	Pseudococcidae
2		*Coccus hesperidum*	Coccidae
3		*Serinetha augur*	Coreidae
4		*Tessaratoma javanica*	Tessaratomidae
5		*Oligonychus biharensis*	Tetranychidae
6	*Flemingia macrophylla*	*Oligonychus biharensis*	Tetranychidae
7	*Flemingia semialata*	*Planococcus lilacinus*	Pseudococcidae
8		*Planococcus citri*	Pseudococcidae
9		*Coccus longulus*	Coccidae
10		*Icerya aegyptiaca*	Monophlebidae
11		*Neostauropus alternus*	Notodontidae
12	*Ber*	*Aonidiella orientalis*	Diaspididae
13	*Ficus bengalensis*	*Hemilecanium imbricans*	Coccidae
14	*Palas*	*Labioproctus polei*	Margarodidae
15	*Samanea saman*	*Trijuba oculata*	Coccidae

Callindra spp. *Jacaranda mimosifolia* *Samanea saman*

Fig. 8.6: Lac insect samples collected by IINRG centre

Maconellicoccus hirsutus *Coccus hesperidum*

Fig. 8.7: Insect pests infesting *kusum*

Coccus longulus *Planococcus lilacinus* *Planococcus citri*

Fig. 8.8: Insect pests infesting *F. semialata*

II. Network Cooperating / Voluntary centres

1. Assam Agricultural University (AAU), Jorhat

Survey in Assam and West Bengal

During January, 2020 to December, 2020 19 blocks of six districts (Dibrugarh, Tinsukia, West Karbi Anglong, Dhubri, South Salmara Mankachar and Dhemaji) of Assam were surveyed. Local people of Dibrugarh and Tinsukia reported occurring of natural lac insects more than 10 years ago and they also reported two host plants *viz., Sisiporua* and *Mithapuri* (Vernacular name) for growing lac insect. Broodlac collected during surveys from Langardang village of West Karbi Anglong during last week of October, 2020 was inoculated at Regional Lac Insect Field Gene Bank at AAU, Jorhat. Three naturally occurring lac host plants *viz., F. semialata, Peepal, Leea* sp. were predominant in Karbi Anglong district of Assam.

Four blocks of two districts (Nadia and Purba Bardhaman) were surveyed during the month of March 2020 and naturally occurring lac insects were not found in any of these districts, but host plants like *Siris* and *Ber* were in abundance in both districts.

Conservation of lac insect and host plant germplasm

Twenty lac insect germplasms have been collected since inception and at present two live races of Assam and two of West Bengal are conserved at Regional Lac Insect Field Gene Bank, AAU, Jorhat. Eighteen lac host plant species were collected and maintained in the Regional Lac Insect Field Gene Bank.

Analysis of host plants for yield parameters

Lac cultivation studies on different host plants revealed that broodlac yield was significantly different among all eight plants *viz., F. semialata, F. strobilifera, I. teysmannii, F. religiosa, Z. mauritiana, L. chinensis, H. rosa-sinensis* and *C. cajan* based on two consecutive years' data. The maximum yield of broodlac was recorded on *F. semialata* (0.31±0.01kg) followed by *C. cajan*, *F. strobilifera*, *F. religiosa*, *Z. mauritiana*, *L. chinensis* and *H. rosa-sinensis* (0.16±0.01kg) whereas lac insect did not survive on *I. teysmannii* till maturity.

Life cycle parameters of *K. chinensis* and *K. lacca* on *F. semialata*

Experiments to study life parameters of *K. chinensis* on *F. semialata* for the last five years revealed that average pre-sexual maturity period was 49 days, male emergence started after 92 days and female longevity was 197.25 days. These parameters were recorded the highest in summer season than in winter (Table 8.6). Lac insect species collected from Purbo Medinipur (AAUK-16) and Howrah (AAUK-17) in 2018 and inoculated on *F. semialata* revealed that the strains are tri-voltine in nature. Data is presented in Table 8.7.

Table 8.6: Life cycle parameters of *K. chinensis* on *F. semialata*

Parameters in days	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021		Pooled data (2016-2021)	
	W	S	W	S	W	S	W	S	W	S	W	S
Pre-sexual maturity stage	36	60	40	42	35	43	36	45	40	56	**37.4**	**49.2**
Male emergence	60	97	45	89	48	80	45	101	59	-	**51.4**	**91.8**
Female longevity	163	196	152	204	155	201	188	188	165	-	**164.6**	**197.3**

Table 8.7: Life cycle parameters of trivoltine strain (AAUK-16, AAUK-17) on *F. semialata*

Parameters in days	2018-19	2019-20		2020		2020-21	Pooled Data (2018-2021)		
	S	M	W	S	M	W	S	M	W
Pre-sexual maturity stage	63	34	34	52	38	30	**57.5**	**36**	**32**
Male emergence	136	41	55	58	43	41	**97**	**42**	**48**
Female longevity	201	96	150	134	90	-	**167.5**	**93**	**150**

W-Winter, S-Summer, M-Monsoon

Effect of weather parameters on settlement density of lac insect crawlers

During 2020, the effect of weather parameters on settlement density of lac insect on *F. semialata* plant revealed a highly significant positive correlation with morning relative humidity (r = 0.99**) indicating longer duration of the crop with high morning relative humidity and non significant (+ve) correlation with Bright Sunshine Hour (BSSH) (r = 0.43). Settlement density also showed (-ve) non significant correlation with rainfall (r = -0.224), Max. and Min. Temperature (r = -0.61, r = 0.63) Therefore, it can be concluded that the morning relative humidity plays a vital role in overall settlement of lac crawlers on the host plant.

Pathogenicity of naturally occurring indigenous isolate of entomopathogenic fungi (EPF) against *Eublemma amabilis* and lac insect

Two entomopathogenic fungi isolated and identified *viz.*, *Isaria fumosorosea* and *Isaria javanica* were evaluated at three doses (10^{-3}, 10^{-5} and 10^{-7}dilution) against lac predator *E. amabilis*. Mortality was recorded from three days after treatment and 100% mortality was recorded at both 10^{-5} and 10^{-7} dilutions after 10 days. The bio-safety test was also recorded on lac insect following two methods *viz.*, 1) Dipping method and 2) Spraying method. In dipping method broodlac was dipped in EPF solution for 2-5 minutes and inoculated on the host plants. Productivity linked parameters and life cycle of lac insects were recorded followed by spraying. In spraying method, dipping before inoculation was not done, whereas 1st spray was done at initial crawler settlement stage, 2nd at sexual differentiation stage, 3rd at male emergence and 4th at female wax secreting stage. The experiment was repeated for two seasons and still continuing. In both cases, results show that EFP is extremely safe for lac and the occurrence of predators *viz. E. amabilis*, *Pseudohypatopa pulverea* and *Chrysopa* spp. are less than untreated host plants.

Integration of lac culture with apiculture

Usually honeybee forages during flowering stage of *F. semialata*. Stingless bees and *Apis cerena indica* visit lac for honey dew from the month of July till October (Dearth period for honeybees). Honey bees were also recorded during November to 1st week of December in both morning and evening hours for food (Fig. 8.9).

Fig. 8.9: Honey bees visiting lac insects for honeydew as food

Oviposition deterrence of *Callosobruchus chinensis*

The effect of different oils, botanicals, chemicals and bio-control agents (Table 8.8 & 8.9) on ovipositional responses of pulse beetle were evaluated by comparing the total number of eggs laid on the treated and control seeds. Oviposition of *C. chinensis* was affected by different plant oils causing 17.06 to 100.0 per cent oviposition deterrence. Among plant oils, citronella oil at the dose of 15 and 20 g/kg showed the highest oviposition deterrence and mustard oil showed the lowest deterrence. However, among the powder formulations, *B. bassiana* formulation showed 100.0 per cent oviposition deterrence at the dose of 20 ml/kg.

The highest germination percentage (98%) was recorded in patchouli oil followed by lemongrass oil (94%), citronella oil (90%), neem oil (72%) and mustard oil (68%) respectively at the dose of 2.5 ml/kg. However, the lowest germination percentage (42%) was in mustard oil at the highest dose of 20 ml/kg also. Among different powder formulations, maximum germination percentage (92%) was recorded in *Vitex negundo* powder followed by *Leucas indica* powder (88%) and *B. bassiana* formulation (32%) respectively at 0.5 g/kg. The lowest germination percentage (6%) was recorded in *B. bassiana* formulation at the dose of 20 g / kg.

Table 8.8: Ovipositional response of *C. chinensis* female to different oils

Treatments		Citronella oil	Lemongrass oil	Patchouli oil	Neem oil	Mustard oil
	Dosage (ml/kg)	Oviposition deterrence	Oviposition deterrence	Oviposition deterrence	Oviposition deterrence	Oviposition deterrence
Oils	2.5	82.72	80.56	59.17	52.41	17.06
	5.0	87.50	83.85	71.90	65.17	32.88
	10.0	93.27	91.10	88.39	74.79	38.69
	15.0	100	95.61	90.70	89.40	60.43
	20.0	100	100	100	95.37	74.38
Malathion 5% dust	5g/kg seed	100	100	100	100	100
Black pepper powder	3g/kg seed	97.55	95.87	95.76	97.25	97.90
Control		0.00	0.00	0.00	0.00	0.00

Table 8.9: Ovipositional response of *C. chinensis* female to different leaf powders and *Beauveria bassiana* formulation

Treatments		*V. negundo* leaf powder	*L. indica* leaf powder	*Beauveria bassiana* formulation
Botanicals and Bio-control agents	Dosage (g/kg)	Oviposition deterrence	Oviposition deterrence	Oviposition deterrence
	0.5	26.42	38.39	89.32
	1.0	39.38	43.13	93.25
	5.0	56.69	61.49	95.81
	10.0	69.36	75.69	100
	15.0	79.73	81.91	100
Control		0	0	0

Coating *Flemingia* seeds with lac resin against *C. chinensis* during storage

Lac resin with different concentration (1%, 5% and 10%) showed effective result in case of feeding deterrence and oviposition of *C. chinesis* than control. After 2 days of treatment adult mortality was recorded as 28%, 31% and 44% respectively, in 1%, 5% and 10% lac resin coated seeds, respectively while adult mortality was not recorded in control after 2 days.

Study on pest complex of lac host plants

- Larvae of *Archips* sp., *Orgyia* sp., *Euproctis* sp., *Somena scintillans* Walker & the pod weevil, *Apion clavipes* Gerst were predominant from July to November.
- White fly and mealy bug attack on host plants *viz.*, *F. semialata*, *F. macrophylla*, *C. cajan*, *Calliandra sp. etc.* has been observed from last week of October till December (Fig. 8.10).

Leaf roller

Orgyia **sp.**

Archips **sp.**

Somena scintillans

Hyposidra talaca

Fluffy white caterpillar

Bemisia tabaci

Planococcus sp

Fig. 8.10: Pest complex of lac host plants

Dissemination of scientific lac cultivation technologies

Training and OFT was conducted at Mesaki, Dhemaji on 24th February, 2020 with a participation of 10 farmers. The second training was conducted at Langardang, West Karbi Anglong on 31st August, 2020 with a participation of 40 farmers and third training was conducted at Kolonga, West Karbi Anglong on 27th November, 2020 with 37 numbers of farmers (Fig. 8.11).

OFT (Pruning of ber), Mesaki, Dhemaji

Training at Dhemaji

Training at Langardang, West Karbi Anglong

Training at Kolonga, West Karbi Anglong

Fig. 8.11: Various training programmes conducted by AAU Jorhat

2. Central Agricultural University (CAU), Imphal

Ant nesting behaviour

The Study on ant nesting behaviour was done at different locations viz. Research field, Lamshang, Gene bank, College Campus and Lamdeng Khunou. Nesting of the black little ant, *Monomorium sp* was found both in field and shade net condition except Lamdeng Khunou and it was also observed that these black little ant species tend to build their nest at the base of the lac encrustation leaving the upper part of the encrustation open. However, *Crematogaster sp* build their nest only in the open environment and seen nesting over the lac encrustation at Research field Lamshang and Lamdeng Khunou, Imphal West district and not seen nesting in the closed environment.

Nesting of *Monomorium spp* at the base of lac encrustation was seen only during rainy season to protect themselves from the rain while during other seasons, *Monomorium species* was found nesting in many places like under the ground, wood log, under the rocks, bricks, fence and under the pot of the host plants with lac encrustation at the Gene Bank of the College campus. Both *Crematogaster sp.* and *Monomorium sp.* has different nesting style (Fig. 8.12 & 8.13). During the observation the *Crematogaster* species was not found nesting on ground surface, they found nesting only over the food sources The *Crematogaster* species built their nests with a mixture of plant debris and mud while the *Monomorium species* built their nest with only fine soil.

Both *Crermatogaster* sp. and *Monomorium* sp. feed on wide variety of food but the workers are partial to the honeydew produced by aphids and other scale insects. During the observation many ants were seen visiting the lac encrustation but only the *Crematogaster sp* built their nest over the lac encrustation.

Fig. 8.12: Ant nesting of *Monomorium spp.* at the base of lac encrustation

Fig. 8.13: Ant nesting of *Crematogaster sp.* (St. valentine ant) over lac encrustation

Survey of Manipur

Details of survey conducted in Manipur during 2020 including location, host plants and lac insects are given in the Table 8.10.

Table 8.10: Details of survey conducted in Manipur

Sl. No.	Surveyed Villages	GPS Coordinates	Host Plant Found	Lac Insect Found
1.	Sekmaijin, Imphal West district	N-24°34.221' E-093°54.521'	*Malvaviscus penduliflorus*, *Calliandra*, Ber, Arhar, *Ficus*	Lac insect was found in *M. penduliflorus*
2.	Kakching Lamkhai, Kakching district	N-24°30.077' E-094°00.757'	*M. penduliflorus*, *Ber*, *Arhar*, *Ficus*	Lac insect was found in *M. penduliflorus*
3.	Mayang Imphal, Imphal West district	N-24°37.254' E-093°53.405'	*M. penduliflorus*, *Ber*, *Ficus*	Lac insect was found in *M. penduliflorus*
4.	Uchiwa, Imphal West district	N-24°34.900' E-093°54.433'	*M. penduliflorus*	Lac insect was found in *M. penduliflorus*
5.	Keithelmanbi Kangpokpi District	N-24°46.045' E-093°48.538'	*Acacia*, *Arhar*, *Calliandra*	Lac insect was found in *Acacia*

Sl. No.	Surveyed Villages	GPS Coordinates	Host Plant Found	Lac Insect Found
6.	Langthabal Sora, Kakching district	N-24°32.223' E-094°01.703	*M. penduliflorus, Ber, Arhar, Ficus*	Lac insect was found in *M. penduliflorus*
7.	Heirangoithong, Imphal west district	N-24°46.429' E-093°55.845'	*M. penduliflorus*	Lac insect was found in *M. penduliflorus*
8.	Kharam Village, Senapati district	-	*F. macrophylla, Calliandra, Ber, Mallotus phillipiensis*	Lac insect was found in *M. phillipiensis*
9.	Kwatha village, Tengnoupal district	-	*F. semialata, F. macrophylla,* Litchi, *Ber, Calliandra, Arhar*	Lac infestation was found only on Litchi plant
10.	Yurembam, Imphal West District	-	*Ber, Calliandra, Mallotus, Ficus, Arhar, M. penduliflorus*	Lac insect was found infesting in new host plant Champak *Magnolia champaca* (Fig. 8.14)

Fig. 8.14: Report of lac insect infesting Champak, *Magnolia champaca* from Imphal West District of Manipur

3. Kerala Forest Research Institute (KFRI), Thrissur

Surveys

Tamil Nadu: A field survey conducted on 27 and 28 February in Trichy, Thanjavur and Kumbakonam resulted in the discovery of a new live lac insect location in Musiri in Trichy district of Tamil Nadu (10.961144° N, 78.438090° E).

Live and mature lac insect samples were collected from Kadayanallur in Thenkashi district of Tamil Nadu during October 2020 and were brought to be maintained at KFRI Gene Bank. These samples were also distributed to five farmers in Palakkad and Thrissur districts of Kerala.

A field visit was organized during December 2020 to three districts of Tamil Nadu *in lieu* with earlier reports of live lac insects. Three new locations with live lac could be reported during the survey which includes Krishnarayapuram, Trichy- Karur Main Road (10.95340° N, 78.280227° E), S.S. Colony, Bypass road, Sakthi Velammal Nagar, Madurai (9.926203° N, 78.09430° E) and Srirangam, Trichy (10.85359° N, 78.691212°E). A new location with dead lac was also reported from NH44, Karur (10.940276° N, 78.056427° E). The live lac insect samples were collected from Sri Rangam in January upon their maturation.

Yanam, Pondicherry Union Territory: Yanam was surveyed during November 2020. Out of 470 host plants observed, *Milletia pinnata* commonly known as Pongam oil tree or Indian beech was found to be the most abundant with 152 trees followed by *S. saman*, (112), an unidentified *Ficus sp* (90), *Albizia lebbeck* (45), *F. religiosa* (31) and *Mangifera indica* (22). *Z. mauritiana*, *F. benghalensis* and an unknown species were also found in few numbers. However, lac was absent in the surveyed area.

Lakshadweep Islands: An extensive field survey was carried out on major islands *viz*., Agatti, Bangaram Atoll, Thinnakara, Amini, Kadmat or Cardomom Island and Kavaratti Island out of the eleven accessible islands of the Lakshadweep Union Territory from 23 March 2021 to 03 Aril 2021, adhering to the strict COVID 19 safety protocols. Number of host plants such as *F. benghalensis*, *F. religiosa*, *S. saman*, *Z. mauritiana and Z. xylopyrus* were found without the presence of lac on any of them. This is probably due to the high saline and humid weather conditions of the island. The Lakshadweep islands are generally dry areas with little vegetation and it was concluded that lac would not be possibly present on these islands. An exception could be Minicoy Island due to its varied vegetation different from the rest of the island group. To investigate the presence of lac in the rest of the islands, further surveys are to be conducted.

Maintenance of lac culture

At gene bank: Live lac insect samples collected from the surveys were maintained in the Gene Bank and distributed to the prospective farmers. They were maintained on around 50 *F. semialata* plants in KFRI Gene Bank. Besides, standard package of practices, Neem oil was also applied to leaves of *Flemingia* species to lessen the attack of whiteflies. However, sooty moulds were observed extensively towards the stage of maturation in the month of March 2021. In KFRI garden - *Eublemma amabilis* and *Tachardiaephagus tachardiae* were also observed even after application of pesticides. The live lac insect samples collected from Trichy and Madurai were inoculated and preserved in the KFRI Gene Bank. For experimental purpose the samples from Krishnarayapuram, Trichy were inoculated on different host plants in the Thrissur district such as *S. saman, F. benghalensis, F. religiosa, Mangifera indica, Calliandra heamatocephala, B. monosperma, Amherstia nobilis, F. semialata, C. cajan, Xylia xylocarpa, Pongamia pinnata Manilkara zapota, Artocarpus heterophyllus* and *Z. mauritiana.* Out of these host plants, *M. indica*, *Z. xylocarpa*, *M. zapota*, *P. pinnata* and *A. heterophyllus* were found to be unsuccessful without any settlement and maturation of crawlers. The female lac insects are nearing the stage of maturation in the successful host plants.

Lac cultivation

At farmers' field: During field visit in Palakkad district, a famer had pointed out that the weaver ant, *Oecophylla* sp was useful for the host plants in providing them with protection against other enemies while mealy bugs, locally known as "Oooran", were attacking the host plants as well as some other plants such as, Chilly, Rubber saplings, Turmeric and Guava. Observations taken in the farmer's field where lac is already inoculated are given in Table 8.11.

Table 8.11: Observations of lac inoculated plants at farmers' field

Name of the farmer	No. of host plants inoculated	Height	Width	Canopy	No. of insects			Associated fauna
					Position of shoot	Live	Dead	
Yogesh R Vadakkanchery Palakkad-	1. *F.semialata*	208.28	8.89	26.46%	Low	52	0	Unidentified scale insects, ants and mealy bugs
					Middle	42	0	
					Upper	30	7	
	2. *F. semialata*	152.4	7.62		Low	24	34	
					Middle	42	29	
					Upper	32	4	

Name of the farmer	No. of host plants inoculated	Height	Width	Canopy	No. of insects			Associated fauna
					Position of shoot	Live	Dead	
Awasthy Krishnan Kizhakkanchery Palakkad- 678684	1. *F. semialata*	143	3.5	52.28%	Low	54	0	Yellow crazy ants, unknown visitor insect, Stick insect, Mealy bug
					Middle	34	18	
					Upper	52	20	
	2. *F. semialata*	125	3.25	45.02%	Low	36	4	
					Middle	51	5	
					Upper	36	4	
	3. *F. semialata*	143	3.25	54.52%	Low	35	3	
					Middle	71	4	
					Upper	35	8	
	4. *F. macrophylla*	113	3.0	32.35%	Low	26	26	
					Middle	36	0	
					Upper	50	4	
Jenny Syriac Laly (Wife) Kizhakkanchery, Palakkad	1. *F. semialata*	118	3.25	26.70%	Low	26	12	Small black ants
		124	4.25	7.86%	Middle	23	8	
					Upper	43	3	
	2. *F. macrophylla*				Low	42	0	
					Middle	36	4	
					Upper	32	14	
K.E. Mohamad Kani, Kizhakkanchery Palakkad-	1. *Cajanus cajan*	236	4.5	6.33%	Low	49	9	Unidentified insects, small black ants, *Oecophylla* sp.
					Middle	84	13	
					Upper	73	12	
	2. *F. semialata*	238	5.5	8.00%	Low	42	0	
					Middle	41	0	
					Upper	38	12	
	3. *F. macrophylla*	224	5.25	9.55%	Low	28	1	
					Middle	32	3	
					Upper	32	4	
	4. *F. semialata*	240	4.50	8.00%	Low	28	2	
					Middle	44	4	
					Upper	28	2	

Name of the farmer	No. of host plants inoculated	Height	Width	Canopy	No. of insects			Associated fauna
					Position of shoot	Live	Dead	
Dr. GavasRagesh	*1. F. semialata*	263	5.6	50.12%	Low	21	10	Yellow crazy ants
Thottapady					Middle	60	15	
Thrissur					Upper	14	20	
	2. F. semialata	244	4.5	46.03%	Low	72	4	
					Middle	42	12	
					Upper	40	11	
	3. F. semialata	290	5.5	69.85%	Low	37	16	
					Middle	67	22	
					Upper	42	19	
	4. F. semialata	256	3.5	73.99%	Low	77	23	
					Middle	57	15	
					Upper	39	17	
	5. F. semialata	202	4.0	78.90%	Low	92	8	
					Middle	47	17	
					Upper	44	23	
	1. F. macrophylla	172	4.0	77.75%	Low	52	2	
					Middle	68	4	
					Upper	64	20	
	2. F. macrophylla	149	3.5	69.28%	Low	56	3	
					Middle	55	1	
					Upper	66	7	
	3. F. macrophylla	201	4.5	43.57	Low	16	0	
					Middle	47	0	
					Upper	47	0	
	4. F. macrophylla	197	4.0	61.66%	Low	34	15	
					Middle	57	15	
					Upper	49	22	
	5. F. macrophylla	226	5.5	5.00%	Low	42	40	
					Middle	33	32	
					Upper	23	10	
Alex	1. *F. semialata*	197	3.1	3.67%	Low	38	28	None
Kootala					Middle	58	14	
Thrissur					Upper	77	13	

Morphological variations of new lac collections: Study on the morphological variations of mature female cells from the same sample inoculated on four different host plants using Scanning Electron Microscopy was carried out. Initial observations revelaed that there is clear cut size variation of the same stock on different host plants and structures like anal fringes and dorsal spine were observed clearly in the SEM images (Fig.8.15).

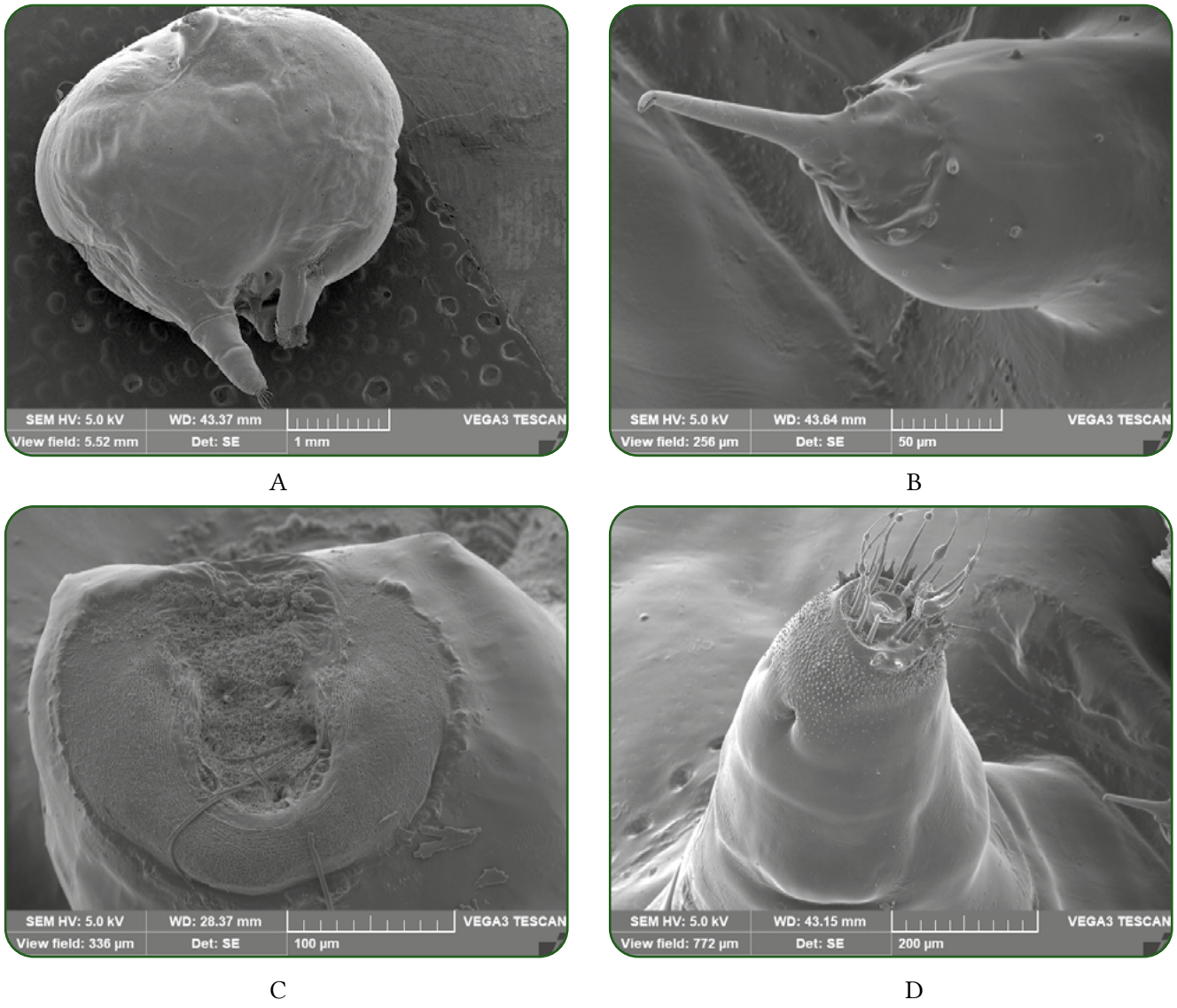


Fig. 8.15: SEM images of the new lac insect lines
A. Female insect B. Dorsal spine C. Brachial plate and D. Anal tubercule

Herbarium: A herbarium of the major host plants of lac insect in Kerala was prepared to be kept in the museum in the future. This herbarium includes a collection of the leaves, fruits/seeds and flowers of the 12 major host plants- *S. saman, F. benghalensis, F. religiosa, Calliandra heamatocephala, B. monosperma, Amherstia nobilis, F. semialata, F. macrophylla, C. cajan, pongamia pinnata, S. oleosa* and *Z. mauritiana.* The herbarium also provides the details of the host plants such as scientific name, common name, classification, flowering period, and date of collection.

Popularization of lac

Pamphlets: Pamphlets in English and Malayalam were prepared and distributed among students, industries

and farmers stating the visions of the network project. They contain information on the history, economic importance, medicinal properties and uses, host plants, lifecycle and importance of conserving the lac insects. The pamphlets also depict the details of the Network Project on Conservation of Lac Insect Genetic Resources and the role of KFRI in the project.

Posters: Posters were developed in three languages, English, Malayalam and Tamil and were distributed to common people during the surveys and collections. They were also put up on notice boards and propagated among the natives of Thrissur. They comprise of the necessity of conserving lac insect genetic resources and contact information was also given to inform when one comes across live or dead lac on trees.

Workshops and Presentations: Representatives of the Arya Vaidya Sala, Kottakal of Malapuram district, the top- notched Ayurvedic medicine manufacturers, visited KFRI and the Lac Insect Gene Bank. They were presented with all the details of lac insects and they were interested in linking their markets with our farmers once there is bulk production. Ayurveda utilizes lac and their byproducts in large quantities in the preparation of medicines for treating illness such as blood impurity, joint pain, fractures, obesity and a lot more.

Students of the department of Zoology, from Kerala Varma College, Thrissur paid a visit to KFRI and attended a small workshop on lac insects.

3a. Krishi Vigyan Kendra, Sirsi

Survey in Northern Karnataka

Survey was conducted during September 2020 in northern Karnataka covering districts *viz*., Gadag, Bagalkote, Vijayapur, Kalburgi, Bidar and Yadgir. Sufficient number of natural population of live lac insects (*rangeeni* strain) were recorded from Vijayapur district on *Ficus benghalensis* L., *Ficus religiosa* L., *Ficus lacor* Buch. - Ham., on *Albizia (Samanea) saman* (Jacq.) in Bidar district and on *F. lacor* Buch. - Ham in Yadgir district. Though sufficient number of lac host plants were present in Gadag, Bagalakote and Kalburgi districts, lac infestation was not observed. Still there is a need for extensive survey especially in Kalburgi district. Collected specimens were sent for taxonomic identification at IINRG, Ranchi and were identified as *Kerria lacca.*

Survey in Southern Karnataka

Survey was conducted during November – December 2020 in southern Karnataka covering districts *viz*., Davanagere, Chitradurga, Tumkur, Bengaluru rural, Doddaballapur, Chikkaballapur, Chamaraj nagar, Ramanagar, Chikkamagaluru and Kodagu. Natural population of live lac insects (*rangeeni* strain) were recorded on *F. religiosa in* Davanagere, on *Annona squamosa* in Chitradurga, on *F. benghalensis* in Ramanagar and on *S. saman* in Chamaraj Nagar and Chikkamagaluru district. Due to developmental works especially widening of roads, many old *Ficus* and *Albizia* trees were felled which might have led to loss of natural population of lac in Southern Karnataka. Special emphasis has to be given on collection and conservation of endangered lac insects species *viz*., *Kerria communis* and *K. lacca mysorensis* from Southern Karnataka.

Commercial cultivation of *kusmi* lac strain

Some farmers from Uttar Kannada and Mysore districts are involved in commercial *kusmi* lac cultivation on *kusum*, *ber* and *Flemingia* with technical guidance from KVK Sirsi (Fig. 8.16). The scrapedlac from Mysore was sold to goldsmiths and artisans @ Rs. 450 per Kg. Farmers have identified the strong market linkage for lac and interested to expand this lac cultivation in tribal areas (Approx. 150 acres) of Mysore district.

Establishment of *F. semialata* plantation

About 20 *guntas* of *F. semialata* plantation was maintained at Agriculture Research Station, Malagi which is 25 Km away from KVK Sirsi for research purpose (Fig. 8.17). These plants will be used further for documentation of insect pests of *Flemingia* as well as to know the performance of *kusmi* lac cultivation under Uttara Kannada conditions.

Exhibition on lac

Arranged exhibition of lac covering lac insect stages, natural enemies, different forms of lac, decorative items made from lac *etc* on 17.8.2020 during inauguration of KVK Sirsi Administrative building which was appreciated by Shri. B. C. Patil, H'ble Minister of Agriculture, GoK, Shri, Shivaram Hebbar, H'ble Minister for Labour and District Incharge (UK), GoK, Dr. V. Venkatasubramanian, Director, ATARI

Fig. 8.16: Commercial lac cultivation on *ber* and *Flemingia*

Fig. 8.17: Planting of *F. semialata* at ARS Malagi

XI, Bengaluru, Dr. M. B. Chetti, Vice Chancellor, UAS Dharwad, Dr. Ramesh Babu, Director of Extension, Board member of UAS Dharwad, progressive farmers and other dignitaries.

4. Maharana Pratap University of Agricultural Sciences and Technology (MPUAT), Udaipur

Survey for lac insects and host plants in arid western plain region of the country

During 2020-21, surveys were conducted in two districts of Rajasthan and six districts of Gujarat and nearby area of Udaipur region, in which 34 different location were covered and it was observed that *Albizia* (*Albizia lebbeck* Benth), *Bargad* (*Ficus benghalensis* Linn.), *Peepal* (*Ficus religosia* Linn.), *Paras peepal* or *Gada peepal* (*Ficus benjamina* Linn.), *Gular* (*Ficus racemosa* Linn.), *Ber* (*Ziziphus mauritiana* Lam. and *Ziziphus jujube* Lam,), and Custard Apple (*Annona squamosa* Linn.) were found frequently prevailing as major lac host plants in the region. Besides them, other lac host plants observed were *Butea monosperma* Lam. (*Palas*), *Acacia nilotica* Willd. (*Babul*), *Acacia catechu* Willd. (*Khair*), *Acacia rabica* Willd. (*Babool*), *Cassia fistula* Linn. (*Amaltas*), *Pithecellobium dulce* (*Kikkar*), *Dalbergia sissoo* (*Shisham*), *Prosopis cineraria* (*Khejadi*), *Acacia auriculiformis* (*Akashmani*), *Calliandra haematocephala* Benth (Calliandra), *Polyalthia* spp. *pendula* (*Ashoka*), *Ficus carica* (*Anjeer*), *Prosophis juliflora* (*Vilayati Babool*). It was also observed that at almost all locations only *rangeeni* strain was seen on these natural hosts.

Conservation of lac insects under *in-situ* conditions

Different activities for the conservation of lac insects under *in-situ* conditions were under taken during at different farmers' fields where host plants were available and identified for the conservation of lac insects under *in-situ* conditions. The broodlac sticks bearing mature female lac insects were collected from the various host plants from Udaipur region during *Baisakhi* and *Katki* season and were inoculated on *palas*, *sitafal*, *ber*, *kikar*, *babool*, *Khejri* and *Peepal* in different areas. A total 125 hosts were utilized for the conservation of lac insect under *in-situ* conditions (Fig. 8.18).

Conservation of lac insect under *ex-situ* conditions

Lac insect genetic resources available in the region were collected and conserved under *ex-situ* conditions on different hosts available at the Gene Bank - cum - Lac Garden situated at Department of Entomology, RCA, Udaipur. 206 kg broodlac sticks of mature live lac insects were collected from different locations during July, 2020 to December, 2020 and were maintained on *arhar*, *palas*, *Flemingia* spp., *Ficus* spp. *palas*, *kiker*, *sitafal*, *anjeer*, *gular*, *siris*, *paras peepal* and *ber* at Lac Insect Gene Bank under development for each location. Different activities of lac insect conservation at Gene Bank and development of lac insects on different host plants are depicted in Fig. 8.19.

Fig. 8.18: Inoculation of broodlac at farmers' field for *in situ* conservation during 2020

Fig. 8.19: Different activities of lac insect conservation at gene bank during 2020

Studies on the effect of lac cultivation on yield of pigeonpea (*C. cajan* Linn.)

Life cycle of lac insect, *K. lacca* (Kerr) on pigeonpea: Biology of *Rangeeni* strain of lac insect was studied on pigeonpea during 2019 in summer season (*Baisakhi)* crop. The mean initial density of settlement of crawlers varied from lower portion to upper portion of plant and ranged from 44-111 crawlers per sq.cm. Mean initial density of settlement of crawlers were 83.70, 80.10, 62.60; 82.90, 79.10, 67.50 and 71.50, 72.10, 69.00 crawlers per sq.cm at lower, middle and upper parts of plant in three sets of experiment, respectively. The mean per cent settlement of crawlers recorded after the initial mortality at 21 days after inoculation in three sets of experiments were 92.15, 91.48, 90.06; 90.91, 89.98, 88.32 and 92.28, 90.78 and 89.12 on lower, middle and upper portion of plant, respectively.

The mean per cent initial mortality recorded during settlement at lower, middle and upper portion of plants were 7.89, 8.36, 9.27; 8.81, 9.86, 11.41 and 7.41, 8.88, 10.14 per cent in three sets of experiment, respectively. The duration of sex differentiation on lower, middle and upper portion of plants recorded after 45 days of inoculation in three set of experiments were 49.20, 48.80, 48.70; 48.90, 48.80, 47.90 and 49.20, 48.90, 48.10 days, respectively. The mean density of female cells at maturity recorded at lower, middle and upper portion of plant were 4.30, 5.30, 4.40; 4.10, 5.60, 4.00 and 4.40, 4.00, 5.30 female cells per sq.cm in three sets of experiment respectively and ranged from 2-8 cells per sq.cm.

Effect of lac cultivation on yield of pigeonpea: Mean plant height, number of branches per plant, number of pods per branch, number of seeds per pod, seed yield per plant and weight of 100 seeds in lac inoculated experiments were 161.30 cm, 11.53, 4.40, 3.57, 24.13 g and 7.63 g, respectively and whereas in control experiment were 172.70 cm, 11.90, 4.60, 3.70, 35.80 g and 8.70 g, respectively. The mean seed yield in lac inoculated experiment and control experiment were 603.33 and 895.00 kg/ha, respectively. The per cent decrease in plant height, number of branches per plant, number of pods per branch, number of seeds per pod, seed yield per plant and weight of 100 seeds in lac inoculated pigeonpea were 6.60, 3.08, 4.35, 3.60, 32.59 and 12.26%, respectively. But the Benefit Cost Ratio was higher (1.95) in lac inoculated experiment than the sole seed crop (control) of pigeonpea (1.84) (Table: 8.12).

Table 8.12: Effect of lac cultivation (*Baisakhi* 2019) on pigeonpea seed parameters

Experiment	Seeds/pod (no.)		Seed yield / plant (g)		Seed yield (kg/ha)		Weight of 100 seeds (g)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Experiment -1	3.60	2 - 4	23.90	22 - 26	597.5	550 - 650	7.50	6 - 9
Experiment - 2	3.60	2 - 4	24.30	23 - 25	607.5	575 - 625	8.10	6 - 9
Experiment - 3	3.50	2 - 4	24.20	22 - 26	605.0	550 - 650	7.30	6 - 9
Over all Mean	3.57	3.5 –3.6	24.13	23.9 – 24.3	603.3	597.5 – 607.5	7.63	7.3 – 8.1
B. Control	3.70	3 - 5	35.80	32 - 40	895.0	800 - 1000	8.70	7 - 10
C. Per cent decrease in lac inoculated experiment	3.60	-	32.59	-	32.6	-	12.26	-

Mass awareness among farmers for conservation of lac insect genetic resources

(i) **Campaigns:** Mass awareness campaigns were done at Kunchauli and Kelwada, Udaipur for creating awareness and promotion of lac cultivation among farmers for *in-situ* conservation of lac insect genetic resources in which progressive farmers were imparted knowledge for the lac cultivation (Fig. 8.20). Thirteen posters have been developed for imparting knowledge and adoption of lac cultivation on available hosts in the region.

(ii) **Interaction and discussion with scientists of the various universities of the country:** The scientists from various universities of the country visited the lac lab got acquainted with the lac insect, its biology and conservation.

Fig. 8.20: Campaigns and sharing of knowledge with farmers during 2020

5. Professor Jaishankar Telangana State Agricultural University (PJTSAU), Hyderabad

Survey for collection of lac insect genetic resources and i*n situ* conservation

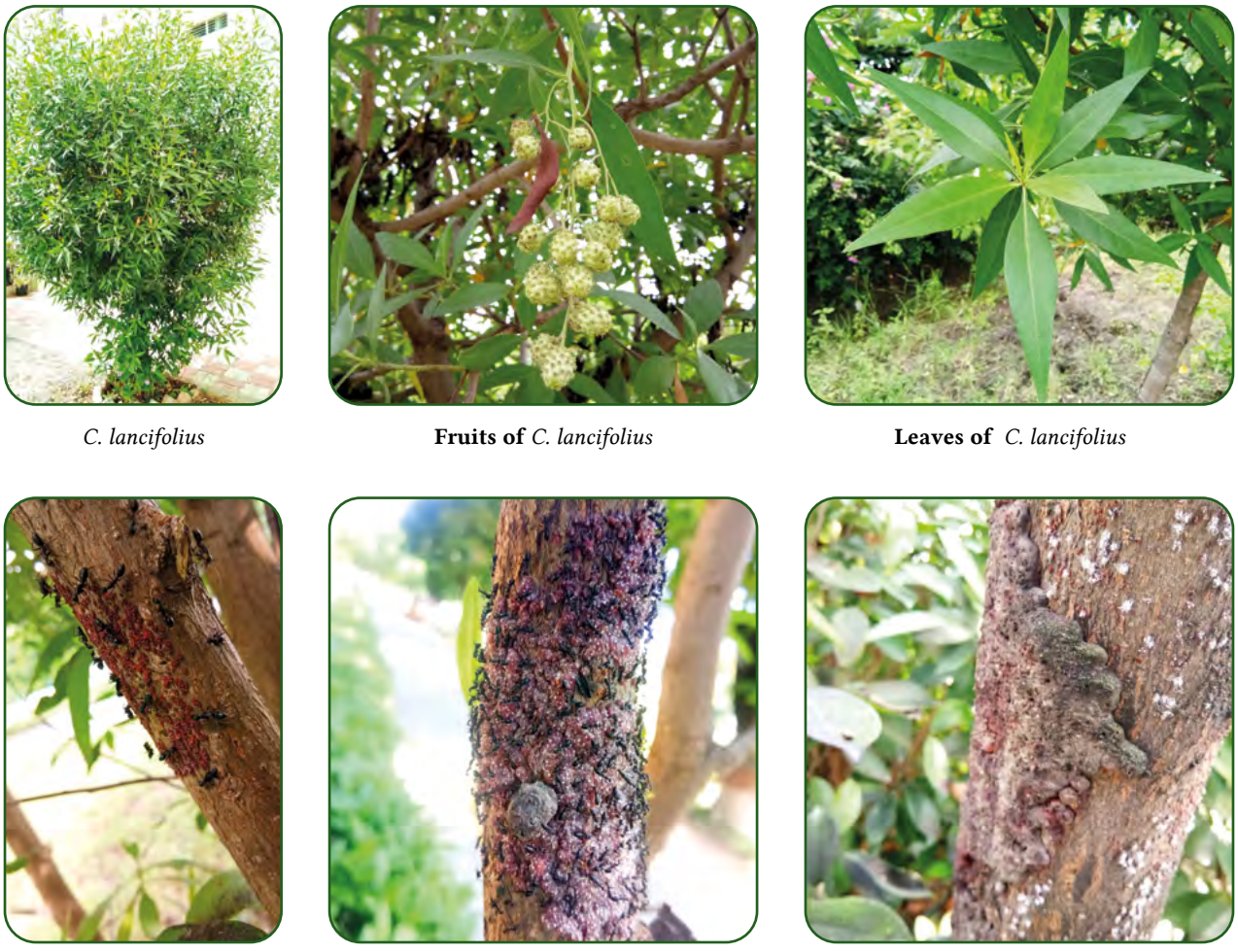
- All the thirty-one districts of Telangana were surveyed during the year for identification of host plants and collection of lac insects.
- Adilabad, Karimnagar, Mahabubnagar, Hyderabad, Rangareddy and Nizamabad districts were found to have lac on different host plants like *Peltophorum pterocorpum*, *S. saman*, *F. benghalensis*, *F. religiosa*, *F. hipsida* and *Ziziphus* spp.
- *In situ* conservation of lac insects and host plants is being done on different host plants *viz*., *Peltophorum pterocorpum*, *S. saman*, *F. benghalensis*, in Hyderabad and Rangareddy districts; and on different host plants *viz*., *P. pterocorpum*, *S. saman*, *F. benghalensis*, *F. religiosa*, *F. hipsida* and *Ziziphus* spp. at Adilabad, Karimnagar, Mahabubnagar, and Nizamabad districts.
- Around 70 plants were inoculated under lac conservation campaign by involving about 20 interested farmers and rural youth from village level SHGs of Rangareddy and Vikarabad districts.
- Pruning and harvesting demonstrations to infuse confidence among prospective lac cultivators were held during June 2020.
- Under brood multiplication, around 100 Kg of brood was produced for demonstration purpose and demonstrations were taken up in Rangareddy district of Southern Telangana Zone (STZ). Re inoculation was done through multiplied brood in the areas of earlier collections.
- Field visits (12 Nos) in potential areas of Khammam, Jagtial, Nagarkurnool, Vikarabad and Rangareddy districts were done. Demonstrations (3 nos.) were organized for village Self Help Groups (SHGs) and hand holding was done for selection of suitable sites for lac cultivation.
- Awareness on pruning and harvesting was created by holding demonstrations to infuse confidence among prospective lac cultivators.
- A group of 25 farmers were trained for conservation and cultivation of lac insects under intensive training while demonstrations were held in villages to the progressive farmers (around 45 nos.).
- On the basis of surveys undertaken in 2020 it was found that expansion of oil palm cultivation in the state under state horticulture programmmes may have impacted natural lac insect habitats. Tribal belts in Khammam districts are found suitable for cultivation of lac followed by Adilabad and Asifababad districts. On the basis of outcome of the surveys undertaken and trainings & demonstrations held, five districts *viz*., Mahbubnagar, Nagarkurnool, Adilabad, Khammam and Siddipet districts were identified as potential areas having considerable presence of lac insect.

5a. Acharya N. G. Ranga Agricultural University (ANGRAU), Guntur

- Survey was conducted for occurrence of lac insects in Krishna, Srikakulam, Vizainagaram, Vishakapatnam, Kurnool, Anantapur, West Godavari, East Godavari & Chittoor districts of Andhra Pradesh. During the survey occurence of Lac insect was observed on *Samanea saman* in Vizainagaram, Guntur and Kurnool districts. Along with this, lac encrustation was also

observed for the first time on *Conocarpus lancifolius* in Tirupati rural mandal of Chittoor district and Kovuru mandal of Nellore district, Guntur and Bapatla areas in Guntur district of Andhra Pradesh (Fig. 8.21).

- During survey in East Godavrai district one farmer was identified who was cultivating *kusmi* strain lac insect on *Flemingia semialata* in *Aghani* (20 acres) and *Jethwi* (20 acres) at Gontivaanipalem village of Yeleswaram mandal, East Godavari district, Andhra Pradesh.
- *Tachardiaephagus tachardiae* How. (Encyrtidae: Hymenoptera), *Aprostocetus purpureus* (Cam.) (Eulophidae: Hymenoptera) and *Bracon greeni* Ashm. (Braconidae: Hymenoptera) were lac associated fauna recorded on encrustation of lac collected from *S. saman* from Kurnool
- First time identified and reported *Kerria thrissurensis* from Guntur district of Andhra Pradesh on *C. lancifolius* host plant
- Lac encrustation was observed on *Pithecellobium dulce* and *Annona squamosa* host plants from Guntur and Pullampeta of Kadapa district
- Various lac products were procured and exhibited at Departments of Entomology at Agicultural College, Bapatla and S.V. Agricultural College, Tirupati, ANGRAU (Fig. 8.22)



C. lancifolius | **Fruits of** *C. lancifolius* | **Leaves of** *C. lancifolius*

Fig. 8.21: *Conocarpus lancifolius* and encrustaion of different stages of lac insect on *C. lancifolius*

Fig. 8.22: Exhibition of value added Lac Products in the Departments of Entomology at Agicultural College, Bapatla and S.V. Agricultural College, Tirupati, ANGRAU

6. Punjab Agricultural University (PAU), Ludhiana

Survey for collection of information / lac insects / host-plants from different parts of Punjab

Regular surveys were conducted for collecting the information w.r.t. lac insects and their host plants during the year 2020 in six districts of Punjab. A total of 11 lac insect samples were collected from five host plants ranging from low to high lac population. The details of survey are given in Table 8.13.

Table 8.13: Status of lac insect in different locations of Punjab during 2020

Districts	Latitude (°N)	Longitude (°E)	Lac insect	
			Host	Population
Ludhiana	30°70.71'	76°21.70'	*Ziziphus mauritiana*	Moderate
	30°91.20'	75°85.38'	*Albizia* sp.	Heavy
	30°91.58'	75°84.08'	*Ficus benghalensis*	Heavy
Fatehgarh Sahib	30°60.84'	76°23.20'	*Ziziphus mauritiana*	Moderate
	30°62.45'	76°38.63'	*Albizia* sp.	Heavy
			Butea monosperma	Low
Faridkot	30°40.41'	74°44.22'	*Ziziphus mauritiana*	High
Ferozepur	30°94.04'	74°95.16'	*Albizia* sp.	High
Sirhind	30°64.32'	76°38.42'	*Ziziphus mauritiana*	Moderate
			Ficus religiosa	Moderate
Moga	30°95.22'	75°12.91'	*Ziziphus mauritiana*	High

Low: <100, Moderate: 100-1000 and High: >1000.

Ex-situ Conservation / Brood multiplication at Lac Insect and Lac Host Park

Eight host plants grown at Lac Insect and Lac Host Park were utilized for conservation of lac insect (*Rangeeni* strain; *Baisakhi* and *Katki* crop). *Baisakhi* crop: 83 plants were inoculated for *Baisakhi* crop (2019-2020). 124.46 kg broodlac was harvested during July 2020 from three host plants, *Z. mauritiana* (3), *F. semialata* (40) and *F. macrophylla* (40) with scrappedlac of 5.86, 7.96 and 7.12 kg, respectively (Table 8.14). *Katki* crop: 43 plants were inoculated with broodlac to check the production potential of lac for *katki* crop (2020). 56.26 kg broodlac was harvested during November, 2020 from three host plants, *Z. mauritiana* (3), *F. semialata* (20) and *F. macrophylla* (20) with scrappedlac of 3.12, 2.08 and 1.70 kg, respectively (Table 8.14).

Table 8.14: Quantity of brood multiplied at Lac insect and Lac Host Park during 2020

Name of host	Number of plants inoculated		Total broodlac output (Kg)		Total scrappedlac yield (Kg)	
	Katki	*Baisakhi*	*Katki*	*Baisakhi*	*Katki*	*Baisakhi*
Ziziphus mauritiana	3	3	19.72	31.50	3.12	5.85
Flemingia semialata	20	40	19.36	48.08	2.08	7.96
Flemingia macrophylla	20	40	17.18	44.88	1.70	7.12
Total	**43**	**83**	**56.26**	**124.46**	**6.90**	**20.94**

Studies on life cycle and productivity-linked parameters of lac insects

Biological and productivity-linked parameters of *Rangeeni* strain (*Baisakhi* crop) of lac insect were studied on different host plants namely *F. semialata*, *F. macrophylla* and *Z. mauritiana* at Lac Insect and Host Park, Entomological Research Farm, Punjab Agricultural University (PAU), Ludhiana during November 2019-July 2020.

The broodlac sticks (5 cm each) of *Rangeeni* strain having mature female (brood) cells were tied to one-year old *F. semialata* and *F. macrophylla* plants. Similarly, broodlac sticks (10 cm each) were tied to branches (2) of three years old *Z. mauritiana* plants. The nymphs were allowed to emerge from mature females for about two weeks. After the emergence of newly hatched nymphs, the sticklacs (*phunki*) were removed from host plants.

The results of different biological and productivity linked parameters on *F. semialata*, *F. macrophylla* and *Z. mauritiana* are presented in Table 8.15.

Table 8.15: Biological parameters of *Baisakhi* crop on different host plants under Punjab Conditions

Parameters	*F. semialata*		*F. macrophylla*		*Z. mauritiana*	
	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
Initial density of settlement (no./cm^2)	57.67- 69.67	63.47±2.23	45.00-64.00	58.26±3.42	84.33-102.66	96.26±3.42
% Mortality	6.83-11.41	9.75±2.23	10.10-11.58	11.02±2.23	7.96-16.63	12.71±2.23
Sex ratio (% male insects)	12.50-15.50	13.67±0.60	11.33-14.00	12.57±0.51	15.83-21.17	18.40±1.67
Density at crop maturity (no./cm^2)	3.33-6.33	5.13±0.56	2.33-4.00	3.40±0.31	4.67-6.33	5.27±0.29
Duration of pre-sexual stages (days)	110-114	112.00±0.70	118-130	121.80±2.15	118-129	121.40±2.24
Initiation of male emergence (days)	189-202	196.00±2.17	187-205	194.20±3.99	186-201	193.40±2.80
Longevity of female cell (days)	216-239	228.40±4.92	217-240	232.40±4.05	216-239	228.40±4.92
Female cell weight (mg)	6.39-7.12	6.84±0.20	6.35-6.92	6.63±0.20	7.84-8.80	8.25±0.28
Resin output (mg)	4.76-5.88	5.33±0.20	4.39-5.61	5.04±0.21	6.84-12.54	8.04±1.21
Fecundity/female (no.)	91-106	98.38±2.65	93.60-102.00	96.28±3.60	107-111.50	110.74±2.21
Broodlac yield /m shoot length (g)	59.20-63.70	63.50±2.34	50.90-65.30	58.00±4.16	241.57-250.00	245.42±2.46
Scrapped yield/m shoot length (g)	5.62-15.72	10.43±2.93	8.01-8.79	8.35±0.23	29.00-32.09	30.65±0.90

Effect of lac cultivation (*Rangeeni* strain; *Katki* crop) on seed yield and quality parameters of pigeonpea, *C. cajan*

- Hundred seed weight was 8.87, 9.09 and 7.50 g in lac inoculated plants as compared to 9.64, 10.06 and 8.56 g in control (un-inoculated) plants resulting in a reduction by 7.99, 9.64 and 12.38 per cent in AL 882, AL 201 and PAU 882, respectively
- Average seed yield per plot in lac inoculated plants was maximum in variety AL 201 (39.06 g) followed by AL 882 (27.99 g) and PAU 881 (19.93 g). The reduction in seed yield was 16.0, 22.08 and 23.07 per cent in variety AL 201, AL 882 and PAU 881, respectively.

Correlation between grain yield and scrapped lac yield

The correlation between scrapedlac yield and grain yield of pigeon pea was found to be significantly negative in all tested varieties, AL 201 (r = - 0.962), AL 882 (r = - 0.956) and PAU 881(r = - 0.920), respectively as shown in Fig. 8.23.

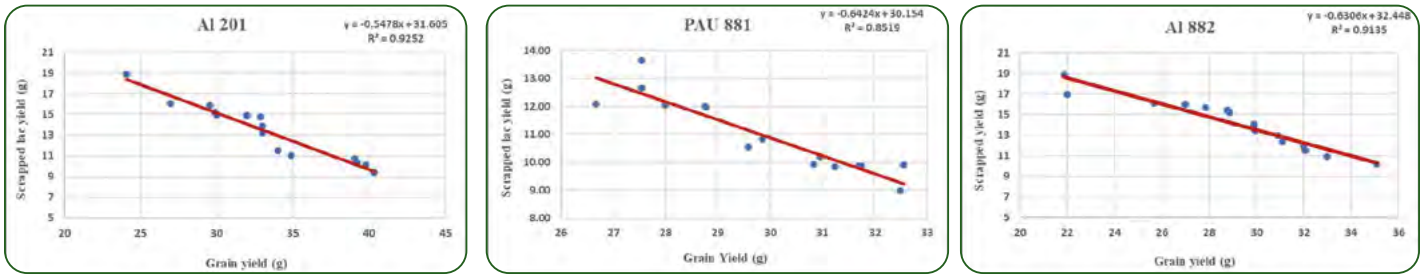


Fig. 8.23: Correlation between grain yield of *C. cajan* and scrappedlac yield

Effect of lac cultivation on biochemical parameters of *C. cajan*

(i) Total chlorophyll content: Total chlorophyll content was 3.19±0.27, 3.47±0.30 and 3.30±0.15 mg/g in lac uninoculated plants whereas it was significantly reduced to 2.76±0.25, 3.23±0.29 and 3.67±0.12 mg/g in lac inoculated plants with a percent decline of 15.75, 7.43 and 11.47 chlorophyll content among leaves of varieties Al 201, Al 882 and PAU 881, respectively.

(ii) Phenol: The phenol content was estimated in both uninoculated and inoculated plants of *C. cajan*. It seemed that the phenol content got significantly ($p<0.01$) increased in lac insect infested plants during maturity stage of growth. The phenol content recorded was 8.05±0.18, 7.47±0.19 and 7.78±0.16 mg/g under controlled conditions however, percent phenol content was found to be increased by 25.87, 19.21, and 26.91in Al 201, Al 882 and PAU 881, respectively.

(iii) Total sugar: Like phenol content, total sugar was also found to be increased significantly ($p<0.01$) in lac inoculated plants of *C. cajan* during maturity stage. The percent increase in sugar content at maturity stage was 12.83, 3.10 and 4.20 observed in PAU 881, Al 201 and Al 882, respectively in lac inoculated plants.

(iv) Protein: Total percent protein content significantly ($p<0.01$) declined in lac inoculated plants (7.38±0.18, 6.75±0.30, 6.53±0.13) as compared to controlled conditions (8.88±0.15, 8.71±0.28 and 9.43±0.18) whereas percent decline in protein content was found to be 16.91, 22.35 and 30.64 among seeds of pigeonpea varieties viz; PAU 881, Al 201 and Al 882, respectively. Results on all biochemical parameters are tabulated in Table 8.16.

Table 8.16: Effect of lac insect, *K. lacca* on biochemical parameters of different varieties of *C. cajan* under Punjab conditions

Biochemical Parameters	Al 201 (Mean±SE)				Al 882 (Mean±SE)				PAU 881 (Mean±SE)				
	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Mean
Total chl (mg/g)	3.19±0.27	2.76±0.25	-15.75	2.34*	3.47±0.30	3.23±0.29	-7.43	1.87^{NS}	3.30±0.15	3.67±0.12	-11.47	2.76*	-11.55
Phenol (mg/g)	7.84±0.18	10.61±0.35	25.87	7.43**	7.41±0.19	9.23±0.34	19.21	4.48*	7.62±0.16	10.45±0.18	26.91	10.15**	+23.99

Bio-chemical Parameters	Al 201 (Mean±SE)				Al 882 (Mean±SE)				PAU 881 (Mean±SE)				
	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Uninoculated	Inoculated	% Decrease/ Increase	t-test	Mean
Total sugar (mg/g)	5.47±0.10	5.64±0.12	3.10	3.47*	5.49±0.11	5.71±0.11	4.20	3.39*	5.35±0.09	6.03±0.05	12.83	15.76**	+6.71
Seed protein (%)	8.71±0.28	6.75±0.30	-22.35	5.65**	9.43±0.18	6.53±0.13	-30.64	13.93**	8.88±0.15	7.38±0.18	-16.91	18.36**	-23.30

Diversity of natural enemies associated with lac insect under Punjab conditions

Studies on the insect fauna associated with lac insect were carried out during June to December, 2020. The lac encrusted sticks were observed visually for presence of predator population. Lac insect samples were collected randomly with 5 replications after *Phunki* removal at every 15 days interval till harvest. The samples were kept in bioagent collection cages (20x20x30 cm) fitted with glass tubes. These cages were monitored at regular intervals to record the emergence of parasitoids and predators.

Under Punjab conditions, lac insect associated fauna comprised ten species namely *Eublemma amabilis* (Noctuidae: Lepidoptera), *Aprostocteus purpureus* (Eulophidae: Hymenoptera), *Bracon greeni* (Braconidae: Hymenoptera), *Chrysoperla zastrowi sillemi* (Chrysopidae: Neuroptera), *Tachardiaephagus tachardiae somervilli* (Encyrtidae: Hymenoptera), *Tachardiaephagus tachardiae* (Encyrtidae: Hymenoptera), *Tyndarichus clavicornis* (Hymenoptera), *Parechthrodryinus clavicornis* (Encyrtidae: Hymenoptera), *Psedohypatopa pulverea* (Lepidoptera) and *Tribolium* sp. (Coleoptera), Among these, *Eublemma* was the predominant species under Punjab conditions (Table 8.17). Different diversity indices such as Shannon Weiners index (H'), Pielou Evenness index (J) and Southwood Dominance index (D) for lac insect natural enemies population are 0.66, 0.63 and 0.36, respectively.

Table 8.17: Natural enemies of lac insects under Punjab conditions

S. No	Name	Predator/parasitoid	Order	% Abundance
1.	*Eublemma amabilis* Moore	Predator	Lepidoptera	25.63
2.	*Aprostocteus purpureus* (Cam.)	Parasitoid	Hymenoptera	18.75
3.	*Bracon greeni* (Ashm.)	Hyper- parasitoid	Hymenoptera	23.75
4.	*Chrysoperla zastrowi sillemi* (Esben-Peterson)	Predator	Neuroptera	5.00
5.	*Tachardiaephagus tachardiae somervilli* (Mahd)	Parasitoid	Hymenoptera	2.50
6.	*Tachardiaephagus tachardiae* (How)	Parasitoid	Hymenoptera	4.38
7.	*Parechthrodryinus clavicornis* (Cam.)	Parasitoid	Hymenoptera	3.12
8.	*Tyndarichus clavicornis* (Alam)	Parasitoid	Hymenoptera	3.13
9.	*Pseudohypatopa pulverea*	Predator	Lepidoptera	7.50
10.	*Tribolium* sp.	Predator	Coleoptera	6.25

6a. ICAR-Research Complex for Eastern Region, Patna, Bihar

Natural occurrence of lac insects

During the survey in twenty-eight districts of Bihar, the natural occurrence of lac insect and its host plants was recorded in eighteen districts (Tables 8.18-8.21). Natural occurrence of lac was found on *F. religiosa* and *F. benghalensis* only. Surprisingly, it was not recorded on *B. monosperma* and *Z. mauritiana* in any place of surveyed areas, except in Banka district. The prevalence of lac insect was more on both species of

Ficus in majority of region and on the protected trees grown in the vicinity of religious places like temples. The abundance of surviving lac insect was more in Southern part of Bihar namely Bhagalpur, Banka, Sheikhpura, Munger, Lakhisarai, Arwal, Nawada and Patna. However, scattered population was also observed in some districts in Northern part of Bihar (Fig. 8.24). During the survey only crimson coloured *rangeeni* strains on these hosts with varying densities were observed. Through interaction with local residents during the visit it was ascertained that the lac insect was highly prone to summer heat mortality and its natural occurrence is highly threatened through human interventions, coupled with the occurrence of parasitoids and predators. Local residents bordering with Jharkhand informed that lac was abundant and was collected by tribal people about 15-20 years back. However, majority of the local people were unaware about this insect. Not long ago, collection of lac was carried out practically throughout the country including Bihar which contributed significantly to national lac production, but now its share is almost negligible after division of Bihar. However, natural occurrence of lac insect is well established particularly on *Ficus* spp. as evident during survey period.

Parasitoids and predators

During the investigation two species of predators *Eublemma amabilis, Pseudohypatopa pulverea,* and two species of primary parasitoids *Tachardiaephagus tachardiae* and *Aprostocetus purpureus* were recorded. Among the parasitoids, *A. purpureus* was found more in number (42 per 10 cm lac encrustation) as compared to *T. tachardiae* (14 per 10 cm lac encrustation).

Table 8.18: Natural occurrence of lac insect and their host trees in Agro- Climatic Zone I (North-West) of Bihar

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
1.	Begusarai	Begusarai, Bhagwanpur, Matihani, Barauni, Naokothi, Teghra, Garhpura, Chhorahi, Balia	*B. monosperma, F. religiosa, Z. mauritiana, F. benghalensis*	*F. religiosa* and *F. benghalensis*
2.	Darbhanga	Darbhanga, Baheri, Biraul, Singhwara, Jale, Bahadurpur, Benipur, Manigachhi, Hanumannagar, Alinagar, Ghanshyampur, Tardih, Kiratpur	*F. religiosa, Z. mauritiana*	*F. religiosa*
3.	East Champaran	Motihari, Chakiya, Mehsi, Kotwa, Harsidhi	*F. religiosa, Z. mauritiana*	Not observed
4.	Gopalganj	Gopalganj, Thawe, Phulwaria, Manjha, Barauli	*F. religiosa, Z. mauritiana*	*F. religiosa*
5.	Muzaffarpur	Paroo, Katra, Minapur,	*F. religiosa, Z. mauritiana*	*F. religiosa*
6.	Samastipur	Samastipur, Pusa, Kalayanpur, Tajpur, Morwa, Patori, Warisnagar, Ujiarpur, Khanpur	*F. religiosa, Z. mauritiana*	*F. religiosa*
7.	Saran	Chapra, Maker, Masharkh, Nagra, Dariypur, Sonepur, Dighwara, Amnour, Taraiya, Panapur, Parsa	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa*
8.	Siwan	Nautan, Siwan, Barharia, Hasanpura, Siswan, Raghunathpur, Darauli, Mahrajganj, Ziradei	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa*

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
9.	Vaishali	Hajipur, Vaishali	*B. monosperma, F. religiosa, Z. mauritiana*	Not Available

Table 8.19: Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone II (North-East) of Bihar

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
1	Kishanganj	Kochadhamin, Thakurganj, Pothia, Bahadurganj, Kishanganj, Dighalbank, Terhagachh	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa*
2	Khagaria	Khagaria, Gogri, Alauli, Beldaur, Parbatta, Chautham, Mansi	*B. monosperma, F. religiosa, Z. mauritiana*	Not available

Table 8.20: Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone IIIA (Southern East) Bihar

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
1.	Bhagalpur	Sabour, Bhagalpur, Kahalgaon	*F. religiosa, Z. mauritiana*	*F. religiosa*
2.	Banka	Banka, Barahat, Dhoraiya, Katoria	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa, B. monosperma*
3.	Sheikhpura	Sheikhpura, Ariari, Chewara, Ghat kusumbha, Shekhopur sarai	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa*
4.	Munger	Munger Sadar, Dharahara, Bariyarpur, Jamalpur, Tetiya bamber, Tarapur	*F. religiosa, Z. mauritiana*	*F. religiosa*
5.	Lakhisarai	Lakhisarai, Barahiya, Pipariya, Surajgarha, Ramgarh Chowk	*F. religiosa, Z. mauritiana, F. benghalensis*	*F. religiosa* and *F. benghalensis*
6	Jamui	Jhajha, Jamui, Barahat, Chakai, Gidhaur, Sono	*B. monosperma, F. religiosa, Z. mauritiana*	Not available

Table 8.21: Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone IIIB (South West) Bihar

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
1.	Patna	Patna sadar, Masaurhi, Dhanarua, Punpun, Bikram, Pali, Danapur, Phulwari	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa, Z. mauritiana*

Sl. No.	District	Surveyed areas (Block)	Host plants observed	Host on which lac insect observed
2.	Bhojpur	Arrah, Jagdishpur, Piro, Barhara, Shahpur, Koilwar, Tarrai, Behea, Agaion	B. monosperma, F. religiosa	*F. religiosa*
3.	Kaimur	Bhabhua, Bhagwanpur, Mohania, Chand, Adhaura, Ramgarh, Rampur	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa, Z. mauritiana*
4.	Arwal	Kaler, Karpi, Kurtha, Sonvadra Bansi, Arwal	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa*
5.	Buxar	Kesath, Chaugain, Buxar, Nawanagar, Barhampur, Dumraon	*F. religiosa, Z. mauritiana*	Not Available
6.	Jehanabad	Kako, Ghoshi, Jehanabad, Makhdumpur	*B. monosperma, F. religiosa, Z. mauritiana*	Not Available
7.	Rohtas	Akorhigola, Bikramganj, Chenari, Dawath, Dehri, Dinara, Karakat, Kochas, Nasirganj, Nauhata, Rajpur, Rohtas, Sasaram	*B. monosperma, F. religiosa, Z. mauritiana*	Not Available
8.	Aurangabad	Nabinagar, Aurangabad, Deo, Kutumba, Obra, Daudnagar	*B. monosperma, F. religiosa, Z. mauritiana*	Not Available
9.	Gaya	Manpur, Banke Bazar, Sherghati, Imamganj, Dobhi, Parayia, Tekari	*B. monosperma, F. religiosa, Z. mauritiana*	Not available
10	Nalanda	Ekangarsarai, Parbalpur, Noorsarai	*F. religiosa, Z. mauritiana*	Not available
11	Nawada	Akbarpur, Gobindpur, Pakribarawan, Ben, Nawada	*B. monosperma, F. religiosa, Z. mauritiana*	*F. religiosa* and *B. monosperma*

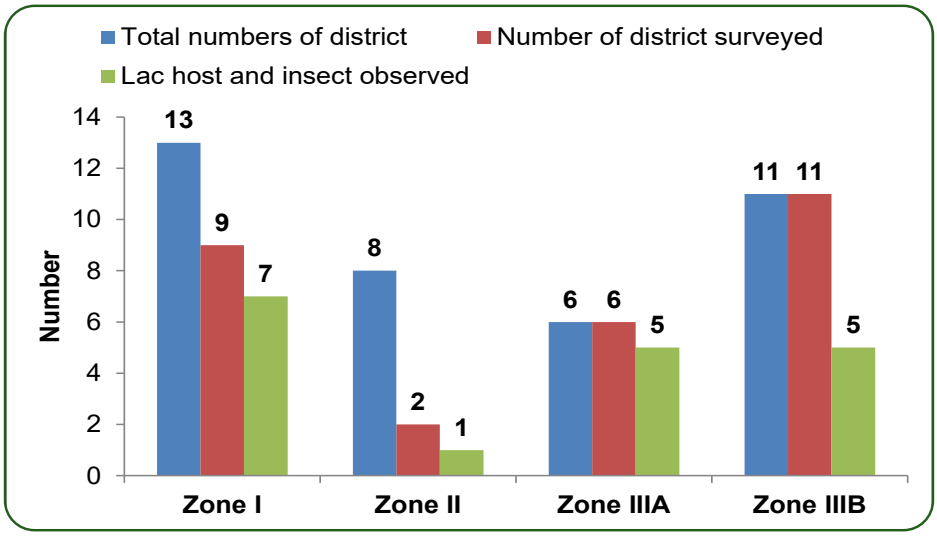


Fig. 8.24: Natural occurrence of lac insect in different agro-climatic zones of Bihar

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

A. *In-situ* conservation of lac-insects / host plants on larger scale

a) Multiplication of collected local lac-insect population

Plants of *F. semialata* were raised in nursery for rearing lac insects for the purpose of conservation and multiplication of the insect. Few seedlings of *F. semialata* were planted in pots and were raised in optimum protected natural condition. During mid-October, on the appearance of emergence marks in the tagged branches of infested trees in field, the branches were partially clipped and were made into cuttings of broodlac of small size (5 cm/ brood stick). Broodlac sticks were wrapped in muslin cloth bags and were inoculated on the succulent branches of substitute experimental host i.e. *F. semialata* both in nursery and in pots as well. '*Phunki*' were removed after complete emergence and settling of Lac insect crawlers on the branches. Periodic management of nursery and potted plants of *F. semialata* bearing lac insect crawlers were performed. Observation on the maturation and growth of lac insects were being recorded timely.

b) Conservation through selfing in Jammu region

Partial brood was allowed for natural inoculation on the same host plants for sustaining and conserving native strain. To be more precise, twelve secure plants were inoculated in the vicinity. Table 8.22 depicts the present status of the conservation of natural population by selfing in Jammu region.

Table 8.22: Conservation of selfing in Jammu region

Host	Total plant surveyed (No)	Frequency of occurrence without inoculation	Trees Inoculated in previous season	Presence of lac	Brood Status
Ber	883	21	412	141	Good
Kikar	513	0	275	56	Good
Palas	629	0	198	34	Poor
Shisham	312	0	93	21	Poor
Kher	298	0	90	14	Poor

c) Artificial inoculation and conservation in mid hills to escape summer mortality:

In artificial inoculation, brood twigs were cut in size 20 - 30 cm in length. Then, the cut pieces of brood twig were tied to fresh tree twigs in such a way that each stick touches the tender branches of trees at several places. This was done on pre pruned *Ber* at Dhar Road from Majalta to Billawar and Basholi, *Kher* and *Ficus racemosa*. Out of 65 *Ber* plants inoculated, lac survived on 49 plants. However, lac was not survivied on any of the 18 *F. racemosa* trees inoculated and only on 9 plants out of 37 *Kher* plants inoculated.

d) Conservation by artificial inoculation

Broodlac samples were inoculated on succulent branches of *Ficus* sp., *Ber* and *Kikar* at University Rainfed Research Station, Raya and around the Jammu region and Himachal Pradesh. Artificial inoculation of the brood was done at SKUAST-J campus on *arhar* plants that were raised in the Gene Bank of the university. A good settlement was recorded on the *arhar* plants so far. *F. semialata* and *F. macrophylla* were raised in nursery for rearing lac insects for the purpose of conservation and were then transplanted to the Gene Bank where, they were inoculated with the brood. A few seedlings of *F. semialata* and *F. macrophylla* were planted in pots and were raised in optimum protected natural condition. Artificial inoculation was done was on the potted plants also.

B. Brood Multiplication and interventions for On-Farm trials and demonstrations

a) Brood Production: Past year collections were subjected to brood production and re-inoculated for further use (Table 8.23). Plants of *F. semialata* and *F. macrophylla* were raised in nursery and1398 seedlings were also distributed among the famers. Besides this, Brood farm was also established at Vijaypur and Chatha.

Table 8.23: Details of broodlac production

Location	Quantity produced (kg)	Reintroduced for conservation in same location (no. of plants)	Demonstrations (no. of plants)
Gol Market	144	59	31
Bantalab	75	35	15
Purkhoo	63	29	15
Udheywala	35	26	9
Kathua	66	34	13
Canal Raod	40	28	11
Nagrota	41	28	11
Kangra (H.P.)	19	13	5
Cherni Pahari	190	76	43
Chi Chi Mata	123	64	29
Ghagwal	64	33	16
Railway Station area	53	29	12
Barmana	17	9	5
TOTAL	**930**		

b) Inoculation and management of broodlac

During mid-October, on the appearance of emergence marks in the tagged branches of infested trees in field, the branches were partially clipped and were made into cuttings of broodlac of small size (5 cm /brood stick). Broodlac sticks were wrapped in muslin cloth bags and were inoculated on the succulent branches of substitute experimental host i.e. *F. semialata* and *F. macrophylla* in nursery. '*Phunki*' were removed after complete emergence and settling of Lac insect crawlers on the branches. Periodic management of nursery and potted plants of *F. semialata* and *F. macrophylla* bearing Lac insect crawlers were performed. Observation on the maturation and growth of Lac insects were being recorded timely.

c) Gene bank

Eleven collections that survived successfully from previous year collections were reinoculated on *flamingia* and being maintained in the Gene Bank (Fig. 8.25). The lac insects samples collected from various lac hosts from different localities were inoculated on different lac host plants at SKUAST- Jammu during the month of June and October 2020. To prevent the infestation of lac insects with different natural enemies and fungi different pesticides were sprayed on host plants at different stages of lac insect.

d) Effect of Temperature on survival of lac insect

The relationship between the temperature and mortality is depicted in Fig. 8.26 that showed increased mortality with the increase in temperature. The mortality started increasing from 16th standard week, when the temperature tends to reach around 33.5^{o}C. Among *Ber*, *Kikar*, *Flemengia* and *Arhar*, maximum mortality of 76.43 per cent was recorded in *Ber* followed by *Flemengia, Arhar* and *Kikar* with per cent mortality of 75.55, 71.83 and 48.46 respectively, when the maximum temperature of 40.4^{o}C was recorded.

Fig. 8.25: Activities at Gene Bank

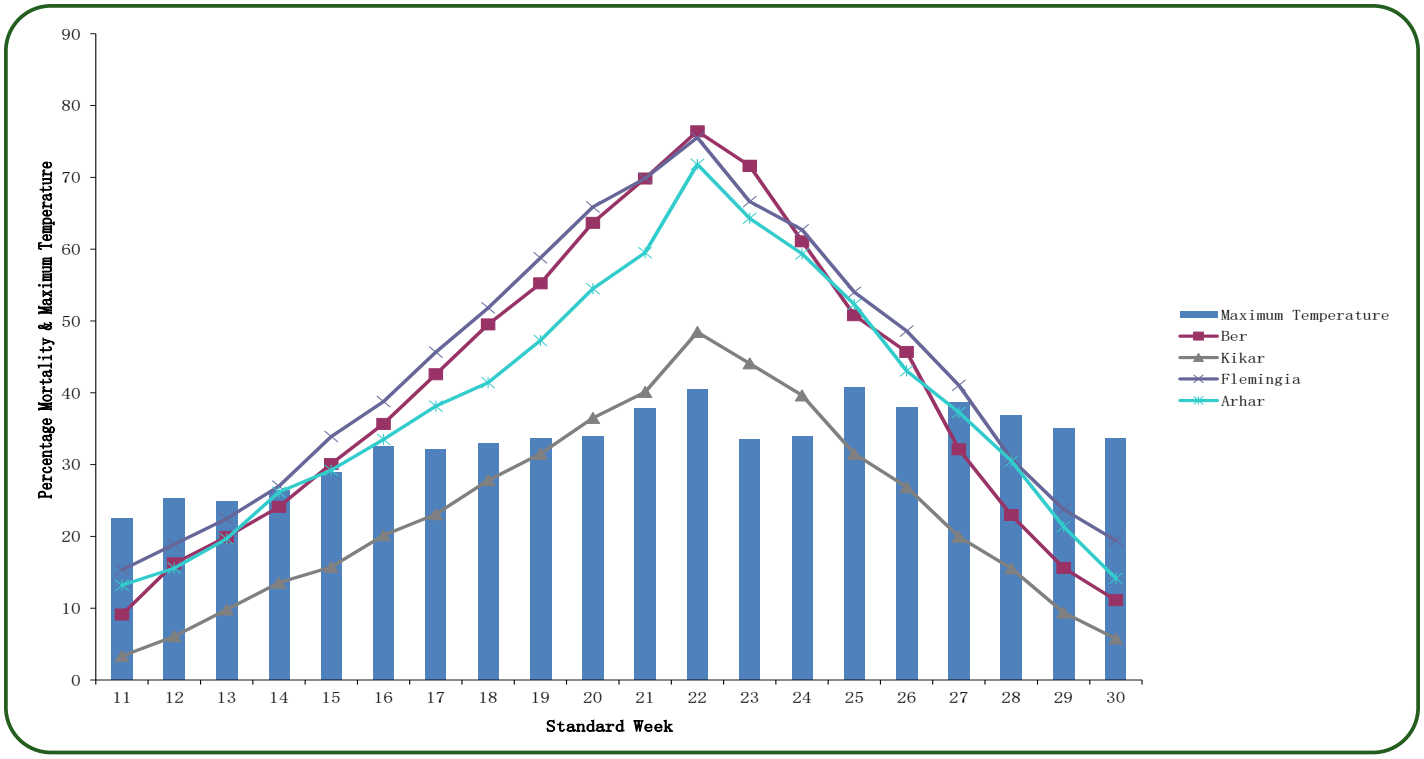


Fig. 8.26: Relation between temperature and mortality of lac insect

e) Parasitism

Predators observed on lac insects were *Eublemma amabilis, Pseudohypatopa pulverea* and *Chrysoperla* zastrowi and parasitoids observed were *Tachardiaephagus tachardiae, Aprostocetus* sp., *Telenomus* Haliday, *Paranathrix tachikawai, Telenomus* sp., *Trichopria* sp., *Aenasius bambawalei, Parechthrodryinus* sp., *Bracon* sp., *Eupelmus* sp. and *Elasmus* sp. Two applications of Indoxacarb (0.5 ml/l) significantly reduced the infestation of parasitoid infected lac cell on *rangeeni* lac on *ber* over the control at 90 days after BLI. At 90 days after BLI the mean incidence of parasitoids was lowered from 2.91/2.5sq cm to 0.72/2.5sq cm. However, the parasitoid numbers varied from 23 to 43. Pesticide applications significantly reduced the mean number predators/parasitoids infested lac cells at harvest. It was 42.31 in case of control and was reduced to 20.08 in treated plants at harvest.

C. Trainings and Demonstrations

a) Trials at Research Farm, SKUAST-Jammu and at farmers' field

Four trails were conducted at Research Farm, SKUAST-Jammu and fifteen trails at selected progressive grower's fields wherein seventy five farmers were exposed to lac cultivation while nearly two hundred eleven farmers were shown lac being grown / cultivated at selected sites for the demonstration of lac cultivation technologies. Saplings of *F. semialata* and *F. macrophylla* and broodlac were distributed to the potential growers for conservation and multiplication. One hundred and eight farmers were provided with broodlac. Twenty two visits for continuous deliberations with the people of the areas were conducted regarding the presence of lac insect in the area and also information was given to them regarding lac cultivation and its value and uses. Informative pamphlets (1018 No.) were also distributed among the participants. Five interactive sessions were conducted for the farmers.

b) Training programmes

Three One-day training programmes were conducted at Raya Station of SKUAST-Jammu, Cherni Phari and Main campus Chatha, SKUAST-Jammu in collaboration with IINRG, Ranchi. The farmers were briefed about the importance of lac insect and lac cultivation to the progressive growers of the region. Progressive growers were also informed about the monetary benefits of lac and how can they create their own livelihood while attaining lac cultivation on large scale. Near about

45 progressive growers actively participated in each training programme. These farmers were given complete demonstration from nursery preparation upto harvesting and inoculation of broodlac on different host plants of the region. Pamphlets were distributed among the farmers containing information about scientific cultivation of lac in vernacular languages.

c) Involvement of students

Not only progressive growers, but 98 RAWE students of SKUAST-Jammu were also enlightened about the importance of lac insect and lac cultivation in the region. They were also briefed about the scientific rearing and handling of the lac insect. Besides this, students from the visiting schools were briefed about the lac insect and their economic importance. Trainings were imparted students of Diploma in Agriculture Training and Diploma in Horticulture Training which included candidates from Department of Agriculture and Horticulture J&K Government. They were briefed about all the technical skills used in the scientific cultivation of lac from nursery preparation to plantation raising and from brood inoculation to brood harvesting.

d) Performance of different locally collected lac strains

Lac insect samples collected on different lac hosts from different locations were inoculated on different lac host plants at SKUAST – Jammu. After inoculation the emergence and settlement data were recorded for each sample of lac insect on host plants. To prevent infestation of lac insects with different natural enemies and fungi different insecticides were sprayed on host plants at different stages of lac insects.

(i) Performance on *F. semialata*: Due to rising temperature and parasitism, the number of stick lac/bush were reduced below 10/plant. However other parameters were not substantially reduced on *F. semialata* (Fig. 8.27).

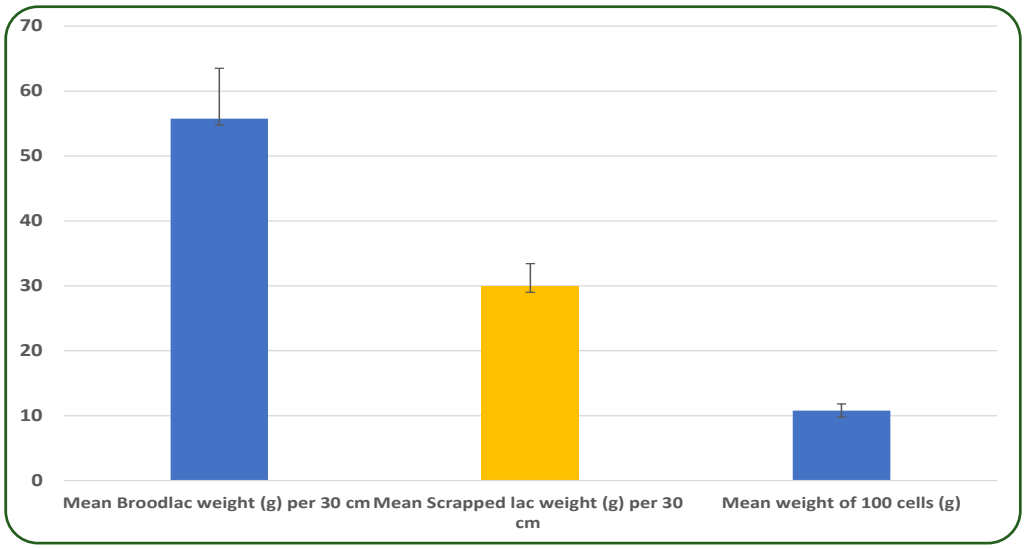


Fig. 8.27: Lac crop performance (*Katki*) on *F. semialata* under intensive management

(ii) *Rangeeni* lac crop performance on natural host *ber* at Raya: Mean number of sticklac per plant varied from 9 to 42. The mean weight of sticklac and raw lac per 30 cm varied from 30.95 to 65.62 g and from 9.20 to 18.18 g, respectively. The mean fresh weight (g) of 100 cell of lac insect varied from 3.09 to 6.61.

8. State Forest Research Institute (SFRI), Jabalpur

Survey in Madhya Pradesh

Survey of lac insect and host plants was done in 18 blocks of 07 districts but lac occurrence was recorded in 16 blocks of 07 districts in Madhya Pradesh. Lac insect species were observed on *Akashmani* (*Acacia auriculiformis*), *Jangle Jalebi* (*Pithecellobium dulce*), *Safed Siris* (*Albizia procera)* and *Peela Gulmohar (Peltophorum pterocarpum*), *Gular* (*Ficus recemosa*) and *Palas* (*Butea monosperma*), *Ghont* (*Zizyphus xylopyrus*), *Ber* (*Z. mauritiana*) naturally in farm lands, revenue lands, and forest lands. Live lac insects were found in the blocks as given in Fig. 8.28. The information on lac insect/host plants during each field survey was recorded in passport data sheets and compiled.

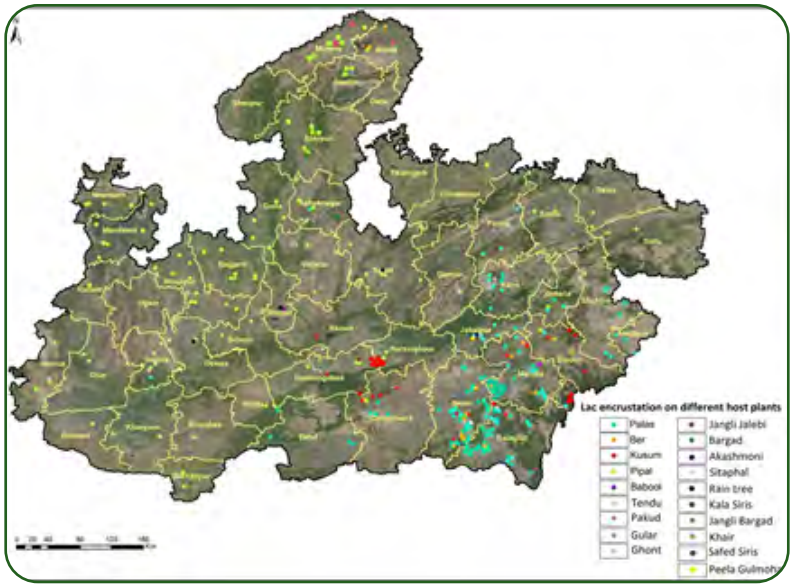


Fig. 8.28: GIS Map showing occurrence of lac insect in different parts of MP during surveys fom 2015 to 2021

Collection and conservation of lac insects under *ex-situ* condition

Lac insect field gene bank

- 70 samples of lac insect from 16 sites of 12 districts of Madhya Pradesh were conserved on *F. macrophylla, F. semialata,* Gular Pipal and Sitaphal in lac insect gene bank for *ex-situ* conservation.
- 45 samples of lac insect from 22 sites of 08 districts of Maharashtra were conserved on *F. macrophylla* plants in lac insect field gene bank.
- Green house was created to protect lac host plants from scorching sun and heat waive of summer.

On –farm trials on lac cultivation technologies in Madhya Pradesh

Pruning demonstration in Madhya Pradesh and Maharashtra

- Pruning demonstrations were conducted in total 5 locations in Madhya Pradesh, in which 185 host plants such as *palas* and *kusum* were pruned and around hundred farmers participated in these demonstratins. Pruning demonstrations were conducted in total 5 locations in Maharashtra, in which 245 *palas* plants ere pruned and in total 81 farmers participated in these demonstratins.

Broodlac inoculation trials

- Twenty three, 20 and 22 kg broodlac samples were inoculated on 60 *Palas* trees of 5 farmers' field in village Khairi, Narayanganj block, Mandla district; on 60 *Palas* trees of 11 farmers' field in village Bodli, Nowrojabad block, Umaria district and on 55 *Palas* trees of 12 farmers' field in village Mediyaras, Anuppur district, respectively.

Harvesting of lac

- 17 kg broodlac had been inoculated on 60 *Palas* trees (November 2019) in village Rehlonkala of Seoni district and 91 kg stick lac have been produced in *Baisakhi* crop and 125 kg in *Katki* crop for forest area by *Van Samiti* member.
- 22 kg broodlac had been inoculated on 55 *Palas* trees in village Kohani (Mandla) and 1.2 quintal stick lac have been produced in *Baisakhi* crop and 120 kg in *Katki* crop for 08 farmers' fields.
- 06 kg broodlac had been inoculated on 12 *Palas* tree in village Rehlonkala (Seoni) and 35 kg stick lac were produced in *Baisakhi* crop and 65 kg in *Katki* crop from 05 farmers' fields.
- 15 kg broodlac had been inoculated on 55 *Palas* trees in village Bhadari (Mandlai) and 1.10 quintal stick lac have been produced in *Baisakhi* crop and 105 kg in *Katki* crop from 05 farmers' fields.
- 15 kg broodlac had been inoculated on 48 *Palas* trees in village Chargaon (Mandla) and 1.05 quintal stick lac have been produced in *Baisakhi* crop and 95 kg in *Katki* crop from 10 farmers' fields.

On –farm trials on lac cultivation technologies in Maharashtra

Broodlac inoculation trials

- In village Malepar, Bhandara district-25 kg broodlac samples have been inoculated on 200 *Palas* trees by 10 women members of Chetanya Mahila Bachat gath.
- In village Khursipar, Bhandara district- 15 kg broodlac samples have been inoculated on 46 *Palas* trees in 04 farmers' field.
- In village Gunthara, Bhandara district-15 kg broodlac samples have been inoculated on 30 *Palas* trees in 03 farmers' fields (Fig. 8.29).

Fig. 8.29: Broodlac inoculation trials in Maharashtra

Broodlac inoculation trials in November 2020

- Village Selotpar, Gondia district -12 kg broodlac samples have been inoculated on 40 *Palas* trees in 6 farmers' field.
- Village Dabba, Bhandara district -12 kg broodlac samples have been inoculated on 40 *Palas* trees in 2 farmers' field.
- Village Khursipar, Bhandara district -18 kg broodlac samples have been inoculated on 60 *Palas* and *ber* trees in 4 farmers' field.
- Village Malepar, Bhandara district- 18 kg broodlac samples have been inoculated on 08 *Palas* trees by 10 women members of Chetanya Mahila Bachat Gad.
- Village Somnapur, Gadchiroli district-18 kg broodlac samples have been inoculated on 80 *Palas* trees in 8 farmers' field.
- Village Malkhapur, Gadchiroli district-10 kg broodlac samples have been inoculated on 40 *Palas* trees on 08 farmers' field.

Socio-economic status of lac growers in different lac production areas of Mandla district of Madhya Pradesh

The study was conducted in Mandla district, which is third largest lac producing district of the state. Random sampling technique was employed to select lac growers. Sixty seven lac producing farmers of three blocks (Nainpur, Mohgaon and Mawai) of Mandla district were selected at random and interviewed. All the relevant information was collected from the lac producers through a pre-tested questionnaire in the year 2020.

Distribution of respondents according to their age: Majority of farmers (34.32%) from Mandla district belonged to middle age group (36-45 years), about (31.34%) respondents were in the young age group (upto 35 years) 23.88% respondents belonged to 46-55 age group, (5.97%) respondents were of senior age group (56-65 years) and (4.47%) of old age group (<66).

Educational status of lac growing farmers: Among lac growing farmers district maximum literacy was reported upto middle school level (40.30%) followed by primary school (26.87%), high school (10.45%), intermediate (1.49%) and only 1.49% at graduate level. About 19.40% lac growing farmers were illiterate.

Family size of lac growers: Family size of majority 59.7% lac grower is of 5-7 members size followed by 22.39% having (<4), 14.93% lac growers having (8-10 family members) and (2.98%) having (>10) family size, respectively.

Classification of lac growing farmers on the basis of land holding: In Mandla district, 37.30% lac growing farmers had small size land holdings (1-2 ha.) followed by 26.9% having medium size land holding (4-10 ha.), 16.4% Semi-medium (2-4 ha.), 13.4% Marginal (<1 ha.), 1.49% large land holding (>10) and 4.48% farmers were landless 6.2).

Lac host plants holding of lac growers: About 95% lac growers have *Palas* and 5% lac growers cultivated lac on *kusum* host tree. Regarding availability of *Palas* host trees for lac cultivation, maximum lac growers 17.91% of each had >25 host trees and 16.42 per cent had 26-50 host each followed by 51-100 host trees were owned by 8.96% farmers of each having 101-200 and <200 host plants. However, 13.43% farmers cultivated lac in forest areas by *van samiti* groups, Whereas, 16.42% farmers dependant on forest and collect *Kusmi* lac from *Kusum* host plants from nearby forest area. The utilization of host tree for lac cultivation in the study area was 92.04% for *Palas* and 7.96% for *Kusum* host tree.

Distribution pattern of scale of lac production (Percentage of lac growers): In term of production, maximum lac growers (38.81%) produced 51-100 kg lac with an average production of 70.91 kg followed by (16.42%) produced 101-150kg lac with average production 124.28, (16.42%) produced lac in 26-50 kg with 38.18 average production, (8.96%) lac growers produced good amount of lac >300 kg with 670 kg average production, (5.97%) produced lac in 151-200 kg with 195 kg average production. However, (4.48%) lac growers produced lac in 251-300 kg with 293.3 average production and only 2.99% lac growers produced lac in 201-250 kg with 240 kg average production of lac.

Source of income of lac growers: Lac is a subsidiary crop for the lac growers who depend on it for meeting cash expenses towards family needs and cash purchase for their household requirements. Amongst the different sources of income, agriculture cropping ranked first (50.62%) followed by Lac (22.9%), Labor activity (19%), salary (4.67%), forest produce (2.41%), Business/shop (0.43%), Milk production (0.19%) and Vegetables (0.03%). Thus in the selected areas, lac is only next to agriculture as an important source of income.

Distribution of farmers' income from lac cultivation: With respect to information on various income sources, there was wide variation in income. Income of selected farmers of Mandla from lac crop is given in Fig 8.30. Income to selected farmers of Mandla district from lac crop in the study revealed that 31.34% farmers earn between Rs. 10,001-20,000, followed by 23.88% farmers who earn between Rs 5001 to 10000 and 23.88% farmers get upto 5000, 10.45% farmers earn more than 40001, 7.46% earn between Rs 20001-30000 and only 2.99% farmers get between Rs. 30,000-40,000 annually from lac production. Almost 78% farmers earn upto Rs 20,000 from lac cultivation.

Percentage share of income from lac cultivation to total income: As per estimation of income of selected farmers of Mandla district, 32.84% farmers share of lac income to total income is 10-20% followed by 23.88% farmers share of lac income ranging between 21-30% and 16.42% farmers share from lac income was <10%, 14.93% farmers share from lac income ranged between 31-40%. Only 11.93% farmers share of total income contributed by lac was more than 40%.

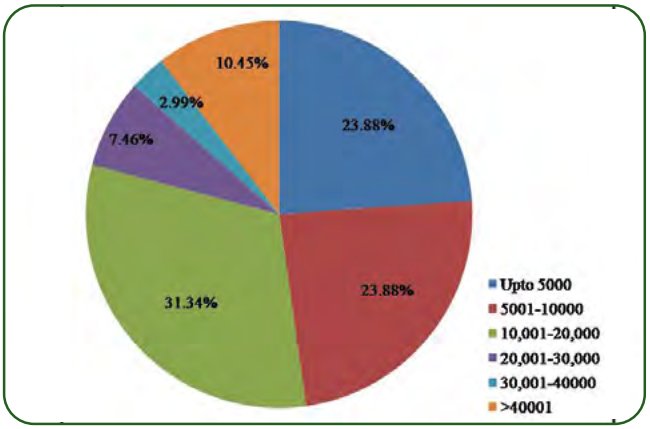


Fig. 8.30: Classification of farmers on the basis of income from lac cultivation in Mandla

Socio-economic status of lac growers in different lac producing areas of Hoshangabad district of Madhya Pradesh

The study pertains to data collected from 19 lac growing farmers from Bankhedi and Pipariya blocks of Hoshangabad district of Madhya Pradesh during the year 2020-2021.

- Maximum literacy was reported under middle school level (26.3%) followed by primary school (10.5%), high school and intermediate (5.26% each). However, 52.6% lac growing farmers were illiterate

- Majority of farmers (36.84%) from belong to young age group (up to 35 years), about (21.05%) respondents were from middle age group (36-45 years), (21.05%) respondents were of senior age group (56-65 years) and (10.53%) of old age group (<66).
- Family size of 36.8% lac growers ranged from (8-10) family members followed by 31.6% having 5-7 family members, 26.3% lac growers having <4 family members and 5.26% having >10 family size.
- About 42.1% lac growing farmers have semi-medium size land holding (2-4 ha.) followed by 31.6% marginal land holding (<1 ha)), 15.8% medium (4-10 ha.), 1.49% small land holding (1-2 ha.) and 5.26% large land holding (>10 ha.)

Lac production status of lac growers: In term of production, maximum lac growers (36.8%) produced 26-50 kg lac with average production of 31 kg followed by 31.6% who produced less than 25 kg lac with average production of 20.16 kg, 15.8% produced good amount of lac (>150 kg) with 259.3 average production, (10.5%) lac growers produced 101-150 kg lac with 121.5 kg average production, 5.26% lac growers produced lac in (51-100 kg) with 90 kg average production.

Source of income of lac growers: Lac is a subsidiary crop for the lac growers who depend on it for meeting cash expenses toward family needs and cash purchase their household requirements. Amongst different source of income, agriculture ranked first (45.40%) followed by labour activity (27.22%), Lac (24.6%), forest produce (2.8%). Income from lac crop of selected farmers of Hoshangabad district in the study revealed that 47.48% farmers earn Rs. 5001-10000 annually followed by 26.40% farmers get more than Rs 30,000, (15.60%) farmers get between Rs 10,001-20,000 and 5.26% farmers earn between Rs 20,001-30,000 annually from lac production. However, only 5.26% farmers get less than 5000 annually (Fig. 8.31).

- Survey revealed that 47.40% farmers share of lac income to total income ranged between 10-20% followed by 21.04% farmers whose income share from lac ranged between 21-30%. However only 15.78% farmers share of total income contributed by lac upto 10% and >30% each.

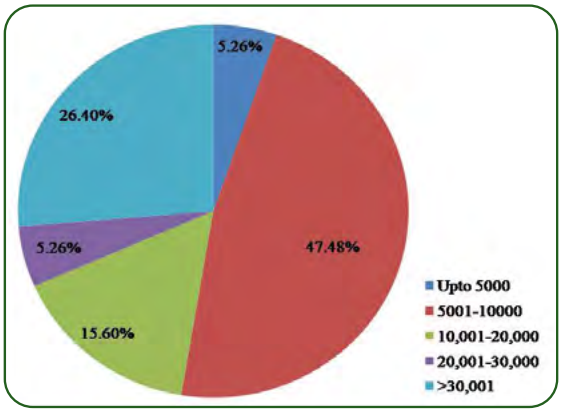


Fig. 8.31: Annual income of farmers from lac cultivation in Hoshangabad district

Socio-economic status of lac growers in different lac producing areas of Chhindwara district of Madhya Pradesh

- The study pertains to data collected from 16 lac growing farmers from Tamia and Junnardeo blocks of Chhindwada district of Madhya Pradesh during the year 2020-2021.
- In Chhindwara district maximum literacy was reported upto primary school level (25%) followed by middle school and high school level (12.5%). However, 50% lac growing farmers were found to be illiterate.
- Majority of farmers (37.5%) from Chhindwara district belong to young age group (up to 35 year) and 37.5% farmers middle age group (36-45 year), about (12.5%) respondents were senior age group (46-55 year) and 12.5% from senior age group (56-65)
- About 43.8% lac growing farmers had marginal size land (<1 ha.) followed by (31.3%) small land holding (1-2 h.a), (18.8%) semi-medium land holding (2-4 ha.) and 6.25% medium land holding (4-10 ha.).
- Family size of 62.5% lac growers ranged between 5-7 members, were followed by 25% having (<4 family

members) and 12.5% lac growers having (8-10 family members).

Source of income of lac growers: Lac is a subsidiary crop for the lac growers who depend on it for meeting cash expenses toward family need and cash purchase for their household requirements. Amongst the different source of income, labour work ranked first (37%) followed by food grain (Agriculture) (27.25%), Lac (24.16%) and forest produce (11.59%).

Lac production status of lac growers: In terms of production of lac, 37.5% lac growers produced between 26-50 kg lac with average production of 33.33 kg and >25 kg with 14.14 average production of lac 18.75% of farmers produced lac between 51-100 kg lac with average production 72.33 kg, 6.25% lac growers produced good amount of lac (>100 kg) with an average production of 270 kg lac crop.

- Income of selected farmers from lac crop in the study revealed that 43.75% farmers earn between Rs. 5001-10000 annually followed by 18.75% farmers who get up to Rs 3000, 12.5% farmers get Rs 3001-5,000 from lac production. However, 6.25% farmers get Rs 10001-20000 and another 6.25% get Rs 20001-30,000 annually from lac cultivation remaining (12.5%) farmers earn <30,000 annually (Fig. 8.32).
- It is also estimated that 43.8% farmers share of income from lac to their total income ranges between 21-30% followed by 31.2% farmers share from lac income ranges between 10-20%. 12.5% farmers share is less than 10%. However only 12.50% farmers share of total from lac income is >30% only.

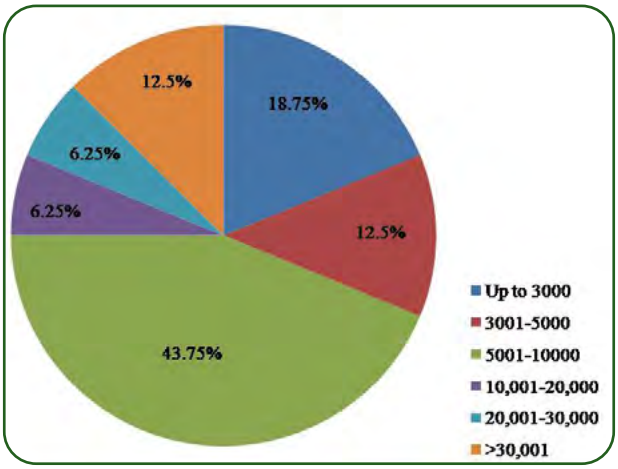


Fig. 8.32: Annual income of farmers from lac cultivation in Chhindwara district

Status of lac hosts in MP

Abundance of lac host plants in Mandla district: Maximum host plant density were noted in forest area (212.31 ha-1) followed by (184.0 ha-1) in farmers' field. Among the listed host plant species in Mandla, *Palas* having maximum 109.29 plants ha-1 followed by Tendu (27.86 plants ha-1), *Ber* (23.57 plants ha-1), *Kusum* (17.14 plants ha-1), Babul (6.43 plants ha-1), Khair (4.29 ha-1), Sitaphal (3.21 plants ha-1), Khair (4.29 plants ha-1) Gular (3.21 plants ha-1) and minimum number of plant ha-1 was found in Pipal and Safed Siris (1.07 plants ha-1).

Abundance of lac host plants in Hoshangabad district: Maximum host plant density were noted in forest area (121 ha-1) followed by (74.17 ha-1) in farmers' field. Among the listed host plant species, *Kusum* is having maximum diversity (63.33 plants ha-1) followed by *Palas* (24.17 plants ha-1), Tendu (3.33 plants ha-1), Sitaphal (0.83 plants ha-1), Gular (0.42 ha-1) Khair (0.42 plants ha-1) and Ghont (0.42 ha-1).

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- How to cultivate Lac insect on *Kusum* in Telugu

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- Arshdeep Singh (2020) Biology of *Kerria lacca* (Kerr) on various host plants and diversity of its natural enemies. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Papers presented in conferences

- Gupta RK (2020). Current status and issues in lac production. In: National Seminar on IPM in field crops: Current status and strategies, held on 6-7 November, 2020 organized by MM University, Ambala.
- Gupta RK (2020). Impact of climate change on Lac insect. In: Virtual Conference on Biodiversity Ecosystem Services in a Climate Change Perspective, held on 10-11, December, 2020 at EMPRI, Bangalore.
- Roopa Patil participated in International conference on Frontier research in applied zoology and insect pest management strategies - A way forward for food and nutritional security held at UAS Raichur on 12 to 14, Feb, 2020.

Events organized

- Arranged an exhibition of lac during lac during KVK Sirsi Administrative building Inauguration on 17.8.2020. It was visited and appreciated by Shri. B. C. Patil, H'ble Minister of Agriculture, GoK, Shri, Shivaram Hebbar, H'ble Minister for Labour and District Incharge (UK), GoK, Dr. V. Venkatasubramanian, Director, ATARI XI, Bengaluru, Dr. M. B. Chetti, Vice Chancellor, UAS Dharwad, Dr. Ramesh Babu, Director of Extension, Board member of UAS Dharwad, Progressive farmers and other dignitaries.

Publicity

Radio Talk

- D. RK Gupta conducted *phone in programme on natural enemies and their role in agriculture with special emphasis on lac*, All India Radio, Jammu in the month of October, 2020.
- Dr. RK Gupta delivered a radio talk on *Rearing of beneficial insects for livelihood in Jammu region with special reference to Lac Insect*, All India Radio, Jammu in the month of September, 2020.

Research Programme

List of Approved Research Projects for the Year 2020-21

Sl. No.	Project No.	Title of the Project	Name of Investigators	% Time	Year of Start	Year of Completion	*
Core Programme – I : Productivity and Quality Improvement							
1.	1.1.067	Understanding lac insect-host plant interaction-A molecular approach	Ms Shruti Sinha Dr. Thamilarasi K	25	June, 2018	May, 2021	-
2.	1.1.070	Taxonomic studies of lac insects (Hemiptera: Coccoidea: Tachardiidae) and associated insect fauna	Shri NN Rajgopal	35	June, 2019	May, 2021	Dr. A Mohanasundaram
3.	1.1.072	Collection, conservation, characterization and evaluation of lac insect/ host plant diversity	Dr. VD Lohot Dr. J Ghosh Dr. Thamilarasi K Dr. A Mohanasundaram	25 25 25 25	July, 2020	Of continuing nature	Dr. KK Sharma, Director
Core Programme – II : Crop Production System Management							
4.	1.1.065	Evaluation of the effect of drip irrigation and plastic mulch on growth and seed yield of *Flemingia semialata*	Er. SK Srivastava	75	January, 2018	March, 2021	Dr. S Ghosal
5.	1.1.068	Effect of abiotic factors on lac associated fauna in *rangeeni* crops (Phase-II)	Dr. A Mohanasundaram	25	August, 2018	December, 2021	-
6.	1.1.069	Agronomic interventions influencing lac production in *palas* (*Butea monosperma*) in summer season	Dr. S Ghosal Shri NN Rajgopal	25 25	March, 2019	May, 2025	-
7.	1.1.071	Lac Integrated Cropping System through Participatory Approach	Ms LC Langlentombi Dr. S Ghosal Dr. NK Sinha Shri NN Rajgopal	50 25 25 25	April, 2019	March, 2022	-
Core Programme – III : Processing, Storage and Quality Management							
8.	1.2.073	Study on spray drying of gum *ghatti* (*Anogeissus latifolia*)	Er. Ranjit Singh Er. Priyanka Sakare **(October, 2018)**	30 25	April, 2018	March, 2021	-
9.	1.2.074	Study on infrared drying of seed lac	Er. Priyanka Sakare Er. Ranjit Singh	25 25	April, 2019	March, 2021	-
Core Programme – IV : Value Addition, Application Development and Product Diversification							
10.	1.2.071	Synthesis of *guar* gum hydrogel-nanoparticle hybrid scaffold	Dr. SKS Yadav	50	July, 2017	March, 2021	-

Sl. No.	Project No.	Title of the Project	Name of Investigators	% Time	Year of Start	Year of Completion	*
11.	1.2.072	Development and evaluation of resin/gum based sticky insect trap	Dr. N Thombare	25	April, 2018	March, 2021	Dr. A Mohanasundaram
12.	1.2.075	Study on natural gum based dietary fibre as encapsulant for delivery of functional feed	Dr. AR Chowdhury Dr. N Thombare Er. Ranjit Singh Shri Ch. Jamkhokai Mate Dr. Biplab Sarkar, ICAR-IIAB	35 25 25 15 -	September, 2019	August, 2022	-
Core Programme – V: Capacity Building of Farmers and Entrepreneurship Development							
13.	1.3.052	Capacity building, skill development, extension education and information service on natural resins and gums	Dr. Nirmal Kumar Dr. SKS Yadav Dr. RK Yogi	25 25 25	October, 2017	Of continuing nature	-
Core Programme – VI: Technology Evaluation, Refinement, Dissemination and Demonstration							
14.	1.3.053	Market information support and impact assessment of technological interventions for NRGs	Dr. RK Yogi Dr. Nirmal Kumar	25 25	October, 2017	March, 2021	-
ICAR-Network Projects							
15.	3.2.026	Network project on Harvesting, Processing and Value Addition of Natural Resins and Gums (ICAR)	Dr. N Prasad (PC & PI)	40	February, 2009	March, 2021	-
		Comparative evaluation of properties of *Bahera* (*Terminalia bellerica*) gum exudates collected from different agro-climatic zones	Er. Anamika Thakur, ICAR HQ Dr. MZ Siddiqui	-	April, 2018	March, 2020	-
		Exploration and preparation of field guide for minor gum & resin producing plants in India	Dr. N Thombare	25	April, 2018	March, 2021	Dr. VD Lohot
		Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees	Dr. SC Sharma Er. SK Pandey	30 30	January, 2019	March, 2021	Dr. VD Lohot
		'Preparation and characterization of modified *guar* gum nanocomposite films reinforced with *piyar* AgNPs for diversified applications'	Dr. MZ Siddiqui Dr. AR Chowdhury Er. Priyanka Sakare	25 25 25	November, 2019	March, 2021	-
16.	3.1.054	Network project on Conservation of Lac Insect Genetic Resources (ICAR)	Dr. KK Sharma (PC & PI)		August, 2014	March, 2021	-

Sl. No.	Project No.	Title of the Project	Name of Investigators	% Time	Year of Start	Year of Completion	*
		Diversity analysis of aleuritic acid content in major lac insect species/ strains and its use for better isolation strategies	Dr. A Mohanasundaram	20	April, 2017	March, 2021	-
		Field guide for lac hosts	Dr. VD Lohot	25	November, 2017	February, 2021	-
		Molecular characterization of new collection Study of endo symbionts	Dr. Thamilarasi K	25	April, 2017	March, 2021	-
		Taxonomic studies of lac insects (Hemiptera: Coccoidea: Tachardiidae) from different agro-climatic zones of India.			April, 2020	March, 2021	Shri NN Rajgopal
ICAR-ICRAF							
17.	2.1.054	Enabling tribal communities to improve their livelihoods through agroforestry systems on a sustainable basis	Dr. J Ghosh Dr. A Mohanasundaram Dr. RK Yogi	25 10 25	Oct., 2017	September, 2020	-
ICAR-DBT							
18.	2.1.055	Identification, cloning and characterization of genes involved in pigment biosynthesis of the Indian lac insect, *Kerria lacca* (Kerr)	Dr. Thamilarasi K Dr. VD Lohot Dr. Anees K	10 15	September, 2017	September, 2020	-
Inter-Institutional Projects							
ICAR-IINRG, Ranchi & ICAR-IIAB, Ranchi							
19.	--	Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp	Dr. AR Chowdhury, Co-PI	25	August, 2016	July, 2021	-
2. ICAR-IINRG, Ranchi & ICAR-RCER Farming System Research Centre for Hill and Plateau Region, Plandu, Ranchi							
20.	--	Enhancing food, nutritional and livelihood security of marginal and small farmers in Jharkhand through need based agricultural technologies	Dr. Nirmal Kumar, Co-PI Dr. NK Sinha, Co-PI	15 15	April, 2018	March, 2021	-

Sl. No.	Project No.	Title of the Project	Name of Investigators	% Time	Year of Start	Year of Completion	*
3. ICAR-IINRG, Ranchi & ICAR-IIHR, Bengaluru							
21.	--	1. Title, 'Development of storage protocol for extending the marketable period of fruits (Mango, Guava, Fig, Jamun, Muskmelon) and vegetables (Drumstick, Brinjal, Bottlegourd)'	Dr. MF Ansari, Co-PI	15	February, 2020	March, 2021	-
		2. Title, 'Development of bio-composite packages from horticultural waste'		15			
KVK, Khunti							
22.	--	Assessment, diffusion and adoption of crop production and NRGs technology	Dr. J Ghosh Dr. NK Sinha Dr. VD Lohot Dr. A Mohanasundaram Dr. SC Sharma Dr. RK Yogi	25 20 10 10 25 10	July, 2020	June, 2025	Dr. Nirmal Kumar
Agri-Business Incubation							
23.	--	Agri-Business Incubation under Component-II of NAIF Scheme of ICAR	Er. SK Pandey Dr. SC Sharma	30 25	April, 2019	March, 2021	Dr. RK Yogi

Exploratory Study

1. 'Preparation and characterization of modified *guar* gum nanocomposite films reinforced with *Acacia nilotica*/*Jhingan* AgNPs for diversified applications' ---- Dr. MZ Siddiqui, PS, PPDD, 25%
2. 'Synthesis of rosin derivative for its use as tackifier' ---- Dr. MF Ansari, PS, PPDD, 50%
3. 'Genetic manipulation in lac host plant (*F. semialata*) to establish better plant-lac insect interaction'---- Dr. J Ghosh, PS, LPD, 10%

Publications and Publicity

Publications

Research Papers

- Ghosal S and Rajgopal NN (2020). Effect of tree size, topography and shoot age on pest infestation and tree growth of *palas* (*Butea monosperma*). *Indian Forester* 146(5): 450-452.
- Kumar N, Yogi RK and Yadav SKS (2020). Knowledge and adoption level of scientific lac cultivation at farmer's field: A case from eastern India. *Indian Journal of Extension Education* 56(2): 88-92.
- Lohot VD, Ghosh J, Thamilarasi K, Mohansundaram A, Sharma KK (2020). *Swadi palas* (IC0629501; 1NGR 19031, a flame of forest (*Butea monosperma*) with trifoliate leaflet and acute apex, larger flower with dull orange colour with early biological maturity. *Indian Journal of Plant Genetic Resources* 33: 270-271.
- Mate CJ and Mishra S (2020). Exploring the potential of moi gum for diverse applications: A Review. *Journal of Polymers and the Environment* (https://doi.org/10.1007/s10924-020-01709-8).
- Mate CJ and Mishra S (2020). Synthesis of borax cross-linked jhingan gum hydrogel for remediation of Remazol Brilliant Blue R (RBBR) dye from water: Adsorption isotherm, kinetic, thermodynamic and biodegradation studies. *International Journal of Biological Macromolecules* 151: 677–690.
- Mate CJ, Mishra S and Srivastava PK (2020). Design of low-cost Jhingan gum based flocculant for remediation of wastewater: flocculation and biodegradation studies. *International Journal of Environmental Science and Technology* 17: 2545–2562.
- Mate CJ, Mishra S and Srivastava PK (2020). Design of pH sensitive low cost adsorbent from the exudate of *Lannea coromandelica* (Houtt) for remediation of Malachite Green dye from aqueous Solution. *Polymer Bulletin* (https://doi.org/10.1007/s00289-020-03263-8).
- Mate CJ, Mishra S and Srivastava PK (2020). *In vitro* release kinetics of graft matrices from *Lannea coromandelica* (Houtt) gum for treatment of colonic diseases by 5-ASA. *International Journal of Biological Macromolecules* 149: 908–920.
- Meena SC, Sharma KK, Swami H, Rana BS, Lekha and Lohot VD (2020). Survey record of lac insect *Kerria lacca* and its host plants in western plains of India. *The Indian Journal of Agricultural Sciences* 90(1): 220–5.
- Saha A, Salim SM, Sudheesan D, Suresh VR, Nag SK, Panikkar P, Paul TT, Palaniswamy R, Das BK and Chowdhury AR (2020). Geochemistry, mineralogy and nutrient concentrations of sediment of river Pampa in India during a massive flood event. *Arabian Journal of Geosciences* 13(1086) (doi: 10.1007/s12517-020-06053-8).
- Sakare P, Bharimalla AK, Dhakane-Lad J and Patil PG (2020). Development of greaseproof paper from banana pseudostem fiber for packaging of butter. *Journal of Natural Fibers* (doi: 10.1080/15440478.2019.1710652).
- Sakare P, Jadhav ML and John H (2020). Study on physical properties of soaked soybean and functional properties of germinated soy flour. *Journal of the Institution of Engineers (India):* Series A 101(4): 787-794.
- Sakare P, Prasad N, Thombare N, Singh R and Sharma SC (2020). Infrared drying of food materials: Recent advances. *Food Engineering Reviews* 12(3): 381-398.
- Sharma SC, Prasad N, Pandey SK and Bhargava VK (2020). Development of integrated small scale lac processing unit. *Agricultural Mechanization in Asia, Africa and Latin America* 51(2): 58 – 66.
- Srivastava SK and Pawan Jeet (2020). Effects of irrigation methods and mulching on growth and seed yield of semialata. *Journal of AgriSearch* 7(1): 18-20.
- Thamilarasi K, Kumari K, Ghosh J, Tribhuvan KU, Lohot VD, Gargi M and Ghosal S (2020). EST-SSRs reveal genetic distinction between lac and grain yielding genotypes of pigeonpea. *Journal of Plant Biochemistry and Biotechnology* 29: 461–472.

Papers presented / contributed in conferences / symposia / seminars

- Following papers were presented in 54th Annual Convention of Indian Society of Agricultural Engineers and International Symposium on Artificial

Intelligence Based Future Technologies in Agriculture, Hyatt Regency, Vimannagar, Pune, January 07 – 09, 2020:

- Sharma SC, Pandey SK and Prasad N (2020). Effect of primary processing parameters on manufacturing quality seedlac, p. 71.
- Pandey SK, Sharma SC and Prasad N (2020). Study on dewaxed decolourised lac preparation and optimization of process parameters for yield and quality, pp. 71-72
- Sakare P (2020). Response surface modeling and optimization of process parameters for enhancing shelf-life of banana, pp. 78-79.

- Yogi RK (2020). Current scenario and trends in natural resins and gums: An overview. Natural resins & gums stakeholders meet 2020 on January 29, 2020 at Girijan Co-operative Corporation Ltd., East Point Colony, Vishakhapatnam.
- Following papers were presented in the International conference on frontier research in applied zoology and insect pest management strategies: A way forward for food and nutritional security held at UAS, Raichur during 12-14 February, 2020.
  - Thamilarasi K, Anees K, Kumari K, Ekbal S and Mohanasundaram A (2020). Functional genomics based analysis of putative lac pigment biosynthesis genes, pp. 30.
  - Mohanasundaram A, Nebapure SM, Sharma KK and Mishra R (2020). Electroantennography and behavioural studies of semiochemicals against lac insect predators. pp. 166-167.
  - VD Lohot (2020). Exploring the potential of Ficus species for cultivation of lac insect (*Kerria* spp).
- Thamilarasi K, Ekbal S, Kumari K, Lohot VD, Mohansaundaram A and Sharma KK (2020). Microbiome diversity of the Indian lac insect *Kerria lacca* (Kerr) In: abstract book of 2nd International Conference on Bioprocess for Sustainable Environment and Energy ICBSEE-2020 held at National Institute of Technology, Rourkela during March 5-7, 2020. ISBN 818553107 – 2, pp. 66.
- Yogi RK (2020) Best Practices for NRG Marketing & Value Addition in times of COVID-19: Challenges and Way Forward. Webinar 4 on "Agricultural Marketing to strengthen the efforts of Government during COVID period without breaking the lockdown guidelines" organized jointly by ICAR-IINRG Ranchi and Chaudhary Charan Singh National Institute of Agricultural Marketing, Jaipur (Rajasthan) at the *Webex Meet,* May 03, 2020.
- Following papers were presented in the National WEBCON on 'Agricultural production & support system managing Covid 19 pandemic: Experience sharing & strategies' organized by Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (UP). May 6-8, 2020.
  - Sakare P (2020). Food packaging: A potential carrier of novel coronavirus.
  - Chowdhury AR, Siddiqui MZ and Sakare P (2020). Development of natural gum based silver nano-composite films for their use as active food packaging.

Books/ Book Chapters / Bulletins/Manuals/ Extension folders / Project reports

- Following book chapters were published in Prasad N, Thombare N, Singh R, Sakare P and Sharma KK (eds.) (2020). Training Manual: ICAR-NAHEP-CAAST Short Training on Natural Resins and Gums: Production, processing, value addition and marketing. ICAR-IINRG, Ranchi, 1-177 pp. ISBN: 978-93-5416-953-3.
  - Thombare N, Lohot VD, Yogi RK, Prasad N and Sharma KK (2020). Introduction and uses of major NRG plants. pp. 14-24.
  - Mohanasundaram A and Sharma KK (2020). Lac insect: Life cycle, crop cycle and pest management. pp. 25-33.
  - Rajgopal NN (2020). Taxonomic aspects of lac insect. pp. 34-39.
  - Ghosal S (2020). Raising and management of lac host plants. pp. 50-60.
  - Thamilarasi K (2020). Role of biotechnology in lac production. pp. 78-81.
  - Sharma SC, Pandey SK and Prasad N (2020). Tapping techniques and tools for resins and gums. pp. 82-94.
  - Singh R (2020). Drying techniques for natural resins and gums. pp. 100-109.

- Thombare N, Ali M and Swami S (2020) Recent advances in applications of natural resins and gums in agriculture. pp. 110-118.
- Siddiqui MZ (2020). Medicinal importance of natural resins and gums. pp. 119-123.
- Sakare P (2020). Natural resin and gum as edible coating material for food. pp. 124-126.
- Pandey SK, Sharma SC, Prasad N and Singh R (2020). Natural lac dye and other lac based technologies for entrepreneurship. pp. 127-138.
- Chowdhury AR (2020). Characterization techniques of natural resins and gums. pp. 139-146.
- Yogi RK and Kumar N (2020). Global scenario of production and trade of natural resins and gums. pp. 157-166.
- Ansari MF (2020). Quality control of natural resins and gums and their industrial applications. pp. 147-156.

- Ansari MF (2020). Preparation of value-added products from gummy mass (GM) – A problem industrial effluent of lac industry. In: Creating wealth from agricultural waste, Indian Council of Agricultural Research, New Delhi, pp. 168.
- Devi TS, Biswas S, Gaibimei P, Arjun AD, Tarafdar A, Murthy GR, Naik RK and Srinivasa Rao CH. (2020). Climate smart post-harvest agriculture and food systems. In: Climate Change and Indian Agriculture: Challenges and Adaptation Strategies, ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana, India. pp. 359-383.
- Prasad N and Thombare N (2020). Mid-term review of AICRPs/ CRPs/ AINPs. Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums. 1-78 pp.
- Prasad N, Mohanasundaram A, Yogi RK, Thombare N, Pramanik A, Singh R and Sinha NK. SFC (2020-2025): Scheme on ICAR-Indian Institute of Natural Resins and Gums including Tribal Sub Plan, North Eastern Hill Sub Plan & Scheduled Caste Sub Plan & incorporating NWP on Harvesting, Processing and Value Addition of Natural Resins & Gums NWP on Conservation of Lac Insect Genetic Resources.
- Sharma KK, Kumar N, Yogi RK and Mohansundaram A (2020) Application for Fakhruddin Ali Ahamad Award 2020. ICAR Krishi Bhavan New Delhi, December 31, 2019, pp. 1-60
- Sharma KK, Sidiqqui MZ, Mohanasundaram A, Yogi RK and Thombare N (2020) Framework and proforma for ranking of ICAR-IINRG, pp. 1-159
- Sharma KK, Chowdhury AR and Srivastava S (2020). Chemistry and applications of lac and its by-product. *In:* Kumar D and Shahid M (Eds) *Natural materials and products from insects: Chemistry and applications* (21-37) Switzerland AG: Springer International Publishing. DOI: 10.1007/978-3-030-36610-0_2.
- Varshney RK [Sharma KK (Ed.)]. (2020). Lac insects of the world – An updated catalogue and bibliography. ICAR- IINRG, Ranchi. pp viii + 84. ISBN: 978-93-5396-869-4.
- Yogi RK, Prasad N and Sharma KK (2020). Impact Report with Future Predictions, pp. 1-7.
- Yogi RK, Kumar Alok and Singh AK (2020). Lac, plant resins and gums statistics 2017: At a glance. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical). No. 5/2020. 1-74 pp.
- Yogi RK (2020). NRGIC on Gum benzoin for Micro Small and Medium Enterprises (MSME), Fragrance & Flavour Development Centre (FFDC), Kannauj under Ministry of MSME, Govt. of India, New Delhi. pp. 1-3

Extension Folders

- Sharma SC, Prasad N and Pandey SK (2020). Integrated small scale lac processing unit. *Extension Folder*, ICAR – Indian Institute of Natural Resins and Gums, Ranchi, 1-4 pp.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholders in April 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (1/2020): 1 -10 pp.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in May 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-

Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (2/2020): pp. 1 -10.

- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in June 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (3 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in July 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (4 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in August 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (4 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in September 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (4 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in October 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (5 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in November 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (6 /2020): pp. 1 -10.
- Yogi RK, Kumar N and Sharma KK (2020). Advisories for NRG based stakeholder in December 2020: Best practices for production, processing and marketing of tribal based commodities during COVID-19. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand (6 / 2020): pp. 1 -10.
- ज्योतिर्मय घोष, ए० मोहनसुंदरम, नवलेश कु सिन्हा एवं राजन चौधरी 2020. कीट एवं रोग नियंत्रण के लिए जैविक कीटनाशक. pp. 1-4
- ज्योतिर्मय घोष, वैभव डी लोहोट 2020. 'स्वादी पलास' प्रजाति (ब्यूटिया मोनोस्परमा) पर शीतकालीन कुसमी लाख की खेती. pp. 1-4

Popular Articles

Following popular Articles were published in LAKSHA, 2020 (ISSN NO. 2454-7840), ICAR-IINRG, Ranchi, 117 p.:

- सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय एवं निरंजन प्रसाद. लाख प्रसंस्करण का यंत्रीकरण. पृष्ठ. 1-7.
- सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय एवं निरंजन प्रसाद. व्यवसायिक रूप से महत्वपूर्ण प्राकृतिक राल एवं गोंद का प्रसंस्करण . पृष्ठ. 8-18.
- सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय एवं निरंजन प्रसाद. चौरी निर्माण के लिए संशोधित. पृष्ठ. 19-26.
- रंजीत सिंह, हिमानी प्रिया एवं लोकेश मीणा. काजू का पेड़ गोंद उत्पादन एवं उपोत्पाद के लिए एक सम्भावित वृक्ष. पृष्ठ. 27-29.
- महताब ज़ाकरा सिद्दीक़ी, अर्णब राय चौधुरी एवं देवब्रत हरि. कृषि एवं नैनो टेक्नोलोजी. पृष्ठ. 30-32 .
- प्रियंका साकरे एवं हरप्रसाद नईया. महुआ: आदिवासी अर्थव्यवस्था के लिए वरदान. पृष्ठ. 40-41.
- अर्णब राय चौधुरी एवं महताब ज़ाकरा सिद्दीक़ी. भारतीय कृषि पर कोविड-१९ का संभावित दुष्प्रभाव. पृष्ठ. 48-49.
- देवब्रत हरि एवं महताब ज़ाकरा सिद्दीक़ी. झारखण्ड में कृषि संसाधन. पृष्ठ. 53-54.
- नंदकिशोर ठोम्बरे एवं प्रियंका साकरे. 1920-2020 भारतीय प्राकृतिक राल एवं गोंद संस्थान का गौरवशाली इतिहास. पृष्ठ. 55-57.
- हरप्रसाद नईया एवं प्रियंका साकरे. प्रोद्योगिकी : जीन सम्पादन का एक नया तरीका. पृष्ठ. 79-80.
- लोकेश मीना एवं रंजीत सिंह. कूड़ा कचरा प्रबंधन से आमदनी: एक विकल्प. पृष्ठ. 81-83.
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- राजकुमार राय एवं अर्णब राय चौधुरी. नारी शक्ति. पृष्ठ. 98.

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- राजन चौधरी, राजकुमार योगी, ज्योतिर्मय घोष एवं प्रिंस. दक्षिणी एशिया में पशुपालन एवं जलवायु परिवर्तन चुनौतियाँ एवं समाधान. जून 2020. पृष्ठ. 78-79.
- राजन चौधरी, ज्योतिर्मय घोष, निर्मल कुमार एवं प्रिंस. मेघदूत देगा मौसम पूर्वानुमान सहित फसलों एवं पशुधन की जानकारी. जुलाई 2020. पृष्ठ. 80.
- राजन चौधरी, ज्योतिर्मय घोष, निर्मल कुमार एवं प्रिंस. आकाशीय बिजली से सावधान सुरक्षित रहने के लिए दामिनी एप. सितम्बर 2020. पृष्ठ. 81.
- नेहा पारिक, अरविन्द कुमार, नीलम कुमारी सिंह, स्मिता गुप्ता, प्रियंका स्वामी, एवं राजन चौधरी. मौसम एवं फसल सलाह मेघदूत और दामिनी मोबाइल ऐप द्वारा. अक्टूबर 2020. पृष्ठ. 74.
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- Langlentombi L, Ghosal S, Sinha NK, Srivastava SK and Rajgopal NN (2020). Lac based intercropping system as carbon sink for climate change mitigation option in India. 2(2): 223-226.
- Srivastava SK, Ghosal S, Langlentombi L (2020). Higher Production of *Flemingia semialata* seeds by mulching with Silver/Black Polyethylene. 2(7): 297-298.
- Lohot VD, Thombare N, Ghosh J, Thamilarasi K, Mohanasundaram A, Thakur VV and Sharma KK. Rain tree (*Albizia saman*): A potential lac host and gum producing tree. 2 (2): 348-353.
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- Priya H, Kumar U and Singh R (2020). Cyanobacteria: Nature's own solution for improved soil fertility and crop yield. 28-32.
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Other popular articles

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- Langlentombi LC and Rajgopal NN (2020). Potential of remote sensing in mapping of non-timber forest products in India. *Food and Scientific Reports*, 1(5): 1-3.
- Rajan Choudhary, J Ghosh RK Yogi and Prince (2020). Animal husbandry and climate change in South Asia: Challenges and solutions. *Madhya Bharat Krishak Bharti*. June 2020, MPHIN/2006/16946:15(3) ICAR-Indian Institute of Natural Resins and Gums, Ranchi.
- Yogi RK, Kumar N and Sharma KK (2020). Analysis of export potential in different countries for NRGs and Global demand supply analysis of NRGs. ATR of the proceeding of the ICAR /DARE Senior Officers'

Committee (SOC) Meeting held on August 05, 2020 through VC. pp.1-7.

- Yogi RK, Kumar N and Sharma KK (2020). Impact of value addition on export of NRGs and employment potential for the domestic sector. pp. 1-10.
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Following Success stories were documented

- Yogi RK, Kumar N and Sharma KK (2020). "*Lakh se lakhpati: Scientific lac cultivation on Kusum and Semialata*"
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- Yogi RK, Kumar N and Sharma KK (2020). "*Kusmi lac cultivation: Sri Jagdish Hansda, Vilage:-Jahajpur, Block:-Jaipur, District:-Purulia (West Bengal)*"
- Yogi RK, Kumar N and Sharma KK (2020). *"Livelihood security through kusmi lac production on Ber and rangeeni on Palas"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Kusmi lac cultivation on semialata Sri Bole Uraon, Vilage:-Namkum, Block:-Namkum, District:-Ranchi (Jharkhnad)"*
- Yogi RK, Kumar N and Sharma KK (2020). "*Young entrepreneurship in lac processing. Sri Bhisma Tandi, Vilage:- Kotmer, Block:- Dharmagarh, District:-Kalahandi (Odisha)"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Sucess story of Jugnu Oraon, Hasahatu, Ormanjhi, Ranchi"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Kusmi Lac Cultivation on Semialata"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Sucess story of Sri Yedunath Munda, Vilage:-Latardih, Block:-Namkum, District:-Ranchi (Jharkhnad)"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Success story of a progressive farmer Purshottam Mandawi"*
- Yogi RK, Kumar N and Sharma KK (2020). *"SHG approach for scientific lac cultivation in Khunti"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Success story of a women farmer SHG approach for scientific lac cultivation in Khunti"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Skill development: Incubation"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Kusmi lac cultivation: Shri Lakhi Ram Bedia"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Lakh se lakhpati: Scientific lac cultivation on Kusum and Semialata: Shri Shakti Dhar Koiri, Ranchi Jharkhand"*
- Yogi RK, Kumar N and Sharma KK (2020). *"Value addition enhanced the profit of lac manufacturer through technological interventions"*

Institute Publications

- ICAR-IINRG Annual Report 2019-20, 1-177 pp.
- Laksha, Rajbhasha Patrika, 2020, 1-121 pp.
- Natural Resins and Gums, ICAR-IINRG Newsletter, July-September 2019, 23(3), 1-8 pp.
- Natural Resins and Gums, ICAR-IINRG Newsletter, October-December 2019, 23(4), 1-8 pp.
- Natural Resins and Gums, ICAR-IINRG Newsletter, January-March 2020, 24(1), 1-8 pp.
- Natural Resins and Gums, ICAR-IINRG Newsletter, April-June 2020, 24(2), 1-8 pp.

Tours/Visits

- Dr. S Ghosal, Pr. Sc. , Dr. Nandkishore Thombare, Sc. and Ms. Langlentombi LC, Sc. visited Mangobandh village to discuss agriculture related problems with farmers and also to create awareness about cleanliness among villagers and children under MGMG program, January 21, 2020.
- Dr. MZ Siddiqui, Pr. Sc. visited Jaradih village (Block-Angarah, Distt.-Ranchi) under the 'MGMG' programme and interacted with farmers, mostly women farmers on January 23, 2020.
- Dr. A Mohanasundaram, Sc. visited to ICAR-Indian Agricultural Research Institute, New Delhi for fabrication of olfactometer, septa preparation from lac insect whole body extract and GC-MS analysis of extracts from *Eublemma amabilis*, January 21 - 25, 2020.
- Dr. MF Ansari, Pr. Sc. visited Benyazara village to interact with lac growing farmers, January 27, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kumhardih, Murhu, Khunti and Roro, Murhu, Khunti regarding exploration

of the possibility of moringa gum tapping from *Moringa oliefera* trees under the sub project "Effect of tapping techniques on gum yield from *Moringa oleifera* trees" ongoing under All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, February 3 – 8, 2020.

- Dr. Mohanasundaram A, Sc. monitored progress work of NPCLIGR project co-operating centre PJTSAU, Hyderabad and informed to establish full fledged Lac insect museum and also kept lac insect collections in Lac insect Gene bank separately, February 14, 2020.
- Dr. Nandkishore Thombare, Sc. visited Forester cum Forest Guard Training School, Hazaribagh to conduct training on 'Cultivation, harvesting, processing and marketing of chironjee (piyar) products', February 20, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kumhardih, Murhu, Khunti regarding finalization of moringa trees for gum tapping experiment under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees", All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, February 24, 2020.
- Dr. SC Sharma, Sr. Sc. visited Jharkhand state co-operative lac marketing & procurement federation limited (JHASCOLAMPF), Purulia Road, Ranchi regarding participation in tender finalization meeting, February 25, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kumhardih, Murhu, Khunti and initiated experiment for moringa gum tapping with different treatment under the sub project "Effect of tapping techniques on gum yield from *Moringa oleifera* trees", All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, February 27, 2020.
- Dr. Nandkishore Thombare, Sc. arranged Institute stall and displayed NRG based products to the students and farmers at the Navsari Agricultural University, Navsari, Gujarat, during National Conference on 'Utilization and conservation of non-timber forest genetic resources for sustainable development', February 27-29, 2020.
- Dr. Nandkishore Thombare, Sc. visited Waghai Botanical Garden, Ambapada, Gujarat, for exploring and photographing gum and resin producing trees, March 1, 2020.
- Dr. Nandkishore Thombare, Sc. visited an arboretum maintained by Navsari Agricultural University, Navsari, Gujarat, for exploring and photographing gum and resin producing trees, March 2, 2020.
- Dr. Nandkishore Thombare, Sc. visited Food Quality Testing Laboratory, NAU, Navsari, Gujarat, for exploring possibilities of collaboration with IINRG for gum and resin research, March 2, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley and initiated experiment for karaya gum tapping from *Sterculia urens* trees with different treatments, March 3, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley regarding experiment for karaya gum tapping from *Sterculia urens* trees, June 3, 2020.
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi regarding improvement in gum tapping die developed earlier based on detailed manufacturing design drawing developed in collaboration with ICAR – CIAE, Bhopal, June 9 - 11, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division visited Secondary School, Pancha, run by Bharat Sevashram Sangha on 12.6.2020 as an expert to plan vegetation development and other community development programme in school surroundings in particular reference to lac.
- Dr R Chaudhari, V Vidyakar, A Prabhat distributed Paddy and Pigeon pea seed for OFTs and FLDs at different villages in Karra, Torpa, Adki, June 11, 15 & 18, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley regarding karaya gum tapping with different treatments from *Sterculia urens* trees, July 03, 2020.
- Dr. R Chaudhari, V Vidyakar, A Prabhat distributed groundnut seed for FLDs at different villages in Karra, Khunti and KeloRaniya, July 1 & 7, 2020.
- Dr. R Chaudhari, V Vidyakar, A Prabhat visited farmers field for sowing of groundnut seeds and progress of OFTs on paddy at different villages in Karra, Khunti and KeloRaniya, July 1 & 7, 2020.
- Dr. SC Sharma, Sr. Sc. visited Diyankal village, Torpa block, Khunti district regarding plantation of semialata seedlings at farmer's field under constitution related activity, July 22, 2020.

- Dr. SC Sharma, Sr. Sc. visited Kankewar, Ramgarh to explore the availability of suitable *Moringa oleifera* trees regarding gum tapping experiment and identification of suitable trees of *Moringa oleifera* trees for experimentation, July 6 & 28, 2020.
- Dr. J Ghosh, Dr N K Sinha, Dr A Mohansundaram, Dr R Chaudhary, Ashutosh Prabhat visited farmers field to know the progress of trial, to install monotrap in paddy field, to provide training on weed management and lac cultivation and to distribute calliandra seedlings, August 05, 2020.
- Dr. Mohanasundaram A, Sc. monitored field level demonstration on scientific lac cultivation on Ber winter crop at Manhatu under which farmers were advised to remove phunki lac and spraying of lac crop using provided/recommended insecticide and fungicide on time under KVK project, August 05, 2020.
- Dr. Mohanasundaram A, Sc. provided *Calliandra calothyrsus* seedlings (150 nos.) to nine different farmers Laxman Oraon (40 nos.), Kuli Kumari (10 nos.), Harumula Oraon (10 nos.), Lattu Oraon (10 nos.) from Konhapa village, Santosh hemoran (10 nos.), Zheran Suran (20 nos.) Dipti Oraon (10 nos.) from Chidii village; Ramesh Tanwar (20 nos.), Chahno village and Xeveir Hamroan (20 nos.), Hazira village for raising and further lac cultivation through KVK, Khunti, August 05, 2020
- Dr. RK Yogi, Sc. and Madan Mohan, STA conducted an Industry visit for collection of primary data on market and export and feedback at Khunti, August 06, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley regarding trials of karaya gum tapping with different treatments from *Sterculia urens* trees, August 06, 2020.
- Dr. RK Yogi, Sc. conducted Survey cum awareness Programs at Khunti on August 10th 2020
- Er. SK Pandey, Sc. visited office of Registrar, Co-operative Society of Jharkhand and participated in meeting w.r.t. training programme to be given by ICAR-IINRG to participant of Jascolampf in 2020-21, August 10, 2020.
- Dr. RK Yogi, Sc. and Madan Mohan, STA Primary data about input and output were recorded from Lac Industry, August 22, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kankewar, Ramgarh regarding gum tapping experiment with different treatments under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees" ongoing under Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, August 29, 2020.
- Dr. Yogi RK, Sc. and Madan Mohan, STA conducted an Industry visit for the market and export data and feedback at Khunti, August 29, 2020
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi and regarding multiplication of gum tapping die (Model – 1 and Model - 2), September 1, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley, Bundu regarding trials of karaya gum tapping with different treatments from *Sterculia urens* trees, September 4, 2020.
- Mohanasundaram A, Sc. provided *Calliandra calothyrsus* seedlings (70 nos.) to six different farmers viz., Shri Babulal Mahto (10 nos.), Shri Maheswar Mahto (15 nos.), Shri Sikari Munda (10 nos.), Shri Sikmar Munda (10 nos.), Shri Anchan Ganju (10 nos.) and Shri Lal Mohan Munda (15 nos.) for conducting field level demonstration at Beniajara under MG MG programme, September 5, 2020.
- Dr. SC Sharma, Sr. Sc. visited Jharkhand State Co-operative Lac Marketing & Procurement Federation Limited (JHASCOLAMPF), Purulia Road, Ranchi regarding e-auction of lac and lac based products, September 9, 2020.
- Dr. RK Yogi, Sc. conducted Industry visit for the market and export data and feedback at Khunti, September 4 & 18, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kankebar, Ramgarh regarding gum tapping experiment with different treatments under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees" ongoing under All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, September 28, 2020

- Dr. SC Sharma, Sr. Sc. visited Taimara Valley, Bundu regarding trials of karaya gum tapping with different treatments from *Sterculia urens* trees, October 3, 2020.
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi regarding manufacturing of gum tapping die for gum extraction from different tree species, October 5, 2020.
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi regarding multiplication of gum tapping die for gum extraction from different tree species and suggested improvements as per requirement for smooth functioning, October 13, 2020.
- Dr. Nandkishore Thombare, Sc. visited Mangobandh village, under Mera Gaon Mera Gaurav programme where villagers were made aware regarding the spread of the corona virus and precautions to be taken to avoid it, October 16, 2020.
- Ms. Langlentombi LC, Sc. visited to Mangobandh village, Namkum under MGMG programme, October 16, 2020.
- Dr. MZ Siddiqui, Pr. Sc. visited Jaradih, Mungadih, Gutidih and Putadag village (Block-Angarah, Distt.-Ranchi) under the 'MGMG' programme and interacted with the farmers, October 19, 2020.
- Dr. RK Yogi, Sc. conducted a field visit in Mungadih area and primary data about input and output were also recorded, October 19, 2020.
- Dr. MF Ansari, Pr. Sc., Dr. SKS Yadav, Sc. and Dr. A Mohanasundaram, Sc. organized an awareness programme focusing on the basic rights and duties as stated by the constitution, cleanliness in and surrounding areas, measures to be taken during Covid 19 period and issues related to lac cultivation under MG MG programme at Benyazara, Angara block, Ranchi, October 20, 2020.
- Dr. RK Yogi, Sc. and Madan Mohan, STA conducted an Industry visit for collection of primary data on market and export and feedback at Khunti, October 22, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kankebar, Ramgarh regarding moringa gum tapping experiment with different treatments under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees" All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, October 31, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley, Bundu regarding trials of karaya gum tapping with different treatments from *Sterculia urens* trees, November 3, 2020.
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi regarding inspection of fabricated gum tapping die for gum extraction from different tree species and suggested improvements as per requirement, November 5, 2020.
- Dr. RK Yogi, Sc., Dr. SKS Yadav, Sc. and Madan Mohan, STA conducted an Industry visit for collection of primary data on market and export and feedback at Khunti, November 07, 2020.
- Dr. SC Sharma, Sr. Sc. visited Jharkhand State Co-operative Lac Marketing & Procurement Federation Limited (JHASCOLAMPF), Purulia Road, Ranchi and participated in tender finalization meeting regarding e-auction of seedlac, November 10, 2020.
- Dr. Yogi RK, Sc. & team executed Survey cum Awareness program in West Singhbhum district of Jharkhand, November 10-15, 2020
- Dr. SC Sharma, Sr. Sc. visited Kankebar, Ramgarh regarding moringa gum tapping experiment with different treatments under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees" All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, November 28, 2020.
- Dr. SC Sharma, Sr. Sc. visited Taimara Valley, Bundu regarding trials of karaya gum tapping with different treatments from *Sterculia urens* trees, December 4, 2020.
- Dr. SC Sharma, Sr. Sc. visited M/s. National Enterprises, Hatia, Ranchi regarding fabrication of gum tapping die for gum extraction from different tree species and suggested minor improvements, December 9, 2020.
- Dr. SC Sharma, Sr. Sc. visited Jharkhand State Co-operative Lac Marketing & Procurement Federation Limited (JHASCOLAMPF), Purulia Road, Ranchi and

participated in tender finalization meeting regarding e-auction of kusmi and rangini seedlac, December 15, 2020.

- Dr J Ghosh, Dr N K Sinha, Dr A Mohansundaram, visited Diyankelfor organizing hand-on- practices of making biopeasticide, December 22, 2020.
- Dr. SC Sharma, Sr. Sc. visited Kankebar, Ramgarh regarding moringa gum tapping experiment with different treatments under the sub project "Effect of Tapping Techniques on Gum Yield from *Moringa oleifera* Trees" All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, December 28, 2020.

Data Base

Sequences submitted to NCBI GenBank database

Gene	Accession no.
ggps	MT439872
dpds	MT431387
tymo	MT496963

Submitted amplicon sequences of the V3-V4 region of 16S rRNA obtained from lac insect crawlers and adult female lac insects to the NCBI under the accession no. PRJNA638760.

- National level database of the NRGs production and EXIM data 2020 has been generated, maintained and updated at NRG Information Cell (NIC), TOT Division, ICAR-IINRG, Ranchi.
- Block level database of beneficiaries under various trainings during previous 10 years and block wise lac host tree as well as broodlac requirement in the state of Jharkhand has been estimated and its validation is under progress.
- Database: Data base of farmers adopted LIAS model under ICRAF project has been prepared

TV/Radio Talk

Expert	Topics	Date of Recording	Date of broadcast/Telecast
TV Talk (Doordarshan, Ranchi)			
Dr. J Ghosh, Pr. Sc.	लाख आधारित कृषि वानिकी परियोजना	February 06, 2020	February 17, 2020
Dr. N Prasad, Pr. Sc.	Scope of lac based cottage enterprises		March 23, 2020
Dr. KK Sharma, Director	लाख उत्पादन के क्षेत्र में रोजगार की संभावनाएं	June 11, 2020	
Dr. S Ghosal, Pr. Sc.	लाख पोषक वृक्षों की नर्सरी तैयार करना एवं उसका प्रावधान	June 23, 2020	July 22, 2020
Dr. SC Sharma, Sr. Sc.	लाख का मूल्य संवर्धन एवं विपणन व्यवस्था	July 24, 2020	
Dr. A Mohanasundaram, Sc.	Enhancement of employment and income of farmers through lac cultivation		July 26, 2020
Dr. S Ghosal, Pr. Sc.	बरसात के मौसम में कुसमी लाख कीट प्रबंधन	July 24, 2020.	August 16, 2020
Dr. KK Sharma, Director	सेमियालता पर लाख की खेती	October 08, 2020.	
Dr. Nandkishore Thombare, Sc.	खाद्य पदार्थों और दवाओं में प्राकृतिक राल एवं गोंद का महत्त्व	October 08, 2020.	
Dr. A Mohanasundaram, Sc.	Insect pest and disease management during rainy/winter season lac crops		October 26, 2020
Dr. Nandkishore Thombare, Sc.	प्राकृतिक राल एवं गोंद का खाद्य पदार्थों और दवाओं में महत्त्व	November 10, 2020.	

Expert	Topics	Date of Recording	Date of broadcast/Telecast
Radio talk (Akashvani, Ranchi)			
Dr. A Mohanasundaram, Sc.	Lac harvesting, storage and marketing system	January 25, 2020.	
Dr. S Ghosal, Pr. Sc.	झारखण्ड में लाख की खेती-संभावनाएं, समस्याएं एवं निदान	November 7, 2020.	November 21, 2020

Patents

- Nandkishore Thombare, Sanjay Srivastava, A Mohanasundaram and KK Sharma (2020) Natural resin based novel non-drying adhesive: Preparation and application in insect trap. Patent (Provisional) filed on 07.05.2020, Application No. 202031019392.
- S Srivastava, A Roy Chowdhury, B Sarkar, Surajit Bhattacharjee and KK Sharma (2020) Natural Gum based nanocomposite hydrogel having Antibacterial and Wound Healing Effects and a method of Preparation thereof. Application no. 201931008616 was submitted to Patent office, Kolkata and was published in patent journal no. 37/2020 Dated 11/09/2020 pp 4067.

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

By Director

Chaired/Convened

- Dr. KK Sharma, Director, ICAR-IINRG chaired the 86th Institute Joint Staff Council meeting, January 13, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the 55th Institute Management Committee meeting of Indian Institute of Natural Resins and Gums, Ranchi, February 28, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the 20th Meeting of Brushware, Polishes, Lac and Lac Products Sectional Committee CHD 23, at BIS HQ, New Delhi, March12, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the Institute Research Council meeting, July 16-17, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the Brainstorming session on reorganization of research divisions of IINRG with all the scientists, August 18, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the 87th Institute Joint Staff Council meeting, July 31, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired Institute Research Council meeting, August 28, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the DPC meeting for clearance of cases of probation of scientists, October 03, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the Institute Technology Management Committee meeting for discussion on ISO certification (9001:2015) for IINRG, December 29, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG chaired the 88th Institute Joint Staff Council meeting, December 31, 2020.

Participated

- Dr. KK Sharma, Director, ICAR-IINRG participated in QRT meeting KVKs of Birsa Agricultural University at Ranchi, January 06, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated as Expert member in RAC meeting of Central Tasar Research and Training Institute at Ranchi, January 18, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in a meeting of SMD directors / PCs / LCPCs of AICRPs / AINPs / CRPs to discuss various issues, progress, review of technical and expenditure status of the respective institutes and projects, at NASC, New Delhi, February 12, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG and Project Coordinator, AINP on CLIGR participated in Review meeting of IINRG and NPCLIGR called by DDG (Engg.) at New Delhi, February 24, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of all ICAR Directors chaired by DG, April 10, 2020.

- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of Pricing Cell of TRIFED, New Delhi, April 15, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of Directors and SMD Officials chaired by DDG (Engg.), April 30, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference SFC meeting of IINRG, Ranchi and CIPHET, Ludhiana chaired by DDG (Engg.), May 28, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in Webinar on 'Linking Agro-forestry farmers with Industry", under the Chairmanship of Smt. Alka Bhargava, Additional Secretary, Department of Agriculture, Cooperation and Farmers Welfare, June 13, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of Directors and SMD Officials on scientists' review chaired by DDG (Engg.), June 24, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of DBT Forest Biotechnology 2nd Technical Expert Committee (TEC) Meeting, June 29-30, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting to discuss about fallout of the PM Meeting within SMD chaired by DDG (Engg.), July 06-07,2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in virtual meeting of Research Advisory Committee for ICAR-Indian Institute of Natural Resins and Gums, Ranchi, July 08-09, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in virtual 92nd Foundation Day and Award Ceremony of the ICAR, July 16, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of Directors and SMD Officials on Impact Assessment, July 22, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of Directors / PCs / CRP-NW PIs chaired by DDG (Engg.) for discussion on enhancing output efficiency, August 05, 2020
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting chaired by DDG (Engg.) for finalizing proforma for Impact Assessment of Engineering Technology, August 20, 2020
- Dr. KK Sharma, Director, ICAR-IINRG participated in special STAG meeting to consider projects recommended by Forest Biotechnology TEC, through video conferencing, September 08, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in the virtual meeting to discuss the modalities and road map to create a platform for innovations in farm machinery under the Chairmanship of Mr. Sanjay Agarwal, Secretary (DAC&FW), September 10, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in 3rd meeting of DBT Forest Biotechnology Technical Expert Committee, through video conferencing, September 15, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in Regional Research Conference of Eastern India organized by Institute of Forest Productivity, Ranchi, through virtual platform on September 22, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in State level project screening committee of RKVY-RAFTAAR chaired by the Development Commissioner, Jharkhand, September 24, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in 'VAIBHAV' (Vaishwik Bharatiya Vaigyanik) Summit aimed at giving an impetus to the objectives of Atal Innovation Mission by leveraging the collaborative experience and deep expertise of International and Indian subject experts to strengthen "AatmaNirbhar Bharat" initiative for High End Research in Science and Technology (online session on 'Automation of Farming System', October 6, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in video conference meeting of meeting ICAR Regional Committee No. IV organized by ICAR-Indian Institute of Vegetable Research, Varanasi, November 27, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in Director's Conference held through video conferencing, December 05, 2020.
- Dr. KK Sharma, Director, ICAR-IINRG participated in Consultative Discussion/Brainstorming meeting with ICFRE for Development of Joint Program on Forest Biotechnology through video conferencing, December 11, 2020.

By Others

- Dr. SC Sharma, Sr. Sc. participated in 54th Annual convention of Indian society of agricultural engineers and international symposium on Artificial Intelligence Based Future Technologies in Agriculture jointly organized by Indian Society of Agricultural Engineers, New Delhi and Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri at Hyatt Regency, Vimannagar, Pune, January 7 – 9, 2020.
- Dr. SC Sharma, Sr. Sc. and Dr. RK Yogi, Sc. participated in Natural Resins & Gums Stakeholders Meet 2020, at Girijan Co-operative Corporation Ltd., East Point Colony, Visakhapatnam orgnaised by ICAR-Indian Institute of Natural Resins & Gums, Ranchi, Jharkhand (Ministry of Agriculture & Farmers Welfare) in collaboration with Girijan Co-operative Corporation Ltd., Vishakhapatnam and NGOs Kovel Foundation, Vishakhapatnam, January 29, 2020.
- Dr. VD Lohot, Sr. Sc., Dr. Thamilarasi K, Sr. Sc., Dr. A Mohanasundaram, Sc. and Mr. Rajgopal NN, Sc. participated and presented NPCLIGR project progress in Seventh Co-ordination committee meeting/ workshop of Network Project on Conservation of Lac Insect Genetic Resources, Central Agricultural University, Imphal, February 03-04, 2020.
- Dr. VD Lohot, Sr. Sc., Dr. Thamilarasi K, Sr. Sc. and Dr. A Mohanasundaram, Sc. participated in XVII AZRA International Conference on Frontier research in Applied Zoology and Insect pest management strategies: A way forward for food and nutritional security at UAS, Raichur, Karnataka, February 12-14, 2020.
- Dr. MF Ansari, Pr. Sc. participated in one-day seminar on 'Powder Rheology and Surface Area Measurements' organized by Anton Paar India Pvt. Ltd, at BIT Mesra Ranchi, February 25, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK participated in XI National KVK Conference 2020 on Empowering Youth for Technology Led Farming and inaugural of Agrotech Kisan Mela of IARI, March 01, 2020.
- Mr. Rajgopal NN, Sc. as a Course Coordinator Conceptualized and organized one-day workshop on "Implementation of Research Data Management-Web- portal – KRISHI for technical Staff" at ICAR-IINRG, Ranchi. March 03, 2020
- Dr. Thamilarasi K, Sr. Sc. participated in 2nd International Conference on Bioprocess for Sustainable Environment and Energy ICBSEE-2020 at National Institute of Technology, Rourkela, March 05-07, 2020.
- Dr. AR Chowdhury, Sc. attended the meeting of BIS CHD 23 committee for review of standards of the Lac & Lac Products and make suggestion for modification of the existing standards to BIS at Bureau of Indian Standards (BIS), Manak Bhawan, New Delhi, March 12, 2020.
- Dr. KK Sharma, Director and Dr. RK Yogi, Sc. (2020) participated in the Video Conferencing to review the scheme of "Mechanism for marketing of minor forest produce through minimum support price and development of value chain of MFP" at Pricing Cell, TRIFED HO, New Delhi, April 15, 2020.
- Er. Ranjit Singh, Sc. attended webinar on automation in agriculture organized by ISAE, April 21, 2020.
- Er. Ranjit Singh, Sc. attended webinar on drones and its application organized by ISAE, April 22, 2020.
- Dr. MZ Siddiqui, Pr. Sc., Dr. A Mohanasundaram, Sc. Er. Ranjit Singh, Sc. and Er. P Sakare, Sc. attended Webinar-4 on 'Best practices for production, processing & marketing of tribal based commodities during COVID-19 organized by ICAR-IINRG, Ranchi in collaboration with Ch. Charan Singh National Institute of Agricultural Marketing (CCSNIAM), Jaipur through Cisco Webex meeting, May 03, 2020.
- Dr. MZ Siddiqui, Pr. Sc. attended one-day on-line workshop on 'Training Management Information System (TMIS) for HRD Nodal Officers of ICAR' organized by HRM Unit, ICAR HQ in coordination with ICAR-IASRI, New Delhi, May 08, 2020.
- Dr. NK Sinha, Pr Sc. participated in the Webinar on 'Agriculture Marketing to strengthen the efforts of government during COVID period without breaking the lockdown guidelines" organized by ICAR-IINRG, Ranchi, May 03, 2020.
- Er. Ranjit Singh, Sc. attended webinar on Patent Search and Analytics using IPGRAM organized by Dr. Rahul Kapoor, May 15, 2020.

- Dr. MZ Siddiqui, Pr. Sc., Dr. SC Sharma, Sr. Sc., Dr. A Mohanasundaram, Sc., Dr RK Yogi, Sc. and Dr. N Thombare, Sc. participated the Webinar on the topic of "Introduction of New J-Gate@CeRA platform" delivered by Shri. Mahendranath Sarkar, Kolkatta, May 22, 2020
- Dr. N Prasad, Pr. Sc. & Head PPD Division attended Standing Finance Committee (SFC) Video Conferencing Meeting chaired by DDG (Engineering), ICAR to discuss SFC proposal of Engineering Division schemes, May 28, 2020.
- Dr. RK Yogi, Sc. attended online state level meeting on "Unit cost estimation of agricultural business modules", June 10, 2020.
- Er. SK Pandey, Sc. participated in webinar on the topic "Prior-art searching with google patent" organized by Turnip Innovation Pvt. Ltd., June 26, 2020.
- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended one-day online Webinar on "Challenges and Roles of Agricultural Engineers under COVID-19 Scenario" organized by Swami Vivekanand College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, July 03, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK participated in monitoring for Annual Action Plane-cum- Zonal Workshop organized by ATARI Patna, July 07, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK participated in Annual Work Review and upcoming Annual Work Plan of Krishi Vigyan Kendra organized by ATARI Patna, July 20-21, 2020.
- Dr. KK Sharma, Director, Dr. Nirmal Kumar, Head TOT Division and Dr. RK Yogi, Sc. attended ITK, Success story documentation and Awareness & Outreach programs, July 07-08, 2020.
- Dr. AR Chowdhury, Sc. attended online one-day sensitization workshop on NABL accreditation of ICAR laboratories, July 20, 2020.
- Er. SK Pandey, Sc. participated in National Webinar on 'Protection of Intellectual Property and MSME' organised online by Chanakya National Law University, Patna, Bihar, July 11, 2020.
- Dr. RK Yogi, Sc. attended Webinar on "Animal Husbandry presentations: Friends of the farmers", July 21-22, 2020.
- Dr. MF Ansari, Pr. Sc. attended a video lecture on 'NABL accreditation of ICAR laboratories' delivered by Mr. N Venkateshwaran, CEO NABL New Delhi, July 22, 2020.
- Dr. Yogi RK, Sc. attended VC meeting by DDG for finalizing the products and procedures for impact assessment of technologies, July 22, 2020.
- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended one-day online Webinar on "Patent Prosecution Challenges and Strategies in India" organized by The Frontiers Legal in association with Turnip Innovations, Awfis, Schindler House, 6th Floor, Chemtex Lane, Hiranandani, Powai, Mumbai 400076, India, July 25, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK participated in meeting with Secretary DARE and DG- ICAR regarding achievement and work activity of Krishi Vigyan Kendra, August 04, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division Attended Video Conferencing Meeting chaired by DDG (Engineering), ICAR for discussion on Budget Utilisation and other General points related to Institutes, AICRPs, AINPs and CRPs under Engineering Division of ICAR, August 05, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division participated in webinar, organized by Kisanmitra with partnership of CCS NIAM, Jaipur under the theme "Agriculture Technology Presentations—Friends of the Farmers", August 06, 2020.
- Dr. MF Ansari, Pr. Sc. participated in two days on-line training programme on Inter Lab Comparison, Proficiency Testing and Evaluation of Scores (ILC-PT)" organized by NITS, BIS New Delhi, August 10-11, 2020.
- Er. SK Pandey, Sc. participated in the Webinar on "Entrepreneurship Opportunities in Mushroom Production" organized by ICAR-RCER under Agri-Business Incubation project, August 11, 2020.
- Er. SK Pandey, Sc. participated in Webinar on "Agriculture Technologies Presentations - Friends of

the Farmers under theme Intellectual Property Rights in Agriculture" organized by KisanMitr, CCS NIAM, Principal Scientific Adviser Office, Government of India, August 13, 2020.

- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended live session "Innovation Commercialization for Atmanirbhar Bharat" organized by Turnip Innovations Pvt. Ltd., August 14, 2020.
- Dr. SC Sharma, Sr. Sc. attended three days "Orientation workshop and training program for ABI units" organized by ICAR – National Academy of Agricultural Research Management, Rajendranagar, Hyderabad through virtual mode, August 17-19, 2020.
- Dr. N Thombare, Sc. attended webinar on "Achieving agrarian prosperity through agri-entrepreneurship" by Dr. Gajanan Rajurkar, Project Lead, Syngenta Foundation India and organized by ICAR-RCER FSRCHPR, Plandu, Ranchi, August 21, 2020.
- Er. Ranjit Singh, Sc. participated in the National Webinar on "Recent advances in dairy process engineering" organized by Department of Food Process Engineering, College of Food and Dairy Technology, Koduvalli in association with Association of Food Scientists & Technologists (India), Chennai Chapter, August 24-28, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK and team participated in online mode on fostering aquaculture technology with ATARI Director and KVK officials of India, organized by Central Pure Water and Fisheries Research Institute, August 27, 2020.Dr. N Prasad, Pr. Sc. & Head PPD Division Attended Video Conferencing Meeting chaired by DDG (Engineering), ICAR to finalize the proforma for impact assessment of Engineering Technology, August 28, 2020.
- Er. P Sakare, Sc. attended webinar on ' Response surface methodology (An introduction and its application in research)' organized by ICAR-CIAE Regional Centre, Coimbatore, August 28, 2020.
- Dr. J Ghosh, Pr. Sc. and I/C KVK with his team and Dr. RK Yogi, Sc. attended Inaugural function of the College and Administration Buildings of Rani Lakshmi Bai Central Agricultural University, Jhansi by the Hon'ble Prime Minister of India, August 29, 2020.
- Er. SK Pandey, Sc. participated in the Webinar on "Patent Protection for Innovation Driven Academic Institutions" organized by Turnip Innovations in association with The Frontier Legal, August 29, 2020.
- Dr. MZ Siddiqui, Pr. Sc. And Dr. SC Sharma, Sr. Sc attended lecture on 'कार्यालय से लिये जाने वाले अग्रिम एवं उसका समायोजन' delivered by Sri Ashwini Garg, F & AO, ICAR - IINRG, Ranchi, September 03, 2020.
- Dr. Yogi RK, Sc. attended Foundation laying of various academic facilities and inauguration in Dr. Rajendra Prasad Central Agricultural University, Samastipur Bihar, September 09, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division attended Video Conferencing Meeting chaired by Secretary, DAC & FW to discuss the modalities and road map to create a platform for innovation in farm machinery, September 10, 2020.
- Dr. SC Sharma, Sr. Sc. attended foundation laying of various academic facilities and inauguration of *"School of Agri-business and Rural Development"* virtually organized by Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, September 10, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division participated in webinar organized by Prime Minister's interaction team under the theme "Interaction with Prime Minister of India over VC" in connection to release of app *e-gopala,* September 10, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division and Dr. RK Yogi, Sc. attended Introductory Video Conferencing Meeting on Third Party Evaluation of DARE/ICAR Schemes under Agricultural Engineering Division under the chairmanship of DDG (Engineering), ICAR, September 11, 2020.
- Dr. RK Yogi, Sc. attended meeting to chalk out the targeted programs with outcome regarding 75th Anniversary of India's independence, September 11, 2020.
- Dr. RK Yogi, Sc. attended VC Meeting of the Pricing Committee for fixation of Minimum Support Price for MFPs covered under the scheme MSP for MFPs, September 14, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division participated in International Webinar on "Bamboo Bio-Engineering

towards developing Entrepreneurship and conserving Natural Resources" jointly organized by Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar and International Bamboo & Rattan Organization (INBAR), Beijing, China, September 24, 2020.

- Dr. RK Yogi, Sc. attended an online lecture of his PG teacher Dr Smita Sirohi on Export potential of agri products during national workshop organised by Central University, Imphal, September 24, 2020.
- Dr. SC Sharma, Sr. Sc. attended National webinar on 'Farm, Food and Farmer' organized by Samagra Vikas Welfare Society (SVWS), Lucknow, September 24 – 25, 2020.
- Dr. MZ Siddiqui, Pr. Sc., Dr. SC Sharma, Sr. Sc. and Dr. AR Chowdhury, Sc. attended an online lecture on 'Philosophy of Mahatma Gandhi' by Prof. Ramjee Singh, a former Member of Parliament and an eminent Gandhian and also the director of Gandhian Institute of Studies, Varanasi on the eve of 150th birth anniversary of Mahatma Gandhi, September 25, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division participated in Webinar organized by NAHEP (ICAR)-CAAST-IARI, New Delhi on "Farm Bill 2020-Understanding the implications", September 26, 2020.
- Dr. MZ Siddiqui, Pr. Sc. attended lectures on 'कृषि शिक्षा में गांधीवादी दर्शन एवं हिन्दी भाषा के बारे में महात्मा गांधी के विचार' delivered by Dr. Rakesh Chandra Agarwal, DDG, (Agricultural Education) and Dr. Abhay Kumar Vyas, ADG (HRM), ICAR, New Delhi, respectively, September 29, 2020.
- Dr. SC Sharma, Sr. Sc. attended session "Automation of Farming System" virtually organized by ICAR – Central Institute of Agricultural Engineering, Bhopal under Vaishwik Bharatiya Vaigyanik (VAIBHAV) Summit 2020, October 06, 2020.
- Dr. RK Yogi, Sc. attended Master training on "Historic reforms in Indian Agriculture "Barrier Free Trade and Efficient Supply Chains "One Nation One Market", October 10, 2020.
- Dr. SC Sharma, Sr. Sc., Dr. RK Yogi, Sc. and Dr. AR Chowdhury, Sc. attended live telecast "World Food Day" organized by ICAR, New Delhi on the occasion of 75th Anniversary of Food & Agriculture Organization, October 16, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division participated in National Webinar on "Hydro-informatics for Smart Water Management in Agriculture" jointly organized by CAE, RPCAU, Pusa; NIH, Roorkee; Depart of WRDM, IIT, Roorkee & Division of Agricultural Engineering, ICAR-IARI, New Delhi, October 20, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division participated in State level plantation advisory committee meeting as convened by Commissioner, MGNREGA to apprise importance of lac host in the venture and to execute MOU with the Institute, October 20, 2020.
- Dr. Palmei Gaibimei, Sc. attended the International online faculty development programme (FDP) on "Green Perspectives in Food Processing Sectors" organized by National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Sonipat, October 05-21, 2020.
- Dr. MZ Siddiqui, Pr. Sc. attended lecture on 'Constitution of India and Fundamental Duties of Indian Citizens' delivered by Dr. LK Kundan, Head, Department of Political Science, Ranchi University, Ranchi, October 26, 2020.
- Dr. AR Chowdhury, Sc. attended a lecture on the theme of 'Vigilant India Prosperous India' by C. K. Sinha, IPS, Anti -Corruption Bureau in a programme for celebrating Vigilance Awareness Week at ICAR-IINRG, Ranchi, November 02, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division acted as Chief Guest in the 'Vigillance awareness week' celebration by ICAR-RCER, Ranchi Centre, Plandu, November 02, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division and Er. SK Pandey, Sc. attended Video Conferencing Meeting chaired by Secretary, DARE and DG, ICAR, New Delhi to discuss proposal of Chattishgarh Minor Forest Produce Cooperative Federation regarding extending the support of ICAR for the development of minor forest produce in the state, November 16, 2020.
- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended Workshop on Copyrights in India organized by Turnip Innovations, Mumbai, November 20, 2020.
- Er. SK Pandey, Sc. participated in Virtual Workshop & Annual review meeting of ABIs/ZTMCs/ITMUs (NAIF scheme) under ICAR Institute of NRM, Agril.

Engg.and Agrl. Education Divisions organized by IP&TM Unit of ICAR, November 23-24, 2020.

- Er. SK Pandey, Sc. participated in technical webinar "Role of Natural Fibers for Atma Nirbhara Bharat" organized by The Indian Natural Fiber Society in collaboration with ICAR-NINFET, Kolkata, November 27-28, 2020.
- Dr. SC Sharma, Sr. Sc., Er. SK Pandey, Sc., Dr. AR Chowdhury, Sc. and Dr. N Thombare, Sc. attended a national Workshop on 'Intellectual Property Management in Agriculture' in virtual mode organized at ICAR –IIAB, Ranchi, November 28, 2020.
- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended International Webinar "Innovations and Advances in Agricultural Engineering" virtually organized by Agricultural Engineering College and Research Institute, Kumulur, Trichy under aegis of Tamil Nadu Agricultural University, Coimbatore, December 02 – 04, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division attended Video Conferencing Annual Conference of Vice Chancellors of Agricultural Universities and Directors of ICAR Institutes organized from ICAR, Krishi Bhavan, New Delhi, December 05, 2020.
- Dr. RK Yogi, Sc. attended National E-Conference on "Empowering Tribal Women: Entrepreneurship & Skill Development, a way towards *Atmanirbhar Bharat*" (NCETW 2020) and Co-Chaired the Technical session, December 05, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division attended meeting to finalize the specification of plant and machinery for establishing lac processing unit at Vedic Lac Foundation, Bundu, Ranchi under SFURTI Plan in the office of Chief Minister Small and Cottage Enterprises Development Board, Ranchi, December 07, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division participated in the Technical Session of the 35th Indian Engineering Congress held in virtual mode organized by The Institution of Engineers (India), Kolkata, December 18, 2020.
- Dr. SC Sharma, Sr. Sc., Dr. AR Chowdhury, Sc., Er. SK Pandey, Sc., Er. P Sakare, Sc. and Dr. N Thombare, Sc. participated 12th Annual workshop for AINP on Harvesting, Processing and Value Addition of NRGs through virtual mode, December 22-23, 2020.
- Er. Ranjit Singh, Sc. attended IISF 2020 – Young Scientist's Conference organized by Ministry of Earth Sciences, Ministry of Science and Technology, Ministry of Health & family Welfare and Vijnana Bharati (VIBHA), December 22-25, 2020.
- Dr. VD Lohot, Sr. Sc., Dr. Thamilarasi K, Sr. Sc., Dr. A Mohanasundaram, Sc. and Mr. Rajgopal NN , Sc. participated in Eighth Co-ordination committee meeting/workshop of Network Project on Conservation of Lac Insect Genetic Resources, ICAR-IINRG, Ranchi (online mode), December 29-30, 2020.
- Dr. AR Chowdhury, Sc. attended National Workshop on 'Modern Interventions in Environmental Management' through online platform organized by ICAR-IIAB, Ranchi, December 30, 2020.
- Dr. AR Chowdhury, Sc. attended online workshop on Swachhta Abhiyan and attended the lecture delivered by Hon'ble DDG education, December 30, 2020.
- Dr. N Thombare, Sc. and Er. Ranjit Singh, Sc. attended National Workshop on 'Modern Interventions in Environmental Management' organized by ICAR-IIAB, Ranchi through online platform, December 30, 2020.
- Er. Ranjit Singh, Sc. attended Workshop on Swachhta Abhiyan under the Chairmanship of Secretary, DARE & DG ICAR, via video conferencing, December 30, 2020.

Human Resource Development

- Mr. Rajgopal NN, Sc. attended DST-SERB sponsored three days' workshop on "DNA Barcoding for Insect Diagnosis" at Division of Entomology, ICAR-IARI, New Delhi, February 19-21, 2020.
- Dr. Palmei Gaibimei, Sc. underwent FOCARS training in NAARM, Hyderabad, January-March, 2020.
- Dr. Palmei Gaibimei, Sc. joined ICAR-IINRG, Ranchi and completed her one-month Institute orientation programme, March- April, 2020.
- Dr. RK Yogi, Sc. attended training program on "E-Learning Course on International Merchandise Trade Statistics", organized jointly by UN

Statistics Division, UNCTAD, and the World Trade Organization, March 16-April 24, 2020.

- Dr. AR Chowdhury, Sc. participated in one-day online workshop on "Training Management Information System (TMIS) for HRD Nodal Officers of ICAR" as HRD Co-Nodal officer of the institute for effective implementation and use of TMIS in the Institute, May 08, 2020.
- Er. Priyanka Sakare, Sc. attended one-week online training course on "Smart Handling and Processing Systems of Horticultural Produce" organized by Centre for Advanced Agricultural Science and Technology (CAAST) for Climate Smart Agriculture and Water Management (CSAWM), Mahatma Phule Krishi Vidyappeth (MPKV), Rahuri, May 10-14, 2020
- Dr. RK Yogi, Sc. attended an online dialogue on "What do we need for a gender-sensitive Covid-19 response in agriculture and food security", May 21, 2020.
- Dr. RK Yogi, Sc. attended an online (Webex meeting) training program on Role of market interventions schemes for enhancing agricultural marketing by Centre for Monitoring and Evaluation CCSNIAM Jaipur, May 22, 2020.
- Dr. SC Sharma, Sr. Sc., Er. SK Pandey, Sc., Dr RK Yogi Sc., Dr. AR Chowdhury, Sc., Dr. Nandkishore Thombare, Sc. and Er. Ranjit Singh, Sc. attended training on implementation of e-office, under Capacity Building Programme (CBP) on e-office for users, at IINRG, June 16, 2020.
- Dr. RK Yogi, Sc. attended NIAP webinar series on "Quantitative Methods for Social Sciences, June 01-23, 2020.
- Dr. RK Yogi, Sc. attended a Webinar on ICAR KRISHI portal, June 2 and July 15, 2020.
- Dr. AR Chowdhury, Sc., Dr. Nandkishore Thombare, Sc., Er. Priyanka Sakare, Sc., Ms. Langlentombi LC, Sc. and Er. Ranjit Singh, Sc. successfully completed 7 days online training on "Analysis of Experimental Data Using R" organized by ICAR-NAARM, Hyderabad from August 05-11, 2020.
- Er. SK Pandey, Sc. participated in online Orientation workshop and training program for ABI units organized by ICAR-National Academy of Agricultural Research Management (NAARM), Rajendranagar, Hyderabad, August 17-19, 2020.
- Dr. RK Yogi, Sc. attended an Online Orientation workshop and training program for ABI units, organised jointly by ICAR-NAARM and IP&TM Unit of ICAR, August 17-19, 2020.
- Dr. SC Sharma, Sr. Sc. attended live session "Patent Protection for Innovation Driven Educational Institutions" organized by Turnip Innovations in association with The Frontiers Legal, August 29, 2020.
- Dr. SC Sharma, Sr. Sc. and Er. SK Pandey, Sc. attended virtual workshop-cum-training on "Intellectual Property Rights in Agricultural Research & Education in India" organized jointly by National Agriculture Higher Education Project(NAHEP) and Intellectual property & Technology Management Unit of ICAR, September 12-28, 2020.
- Dr. SC Sharma, Sr. Sc. attended session "Automation of Farming System" virtually organized by ICAR – Central Institute of Agricultural Engineering, Bhopal under Vaishwik Bharatiya Vaigyanik (VAIBHAV) Summit 2020, October 6, 2020.
- Dr. MZ Siddiqui, Pr. Sc. attended MDP on Priority Setting Monitoring and Evaluation of Agricultural Research Projects (on-line) organized by ICAR-NAARM, Hyderabad, October 12-17, 2020.
- Er. Ranjit Singh, Sc. attended online training on Post-Harvest Management of Agricultural Produce during Natural Calamities/Disaster jointly organized by NIDM, New Delhi and ICAR-CIPHET, Ludhiana, October 19-21, 2020.
- Dr. Palmei Gaibimei, Sc. completed her three months Professional Attachment Training (PAT) in National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Sonipat on "Extraction of protein from guar meals and its characterization", October - December 2020.
- Dr. RK Yogi, Sc. attended an Online National Seminar on "Big Data in Agriculture, conducted by ICAR-NAARM, Hyderabad, December 10-11, 2020.
- Dr. NK Sinha, Pr. Sc. And Dr. J Ghosh, Pr. Sc. participated in 2 weeks DST sponsored online National Training Programme on "Integrated

Watershed Management for Rural Livelihood", at ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Udhagamandalam, December 28, 2020 -January 08, 2021.

Honors, Awards and Recognitions

For Director

- Chairman, Brushware, Polishes, Lac and Lac products Sectional Committee CHD 23 of Bureau of Indian Standards, New Delhi
- Member, Regional Advisory Committee on Off Farm Sector in Jharkhand, NABARD, Ranchi
- Member, Research Advisory Committee of Central Tasar Research and Training Institute, Ranchi
- Guest of Honour and Co-chaired the Technical Sessions in the 7th Annual Review Meeting of Network Project on Conservation of Lac Insect Genetic Resources, held at Central Agricultural University, Imphal (Manipur), February 03-04, 2020.
- Co-chaired the Technical Sessions in the 8th Annual Review Meeting of Network Project on Conservation of Lac Insect Genetic Resources, organized by ICAR-IINRG, Ranchi through Video Conferencing, December 29-30, 2020.
- External Examiner for evaluating the Ph.D. thesis / project report / dissertation 'Biology of *Kerria lacca* (Kerr) on various host plants and diversity of its natural enemies' of PAU, Ludhiana.

For Others

- Dr. S Ghosal, Pr. Sc. and Head LP Division reviewed 3 research articles for their publication in Legume Research, Agricultural Science Digest and Journal of Experimental Agriculture International during 2020.
- Dr. A Mohanasundaram, Sc. serving as an editor in magazine Agriculture and Food: e-newsletter since January 16, 2020.
- Dr. Thamilarasi K, Sr. Sc. served as Chief Editor, Dr. A Mohanasundaram, Sc. as Managing Editor and Dr RK Yogi Sc. as Assistant Editor compiled and edited *SANRAG e-Newsletter,* 1(1), January, 2020 and 1(2), July, 2020 editions.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Editorial Board, World Journal of Pharmaceutical Sciences, since January, 2013.
- Dr. Nandkishore Thombare, Sc. reviewed 3 manuscripts for publication in Carbohydrate Polymers, International Journal of Environment and Waste Management and Asian Journal of Research in Biochemistry during 2020.
- Dr. NK Sinha, Pr. Sc. received Reviewer Excellence Award from Indian Journal of Agricultural Research on February 10, 2020.
- Dr. Thamilarasi K, Sr. Sc. received Prof. P. Kameswara Rao best oral presentation award for the paper presented on "Functional genomics based analysis of putative pigment biosynthesizing genes" in XVII AZRA conference International Conference on Frontier Research in Applied Zoology and Insect Pest Management Strategies-A way forward for food and nutritional security held at UAS, Raichur, February 12-14, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division acted as Chairman, Kisan ghosthi organized during 'Kisan mela cum technology and machinery exhibition', February 13-14, 2020. Total 2000 farmers participated in the event.
- Dr. Nandkishore Thombare, Sc., acted as Co-Chairman for evaluation of poster presentations during National Conference on 'Utilization and conservation of non-timber forest genetic resources for sustainable development' organized by Navsari Agricultural University, Navsari, Gujarat, February 27-29, 2020.
- Er. Priyanka Sakare, Sc. as a reviewer, reviewed a manuscript titled Starch/Banana pseudo-stem bio-composite films for potential food packaging application for its publication in BioResources, February 2020.
- Er. SK Srivastava, Sc. received best article prize for the article titled 'Lac based intercropping system as carbon sink for climate change mitigation option in India' from Agriculture & Food: e-Newsletter, February, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division has been honoured with 'Reviewer Excellence Award' by Legume Research, February 2020.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Technical Editorial / Advisory Board of 'Krishak

Vandana'--a highly reputed monthly Hindi Magazine on Agriculture & Farming, published from Jabalpur (M.P.), since March 2012.

- Dr. AR Chowdhury, Sc. reviewed a Manuscript titled 'Stability of Grape Seed Oil Primary Emulsions with varying Levels of Casein and Whey Proteins affected by High Intensity Ultrasound' for its publication in Journal of Food Science and Technology, April 23, 2020.
- Dr. NK Sinha, Pr. Sc. received Reviewer Excellence Award from Legume Research, May 02, 2020.
- Dr RK Yogi, Sc. performed as an Organising Secretary for conducting a series of Webinars on "Benefitting stakeholders in Agricultural marketing to strengthen the efforts of Government during COVID period" by CCS National Institute of Agricultural Marketing, Jaipur in collaboration with ICAR-Indian Institute of Natural Resins and Gums, Ranchi, April 30 to May 24, 2020.
- Dr. AR Chowdhury, Sc. received 3rd 'Best Poster Presentation Award' on the paper titled 'Development of Natural Gum based Silver Nano-Composite Films for their use as Active Food Packaging' in National Webcon on 'Agricultural Production & support system managing Covid 19 pandemic: Experience sharing & Strategies' held at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, UP, May 6-8, 2020.
- Er. Priyanka Sakare, Sc. received best poster presentation award (3rd place) for poster titled 'Food packaging: A potential carrier of novel coronavirus' in the National WEBCON on 'Agricultural Production & support system managing Covid 19 pandemic: Experience sharing & Strategies' organized by Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (UP), May 6-8, 2020.
- Dr. Nandkishore Thombare, Sc. received, The Mosaic Company Foundation Award-2019, for "Outstanding Doctoral Research in the Area of Plant Nutrition" comprising gold medal, certificate and cash prize, announced during May, 2020.
- Dr. A Mohanasundaram, Sc. nominated as a Co-guide/ Member of the Advisory committee of Mr Vidya Sagar, M. Sc. (Forestry) student of Birsa Agricultural University, Kanke, Ranchi, June 08, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division has been awarded with Excellence in Reviewing by Journal of Experimental Agriculture International, June 13, 2020.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Editorial Board and Reviewer Research Journal of Chemistry and Environment, an International Monthly Online NAAS Indexed Journal, since June 2014.
- Dr. Nandkishore Thombare, Sc. received Jawaharlal Nehru Award for P.G. outstanding doctoral thesis research in agricultural and allied sciences 2019 (for Natural Resource Management) including certificate of honor and cash prize, offered by the Ministry of Agriculture and Farmer's Welfare, Govt. of India, as announced on 92nd Foundation Day of ICAR celebrated on July 16, 2020.
- Dr RK Yogi, Sc. acted as an External Examiner for viva-voce examination of 6 graduate and 2 post graduate students of Integrated M.Sc. in Agriculture, Rural & Tribal Development at Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), Ranchi for the project on "Analysis of potentiality and prospects of honey market in Ranchi district of Jharkhand: A way to sweet revolution", August 10, 2020.
- Dr. J Ghosh, Pr. Sc. nominated as Cochairman of Developmental Action Plan on Scheduled Caste (DAPSC), August 31, 2020.
- Dr. NK Sinha, Pr. Sc. received Reviewer Excellence Award from Agricultural Reviews, September 02, 2020.
- Dr. MF Ansari, Pr. Sc. participated as external expert in BIT's Doctoral committee constituted for extension and enhancement of fellowship for JRF Ms. Sindhuja P, in the externally funded project SERB sponsored project (EEQ/2016/000656), September 11, 2020.
- Dr. J Ghosh, Pr. Sc. nominated as Expert member of Project Expert Group (PEG) for reviewing the progress of AICRP (Forest Genetics and Tree Improvement) of Indian Council of Forest Research and Education (ICFRE), Dehradun and reviewed six projects of AICRP, September 15, 2020.
- Dr. AR Chowdhury, Sc. received 2nd best article award for an article published in *Laksha*, a Hindi Annual Magazine published form the Institute on the eve of '*Hindi Divas Samaroh*' at ICAR-IINRG, Ranchi, September 30, 2020.

- Dr. Nandkishore Thombare, Sc. received first prize in Hindi essay writing competition organized on the occasion of *Hindi diwas* during September 2020.
- Er. Ranjit Singh, Sc. received first prize in Hindi poem competition organized on the occasion of *Hindi diwas* during September 2020.
- Dr. MZ Siddiqui, Pr. Sc. continued as Vice-President of Society for Advancement of Natural Resins & Gums (SANRAG), Ranchi, since October 19, 2016.
- Dr. MF Ansari, Pr. Sc. reviewed 3 research papers for the journals Polymer-Plastics Technology and Engineering, Pigment and Resin Technology and Iranian Polymer Journal during 2020.
- Er. Ranjit Singh, Sc. reviewed manuscript titled 'Effect of process parameters on extraction of pectin from sweet lime peels' submitted to Journal of the Institution of Engineers (India): Series A, November 3, 2020.
- Dr. J Ghosh, Pr. Sc. chaired Technical session IV in National Seminar on "Crop Breeding for wider adaptation" at Birsa Agricultural University, Ranchi, December 12-13, 2020.
- Er. Ranjit Singh, Sc. awarded Best paper presentation in Online Conference on "Science, Technology and Innovation (STI) for sustainable food system-2020" organized by Division of Food Technology, Department of Chemical Engineering, Vignan's Foundation for Science, Technology and Research, Guntur Dist., December 15-16, 2020.
- Dr. Nandkishore Thombare, Sc. received Certificate for Excellence in Reviewing from Asian Journal of Research in Biochemistry during December, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division received Outstanding Agricultural Engineering Scientist Award – 2020 for his contribution to Harvesting, Processing and Value Addition of Natural Resins and Gums from Dr. B. Vasantharaj David Foundation, Chennai.
- Dr. N Prasad, Pr. Sc. & Head PPD Division worked as Assistant Editor, Journal of Agricultural Engineering published by Indian Society of Agricultural Engineers, New Delhi.
- Er. SK Pandey, Sc. reviewed one research paper titled "Development and evaluation of pepper harvester" submitted for publication in Journal of AgriSearch Published by Society for Upliftment of Rural Economy (SURE), Varanasi.
- Dr. AR Chowdhury, Sc. reviewed a manuscript titled 'Release-controlled study of Polysaccharide Loaded Curcumin Edible Films' for Journal of Food Science and Technology.
- Er. Priyanka Sakare, Sc. reviewed a manuscript titled 'Physical properties of different varieties of groundnut (*Arachis hypogea*)' submitted to Journal of Agricultural Engineering.
- Dr. NK Sinha reviewed 4 research articles for Indian Journal of Agricultural Research,
- Agricultural Reviews, Journal of Environmental Biology, Legume Research and Agricultural Science Research Journal during 2020.
- Dr. NK Sinha, Pr. Sc. nominated in Panel of Reviewers of the Journal of Environmental Biology.
- Dr. A Mohanasundaram, Sc. as an Editor reviewed five research papers for the Indian Journal of Entomology during 2020.
- Mr. Rajgopal NN, Sc. is serving as an Associate Editor for the Indian Entomologist - a biannual online magazine published from the Entomological Society of India (ESI).
- Dr. VD Lohot, Sr. Sc. received "Biodiversity Conservation Award 2020" from Dr. B. Vasantharaj David Foundation, Chennai.
- Er. Priyanka Sakare, Sc. served as External Examiner/Paper Setter for the course PFE-312 Agricultural Structures and Environment Control, for Undergraduate Autumn Semester Examination-2019 of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar.
- Article by Vaibhav D Lohot, Nandkishore Thombare, Jyotirmoy Ghosh, Thamilarasi K, A Mohanasundaram, V.V. Thakur and K.K. Sharma (2020) on "Rain tree (*Albizia saman*): A potential lac host and gum producing tree" was awarded the Article of the Year Award by Agriculture & Food: e- Newsletter.
- Dr. RK Yogi, Sc. reviewed 23 articles for their publication in journals such as Journal of Agricultural Economics and Rural Development, Journal of Agricultural Science and Technology, International Journal of Agricultural Sciences, International Journal of Agricultural Education and Extension, International Journal of Forestry and

Wood Science, Asian Journal of Agricultural and Horticultural Research, Journal of Plant and Animal Sciences, Indian Journal of Agricultural Marketing, Advances in Research, Asian Journal of Agricultural Extension, Economics and Sociology during 2020.

- Dr. J Ghosh, Pr. Sc. acted as Research Advisory Group (RAG) member, Institute of Forest Productivity (IFP) and evaluated five Projects of IFP during 2020.
- Dr. J Ghosh, Pr. Sc. evaluated 2 Ph D thesis and 4 M.Sc thesis of Bihar Agricultural University, Sabour, Bhagalpur and taken final viva voce examination during 2020.
- Dr. J Ghosh, Pr. Sc. appointed as paper setter & Examiner for UG Graduate End term exam of course APG-306 for Dr. Rajendra Prasad Central Agricultural University, Pusa and for course FB-1202 for Birsa Agricultural University, Ranchi during 2020.

Capacity Building/Lectures/Talk Delivered

By Director

- Dr. KK Sharma gave a talk on Lac production scenario in Palamau district on 28th May 2020 which published in local newspapers on 29th May 2020.

By Others

- Dr. A Mohanasundaram, Sc. delivered a lecture on the topic of "Lac associated insect fauna and pest management in lac" during Advanced Method of Lac Production and its uses at TOT division, IINRG, Namkum, Ranchi, January 7, 2020.
- Dr RK Yogi, Sc. jointly organised Training under Scheduled Caste Sub plan (SCSP) on "Recent Advances in Management Practices of Horticultural Crops" at ICAR-RCER, Ranchi Centre, Plandu, Ranchi.
  - for SC households from Palamau (24), January 6-10, 2020.
  - for SC households from Ranchi (22), January 13-17, 2020.
  - for SC households from Ranchi (22), January 20-24, 2020.
- Dr. RK Yogi, Sc. jointly organised One-day workshop cum animal unit distribution program under Scheduled Caste Sub plan (SCSP) for SC households.
  - from Chandaghasi, Namkum, Ranchi (17), January 24, 2020.
  - from Hazaribag (20), January 28, 2020.
  - from Bokaro (20), January 29, 2020.
  - from Khunti (21), January 27-31, 2020.
  - from Khunti (21), February 6, 2020.
  - from Ranchi (23), February 13, 2020.
  - from Chatra (20), February 25, 2020.
  - from Palamu (30), February 26, 2020.
  - from Garhwa (50), February 27, 2020.
- Dr. RK Yogi, Sc. jointly organised Natural Resins and Gums Stakeholders Meet 2020 at Girijan Co-operative Corporation Ltd., East Point Colony, Visakhapatnam, January 29, 2020.
- Dr. SC Sharma, Sr. Sc. delivered a lecture on "Commercially Important Natural Resins and Gums Production" under NRG Stakeholders' Meet 2020 jointly organized by ICAR- IINRG, Ranchi, Girijan Co-operative Corporation Limited, Visakhapatnam, NGOs Kovel Foundation, Visakhapatnam and CCN Sahyog, Visakhapatnam organized at Girijan Co-operative Corporation Limited, Visakhapatnam, January 29, 2020.
- Dr. AR Chowdhury, Sc. delivered a lecture cum demonstration on 'Characterization techniques of natural resins and gums' to Agro-Industrial attachment training for Rural Agricultural Work Experience for B. Sc. (Ag.) student from BAU, Ranchi at ICAR-IINRG, Ranchi, February 8, 2021.
- Dr. NK Sinha, Pr. Sc. delivered lecture on 'Lakh poudho ko ugaana ewam uska prabandhan' (in Hindi) in the 'Lakh utpadan ewm upyog ki unnat Vidhiya' organized ICAR-IINRG, Ranchi, February 10-14, 2020.
- Dr. SC Sharma, Sr. Sc. delivered a lecture on "Improved Equipments for Lac Processing" to farmers/ beneficiaries (35 Nos.) sponsored by Chhattisgarh Minor Forest Produce, Jashpur (Chhattisgarh), February 14, 2020.
- Dr. RK Yogi, Sc. jointly organised Exposure visit program under Scheduled Caste Sub plan (SCSP) for SC households from Khunti (21) 2020 at IINRG, Ranchi, February 13-14, 2020.
- Dr. RK Yogi, Sc. jointly organised Exposure visit program under Scheduled Caste Sub plan (SCSP) for SC households from Bokaro (50) at IINRG, Ranchi, February 14, 2020.

- Dr. Nandkishore Thombare, Sc. conducted training on 'Cultivation, harvesting, processing and marketing of chironjee (piyar) products' benefiting about 20 master trainer from different block of Ranchi and Hazaribagh district at Forester cum Forest Guard Training School, Hazaribagh, February 20, 2020.
- Dr. Nandkishore Thombare, Sc. delivered a Lead Lecture on 'Processing and value addition of natural resins and gums for diverse applications' during National Conference on 'Utilization and conservation of non-timber forest genetic resources for sustainable development' organized by Navsari Agricultural University, Navsari, Gujarat, February 27-29, 2020.
- Dr. RK Yogi, Sc. jointly organised review meeting on ICAR-IINRG Publication Repository (KRISHI) at IINRG, Ranchi, February 29, 2020.
- Dr. Nandkishore Thombare, Sc. delivered a guest lecture on 'Research methodology for quality research' to the PG students of College of Forestry, Navsari Agricultural University, Navsari, Gujarat, March 02, 2020.
- Dr. RK Yogi, Sc. and Mr. Rajgopal NN, Sc. jointly organised One Day Workshop on "Implementation of Research Data Management -web-portal – KRISHI for Technical Staff" at IINRG, Ranchi, March 03, 2020.
- Dr. S Ghosal, Pr. Sc. and Head LP Division delivered a lecture on '*urvarak ka lakh poshak vriksh par samuchit upoyog*' for the regular training conducted at TOT Division, IINRG, Ranchi, on March 17, 2020.
- Dr. SC Sharma, Sr. Sc. delivered a lecture on "Improved Equipments for Lac Processing" to sponsored (35 Nos.) farmers/beneficiaries, March 19, 2020.
- Dr. RK Yogi, Sc. delivered a lecture on "Economics of lac cultivation and marketing" March 19, 2020.
- Dr. RK Yogi, Sc. jointly conducted One-week training on scientific lac cultivation, March 16-20, 2020.
- Dr. VD Lohot, Sr. Sc. guided two M.Sc. (Biotechnology) students from Department of Biotechnology, Ranchi Women's College, Ranchi, from 01/01/2020 to 31/03/2020.
- Dr. RK Yogi, Sc. interacted with three stakeholders about lac production, demand and marketing activities and with Chhattisgarh State Rural Livelihood Mission, Raipur regarding the list of Potential vendors for lac market linkages with FPOs promoted by CGSRLM at Kanker, Kondagaon and Bastar, April 2021.
- Dr. A Mohanasundaram, Sc. delivered three lectures on the topic of "Lac insect life and crop cycle", "Insects pests of lac and their Management" and "*Rangeeni* lac cultivation on *Palas*" during Orientation training for newly joined scientists through WhatsApp video calling from LP division, IINRG, Ranchi, April 27, 2020.
- Dr. A Mohanasundaram, Sc. as a resource person delivered a talk on the topic entitled: "Lac Integrated Agro-forestry System: An additional Income to Farming Community" through Zoom meeting in a one-week Faculty Development Programme on "Climatic change Adaptations and Alterations in Farming Practices" organized by School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Krishnankoil, Tamil Nadu, May 29, 2020.
- Dr. RK Yogi, Sc. delivered a talk on "Best Practices for NRG Marketing & Value Addition in times of COVID-19: Challenges and Way Forward" in the Webinar 4 organised jointly by ICAR-IINRG Ranchi and Chaudhary Charan Singh National Institute of Agricultural Marketing, Jaipur (Rajasthan) at the Webex Meet, May 03, 2020.
- Dr. A Mohanasundaram, Sc. as a lead speaker delivered a talk on the topic entitled: "Best Practices for Production of Tribal based commodities during Covid-19" through Webex meeting organized by Ch. Charan Singh National Institute of Agricultural Marketing (CCSNIAM), Jaipur in association with ICAR-IINRG, Ranchi, May 03, 2020.
- Dr. RK Yogi, Sc. organised Training on "Orientation program for the newly posted ARS Scientist", May 13, 2020.
- Dr. A Mohanasundaram, Sc. as a resource person delivered a talk on the topic entitled: "Lac Integrated Agro-forestry System: An additional Income to Farming Community" through Zoom meeting in one-week Faculty Development Programme on "Climatic change Adaptations and Alterations in Farming Practices" organized by School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Krishnankoil, Tamil Nadu, May 29, 2020.
- Dr. RK Yogi, Sc. jointly conducted "Hands on Training for Survey & Data Compilation under SC Sub Plan" June 08, 2020.

- Following lectures were delivered by the Scientists during ICAR-NAHEP-CAAST short training on Natural Resins and Gums: Production, Processing, Value addition and Marketing at ICAR-IINRG, Namkum, Ranchi, July 20-30, 2020.
  - Dr. A Mohanasundaram, Sc. on Life cycle, crop cycle and pest management, July 20, 2020.
  - Dr. VD Lohot, Sr. Sc. on Collection and conservation of lac insects and lac host plants biodiversity, July 20, 2020.
  - Dr. Nandkishore Thombare, Sc. on Introduction and uses of major NRG plants, July 20, 2020.
  - Dr. RK Yogi, Sc. on Global Scenario of production and trade of NRGs, July 21, 2020.
  - Er. Priyanka Sakare, Sc. on Natural Resin and Gum as edible coating material for food, July 22, 2020.
  - Er. Ranjit Singh, Sc. on Drying techniques for natural resins and gums, July 22, 2020.
  - Dr. SC Sharma, Sr. Sc. on Tapping techniques and tools for resins and gums, July 23, 2020.
  - Dr. J Ghosh Pr. Sc. on Lac on their host plants, July 23, 2020.
  - Dr. Nandkishore Thombare, Sc. on Recent advances in application of natural resins and gums in agriculture, July 24, 2020.
  - Dr. MF Ansari, Pr. Sc. on Quality Control of Natural Resins and Gums and their Industrial Applications, July 25, 2020.
  - Er. SK Pandey, Sc. on Natural lac dye and other lac based technologies for entrepreneurship, July 27, 2020.
  - Dr. AR Chowdhury, Sc. on Characterization techniques of natural resins and gums, July 28, 2020.
  - Dr. MZ Siddiqui, Pr. Sc. on Medicinal importance of natural resins and gums, July 30, 2020.
- Dr. Nandkishore Thombare, Sc. as a Co-convener organized 10 day's training on '*Natural Resins and Gums: Production, Processing, Value Addition and Marketing*' through online mode for 24 participants including PG students, research scholars and faculty members of CAAST project from Navsari Agricultural University, Navsari, Gujarat, July 20-30, 2020.
- Dr. A Mohanasundaram, Sc. provided on farm training on Integrated pest management on paddy under which pheromone traps were installed and also provided insecticides to four farmers for conducting On Farm Trail of Integrated pest management on Paddy under KVK project, August 5, 2020.
- Dr. RK Yogi, Sc. conducted Front line demonstrations on "Scientific lac cultivation: Pest management" at Khunti, August 14 and 17, 2020.
- Dr. Nandkishore Thombare, Sc. as a co-supervisor, has started to supervise the PhD work of Mr. Saurav Kumar, Scientist, CSIR-CSIO, Chandigarh, related to exploring the uses of Shellac for electronic application since August, 2020.
- Dr. SC Sharma, Sr. Sc. delivered a lecture on "Improved equipments for lac processing" to representatives from Forest Research Center for Eco-Rehabilitation, Prayagraj, Uttar Pradesh, September 24, 2020.
- Dr. RK Yogi, Sc. conducted *Hindi Mash* (1-30 September 2020) and *Hindi Samaroh*, September 30, 2020.
- Dr. RK Yogi, Sc. conducted Training for 2 trainees sent by the Forest Research Centre for Eco-rehabilitation, Prayagraj UP, September 2020.
- Er. SK Srivastava, Sc. delivered orientation lecture to two newly joined scientists of ICAR-IINRG Mr. Sandeep Kumar and Dr. Rahul Bakade, October 5, 2020.
- Dr. RK Yogi, Sc. jointly conducted Sub Master training on "Historic reforms in Indian Agriculture" Barrier Free Trade and Efficient Supply Chains "One Nation One Market" for 175 officials of IFFCO Fertilizer Associations across various states of Jharkhand, Chhattisgarh, Maharashtra, MP, Delhi & Union territories, October 14, 2020.
- Dr. AR Chowdhury, Sc. delivered a lecture cum demonstration on Laboratory safety measures in a training programme on 'skill upgradation for skilled supporting staff', December 15, 2020.
- Dr. A Mohanasundaram, Sc. delivered invited talk on "Lac Culture" through online mode to PG students and other faculties (100 participants) of Department of Zoology, Kanya Maha Vidyalaya, Jalandhar, December 24, 2020.
- Dr. N Prasad, Pr. Sc. & Head PPD Division delivered a lecture on "Mechanization of Lac Production and Primary Processing – An overview" in a Webinar on Status & Strategies for Farm Mechanization in India under the aegis of NAHEP-IDP, Junagadh Agricultural University, Junagadh, Gujarat, December 24, 2020.

Events -2020

Constitution Day celebration

The under mentioned invited lectures under Awareness Campaign Focused on Citizens' Duties including Fundamental Duties as enshrined in the Indian Constitution" were organized throughout the year at ICAR – IINRG, Ranchi, as a part of Constitution day celebtation Dr. SC Sharma, Sr. Sc. acted as a Convener for this programme.

Lecture topic	Date	Expert
Important Constitutional Amendments & their Significance	January 22, 2020	Dr. J. P. Khare, Associate Professor, University Department of Political Science, Ranchi University, Morabadi, Ranchi (Jharkhand)
Constitution and Citizen Duties, Land Legislations and Reforms	February 26, 2020	Dr. Pankaj Kumar Chaturvedi, Principal, Chotanagpur Law College, Nyay Vihar Campus, Bargawan, Namkum, Ranchi (Jharkhand)
Constitution of India and National Struggle for Freedom	August 26, 2020	Dr. Dhirendra Tripathi, Assistant Professor, University Department of Political Science, Ranchi University, Ranchi (Jharkhand)
Public Awareness Campaign on Fundamental Rights and Citizens Duties enshrined in the Constitution	October 15 - 31, 2020	Nodal Officer and Members of different adopted villages under *Mera Gaon Mera Gaurav*
Constitution and India and Fundamental Duties of Indian Citizens	November 26, 2020	Dr. L. K. Kundan, Head, University Department of Political Science, Ranchi University, Ranchi (Jharkhand)




Plantation of *Flemingia semialata* (Experts delivering lecture under condition day celebration) Besides conducting lectures, ICAR – Indian Institute of Natural Resins and Gums, Namkum, Ranchi also organized plantation of *Flemingia semialata* seedlings at farmers' field on July 22, 2020 in Diyankal village of Torpa Block, Khunti under Awareness campaign focused on Citizens' Duties including Fundamental Duties as enshrined in the Indian Constitution. During the event, officials of the institute along with farmers of Diyankal village planted about 100 seedlings of *F. semialata* (a lac host plant) to promote lac cultivation following social distancing and wearing face masks to avoid spread of COVID - 19. Villagers were also informed about scientific method of lac cultivation, tools and equipments used for lac cultivation to reduce cost of cultivation and primary processing to increase the value of their product.

Plantation of *Flemingia semialata* seedlings at farmers field

Public Awareness Campaign: ICAR-Indian Institute of Natural Resins and Gums, Ranchi organized "Public Awareness Campaign Focusing on Fundamental

Rights and Citizens Duties as enshrined in the Constitution" during October 15 - 31, 2020 under the *Mera Gaon Mera Gourav* programme. Teams of scientists and technical experts visited the adopted villages Benyajara, Jaradih, Sursu in Angarha block and Mangobadh in Namkum block and conducted different activities.

Theme of the visit was to create awareness among the villagers about fundamental rights and citizens' duties enshrined in the Indian constitution and providing guidance regarding disposable of stubble and farm residues. During the event, experts from different teams explained about the importance of fundamental rights and duties in the development of a responsible citizen, sensitize the villagers regarding use of face masks, and maintain social distancing and hygiene. scientists and technical experts also briefed about the purpose of sanitation in daily life to villagers during the programme under *Swachh Bharat Abhiyan* and distributed face mask, soap and sanitizer to avoid spread of COVID-19. During the event, experts suggested for inclusion of millets and pulses in diet which have more vitamins and minerals for better nutrition, informed about energy efficient technologies and encouraged to use LED lights to save energy.

The lectures by teams were followed by interactive sessions in which farming related queries were addressed by the scientists. The experts also made a visit around the villages to assess the situation of farming and suggested remedial measures for control of pests and predators of lac insect, soil health and mechanization in farm activities and motivated them to visit the institute. Villagers were also informed about the various socio-economic issues of rural life and role of the lac cultivation in income generation and various government schemes to promote lac cultivation like Minimum Support Price and implementing agency JASCOLAMPF. On this occasion villagers, children, members/officials of local governing bodies from the various villages participated actively.


Experts of ICAR – IINRG, Ranchi interacting with villagers of Beniyajara, Namkum, Jaradih, Angarha and Sursu

Experts visit to farmers' field

Distribution of face-masks to villagers at Mangobadh, Namkum

Awareness campaign on crop residue management at Mangobadh, Namkum

International Day of Yoga

International day for Yoga-2020 was organized where staff of the institute along with their family members collectively practiced Yoga for 45 minutes from Home on June 21, 2020. Dr. Nandkishore Thombare, Sc. acted as a Nodal officer for this program.

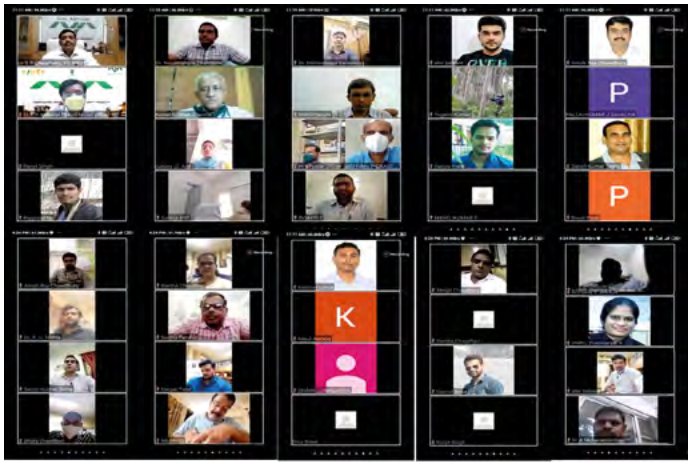
NRG Stakeholders Meet

One day NRG Stakeholders Meet was organized at Girijan Co-operative Corporation Ltd. (GCC), Visakhapatnam in collaboration with NGOs Koval foundation, Visakhapatnam and Sahyog, CCN, Visakhapatnam, January 29, 2020. Dr. N Prasad, Pr. Sc. & Head PPD Division acted as a Convener for this programme.

ICAR-NAHEP-CAAST Training on Natural Resins and Gums: Production, Processing, Value Addition and Marketing

A short training on 'Natural Resins and Gums: Production, Processing, Value Addition and Marketing' was organized by the ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand, from July 20-30, 2020, through online mode (zoom conferencing). The inauguration ceremony was held on 20th July in the gracious presence of Dr. SR Chaudhary, Hon'ble Vice Chancellor, Narsari Agricultural University, Navsari, Dr. KK Sharma, Director, ICAR-IINRG, Ranchi, Dr. TR Ahlawat, PI & Nodal Officer, NAHEP-CAAST, NAU, Navsari, Dr. Niranjan Prasad, Convener and Head PPD Division, other dignitaries, resource persons from ICAR-IINRG and participating students from NAU.

The training covered different aspects of natural resins and gums (NRGs) including Overview, Production, Harvesting and Processing, Value Addition, Characterization and Quality Control, Marketing and Extension through a series of 20 lectures. Total 24 participants including PG students, Research Scholars and Faculty members of CAAST project of NAU, actively participated in the short online training. The lectures were complemented by the demonstration videos / virtual field visits/ other relevant audio-visual for the better understanding of the subjects to the participants. Each lecture was followed by the interaction session, where queries and doubts from the participants were addressed by the resource person. Feedback regarding the content and conduct of the training was received from participants through online feedback form, and overall response from the participants was found satisfactory. The online training on NRGs will surely help the students and other participants in their academic career.



Participation of faculty and students in ICAR-NAHEP-CAAST Training on NRG

Parthenium Awareness Week-2020

ICAR- Indian Institute of Natural Resins and Gums (IINRG), Ranchi observed fifteenth 'Parthenium Awareness Week' during August 16-22, 2020. During the week, all the office bearers and employees of the institute participated in the Parthenium eradication campaign and uprooted the Parthenium from the Institute campus. Dr. NK Sinha, Pr. Sc. acted as coordinator for this programme.

The programme concluded with the address of the Director, Dr. KK Sharma. While addressing the employees IINRG Director emphasized on creating a parthenium free environment. He told that parthenium makes the land barren by consuming nutrients from the soil. Dr. Sharma said that it causes skin irritation when the parthenium comes in contact with the body, which eventually leads to contact-dermatitis in people with allergic reactions. Pollens of this weed cause many diseases related to respiratory disorder. He also mentioned that the Mexican beetle (*Zygogramma bicolorata*) is capable of managing parthenium especially by feeding on small plants and the apical part of the older plant. This beetle feeds on parthenium and does not harm other plants, humans and animals; therefore, it has proved to be very useful in the control of Parthenium. Subsequently, the Director administered the oath to the scientists and all other employees of the institute for the removal of Parthenium.

On this occasion, Dr. NK Sinha, Pr. Sc., said that Parthenin and another important chemical Sesquiterpene lactones found in Parthenium grass are responsible for allergies and dermatitis. He said that Parthenium grass is a hindrance in many activities in crop production and it causes severe loss in crop production. Therefore, everyone should be vigilant to prevent the spread of this weed. It should be uprooted and destroyed before flowering.

Parthenium eradication by institute offical in IINRG campus

97th Foundation Day

ICAR-IINRG celebrated its 97th Foundation day on September 21st, 2020 in virtual mode. On this occasion, Dr. Arunava Pattanayak, Director, ICAR-Indian Institute of Agricultural Biotechnology, Garkhatanga, Ranchi was the chief guest and Dr Arun Kumar Singh, Head, ICAR-Farming System Research Centre for Hill and Plateau Region, Plandu, Ranchi was present as guest of honour. The dignitaries like Dr. KK Singh, ADG (Farm Engineering) and Dr. SN Jha, ADG (Process Engineering) and former Directors of the Institute, Dr. Bangali Baboo, Dr. R Ramani and the scientists from IIAB, ICAR- FSRCHPR and other institutes in the virtually participated foundation day programme. While welcoming the dignitaries, Dr. KK Sharma, Director, ICAR-IINRG appraised of the expertise gained by the Institute in the field of production, processing and value addition of Lac and other Natural Resins and Gums (NRGs). He also added that the Institute is going to complete its centenary in the near future and efforts are continued to make significant impacts on the farming community through the scientific cultivation of the lac and other NRGs.

The Chief Guest Dr. Pattanayak addressing the gathering online congratulated the IINRG team on the eve of 97th Foundation day of the Institute for the remarkable achievement in the field of NRGs and lac. He also pointed out the fruit coating formulation developed by Institute has great potential and should be promoted to the commercial scale. Dr. AK Singh also appraised the achievements and technologies developed and transferred by the Institute. The former directors of the Institute also expressed their views on the occasion. Dr. Bangali Baboo appreciated the work on hydrogel technology and urged for continuation of this type of work. Dr. R Ramani in his view, exhorted the study on tamarind gum to explore more application areas of the same.

Felicitation of the distinguished workers

On this occasion 10th Ms Dorothy Norris memorial lecture was delivered by Dr. J S Yadav, former director CSIR-IICT, Hyderabad on 'Chemistry of insect Pheromones and their Application Technology (PAT) as an alternative to pesticides' and he illustrated very particularly application of eco-friendly and environmentally safe pheromone technology in the agro practices in country for overall benefits of the agrarian society.

An MOU was exchanged between ICAR-IINRG and Chakriya Vikash Sansthan, Ormanjhi, Ranchi in the area of training on scientific lac cultivation for tribal farmers and Director, ICAR-IINRG, Ranchi and Shri Devendra Nath Thakur, Director, Chakriya Vikash Sansthan, Ormanjhi, Ranchi signed the MoU on the behalf of their respective organizations. An extension folder on 'Cultivation of winter *Kusmi* lac on *Swadi Palas*' was also launched by the dignitaries. On this occasion, distinguished workers of the Institute in technical, administrative and skilled supporting staff categories were felicitated with certificates and trophies for their commendable contribution in their sphere of work. Dr. N Prasad, Head Processing and Product Development Division and Convener of the programme delivered vote of thanks to the dignitaries and organizers at the concluding session of the programme. Dr. MF Ansari and Dr. AR Chowdhury were the co-conveners of the programme.

Inauguration of the 97th Foundation Day ceremony

Plantation raising and Walkathon

ICAR-Indian Institute of natural Resins and Gums organized Plantation raising and Walkathon event in the occasion of celeberating 150th Birth anniversary of Mahatma Gandhi on 01st October, 2020 at Institute Research Farm. Around ninety number of *kusum* seedlings were planted by the all staffs of IINRG under the leadership of Dr. KK Sharma, Director, ICAR-IINRG, Namkum. In this occasion Walkathon competition was also conducted among the staff amongst which Ms. Priyanka Sakare, in

the womens' category, Shri Bandhanu Oraon in the above 45 years age category and Shri Ashutosh Prabhat in the below 45 years age category were awarded the first prize in the Walkathon event. Books on Gandhian thoughts were awarded as prizes to the winners of the event by Dr KK Sharma Director, Dr. Nirmal Kumar, Head Tansfer of Technology division and Dr. Niranjan Prasad, Head PPD division. The programme was convened by Dr S Ghosal, Head Lac production Division.

Planting of *kusum* seedling at IRF

Inauguration of walkathon event at IRF

Seventh Annual Workshop of AINP on CLIGR

Seventh Annual Review / Co-ordination committee meeting of Network Project on Conservation of Lac Insects Genetic Resources (NP-CLIGR) was held at CAU, Imphal on February 03-04, 2020. Dr. KI Singh, PI, CAU, Imphal welcomed the gathering during the inaugural session, which was chaired by Dr. KK Singh, ADG (Farm Engineering). Prof. M. Premjit Singh, Honourable Vice Chancellor, CAU, Imphal was the Chief Guest and Prof. Indira Sarangthem, Dean, College of Agriculture, Iroisemba, CAU, Imphal and Prof. Y. Jakendra Singh, Dean, College of Food Technology, CAU, Imphal were the Guests of Honour.

Dr. KK Sharma, PC, NP-CLIGR and Director, ICAR-IINRG addressed the participants highlighting concern over depletion of lac insect bio-diversity, need of *ex-situ* and *in-situ* conservation of lac insect and the importance of lac in various fields especially in providing livelihood support to tribals and rainfed farming community. He added that Network Co-operating Centres were created based on agro-ecological zone. He informed that Manipur has rich diversity of lac host plants and lac insect population in the state and added that growing lac and using it in processing will replace the synthetic chemicals in the value chain as north eastern states are giving emphasis towards organic farming.

Inaugural Session of 7th Annual Workshop of AINP on CLIGR at CAU, Imphal

Dr. KK Singh, ADG (Farm Engineering), addressed the participants by his remarks on the production of the *Rabi* crops that yielded bumper crop this year and significant increase in the union budget for the agriculture sector and ICAR *per se*. He also emphasized the Network Centers to take adequate measures to utilize the budget allotted for each Centre completely.

Prof. M. Premjit Singh, Vice Chancellor, CAU, Imphal, while addressing, emphasised on skill development for unemployed youth regarding bee keeping, mushroom cultivation, lac cultivation and its value addition which could strengthen the rural youths. Manipur is rich in bio-diversity from which new hosts such as *Malvaviscus penduliflorus* and *Bombyx ceiba* for lac insect were reported from Imphal Centre. He also felt that intervention of lac with litchi and lac with honeybees may also be taken up in research mode.

On this occasion, two publications viz., "*Makhioti gosot laa khetir orthoinaitik bishlekhon*", "*Ahomot laa kheti*" by AAU, Assam; one publication –"Lac Cultivation" (in Punjabi) by PAU, Ludhiana, one book titled "Lac Insects of the World: An Updated Catalogue and Bibliography" by IINRG, Ranchi were released.

Business Session

Field visit and Business Session was held on 04th February, 2020. Major recommendations arrived after deliberations in the Workshop were

- All the Centres would compile year-wise, the observations recorded on status of lac insect and host plant availability during surveys conducted from beginning of the project till March, 2020 in the prescribed format already shared with the Centres and submit the soft copy of the compilation along with good quality photographs in JPG format to the Lead Centre on or before April 30, 2020.
- The project needs to be continued in the next plan so as to complete the status of lac insect availability/ cultivation in the remaining districts.
- Based on the survey/research/financial achievements, the Network Co-operating Centres were evaluated on the performance parameters.
- All the Centres to submit the progress report on quarterly basis.
- Salary and arrear of enhanced salary of SRFs and salary of contractual Lac culture attendant should be paid within this financial year.
- Dr. K K Singh, ADG (Farm Engineering), suggested to submit a half page write up of five elegant technologies/highlights and also to prepare detail plan for next five years for SFC document.

Eighth Annual Workshop of AINP on CLIGR

Eighth Annual Workshop of AINP on HPVA of NRG was organized during December 29-30, 2020 through Online Virtual Platform from ICAR-IINRG, Ranchi.

Inaugural session

The eighth Annual Review / Co-ordination committee meeting of Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) was held online (virtual mode) from 29th to 30th December, 2020. Dr. K. Alagusundaram, DDG (Engineering) graced the inaugural session as Chief Guest and Dr. K. K. Singh, ADG (Farm Engineering) as Guest of Honour. Fifty participants including PIs & Co-PIs, RAs & SRFs of Network cooperating Centres and Voluntary Centres took part in the deliberations.

The session began with the welcome address by Dr. Thamilarasi K. Co-PI, ICAR-IINRG. Dr. K. K. Sharma, Project Coordinator, NP- CLIGR presented the progress of past year and the major achievements of the project of the past six years (2014-2020). He informed that 65.8% of the districts in the country have been surveyed for availability of lac insect and host plants to prepare the

Organization of 8th Annual Workshop of AINP on CLIGR through online mode

lac map of the country. Endangered lac insect populations from threatened areas have been collected and conserved in Regional Field Gene Banks in the different Agro-Ecological Zones as well as in National Lac Insect Germplasm Center of ICAR-IINRG, Ranchi. He added that the potential areas for lac cultivation were identified in the different Agro-Ecological Zones. Further, he mentioned that a new and efficient method of Aleuritic Acid preparation has been developed as the old method is cumbersome and time consuming. Extensive trainings were conducted and infrastructure developed by Network Cooperating Centers (NCC) and now each center has come up to a stage for introduction of lac cultivation in their respective areas for producing lac on commercial scale due to handholding and trainings given by the Lead Centre.

Dr. K. Alagusundram DDG (Engineering), in his opening remarks congratulated the team for good achievements under the Network Project. He was happy to see large number of women participants to maintain the gender balance. He exhorted the PIs and Co-PIs of the Cooperating Centers to complete the survey of remaining districts in next plan period and conduct extensive training / awareness programmes to benefit the farmers for land use diversification and increasing the farm income. He also emphasized on apprising the higher authorities of the achievements made and to develop a platform to increase the economic benefit for our country through this project. Dr. K.K. Singh ADG (FE) in his address, suggested to make block instead of district as unit for survey for comprehensive coverage of the area. He informed that lac insects are important resources of our country that provide livelihood to the poor people especially in rain-fed areas and need to be conserved on priority. He emphasized on identifying and involving all the stakeholders of the region concerned for better impact

of the project. On this occasion, 'Handbook on Lac Insect and Host plant in Kerala' and two brochures in English and one in Malayalam by KFRI Centre and one Bulletin entitled 'Rahar Gasot Laa Kheti Aaru Khekhokor Doita Uparjan' in Assamese prepared by AAU, Jorhat were released by the dignitaries.

Technical Sessions

The technical session was chaired by ADG (FE) and Co-Chaired by Dr. K. K. Sharma, Director, IINRG & Project Coordinator, NPCLIGR. Progress of work and budget utilization were presented and discussed.

Business Session

Business Session was held on 30th December, 2020. Major recommendations arrived after deliberations in the Workshop are:

A. Research

1. Yearly plan should be formulated to cover the districts of the country that remain to be surveyed so as to compile the district wise lac map of the country.
2. District is too big unit for recording observation on availability of lac insect / host plant and identification of potential area for introduction of lac cultivation. Therefore, block wise survey plan should be prepared for development of lac map of the country.
3. Prepare quantifiable and measurable target of the next year plan and make strategies to achieve these targets within proposed time line.
4. Develop the digital field guide of lac host plants into a web portal for better and wider acceptability.
5. Live lac insect (before initiation of emergence) and samples preserved in absolute alcohol (matured female cells) based on different species, population, strain, state wise variant, colour variant and any other distinct morphological characters should be collected and deposited with the Lead Centre.
6. All the host-plants where natural lac insect found should be collected in the form of either seeds, seedlings, cutting or small plants and added to their Regional Field Gene Banks. Same samples should be sent to Lead Centre for *ex-situ* conservation.
7. Record GPS location data of the surveyed areas.
8. Based on the survey/research / financial achievements, the Network Co-operating Centre were evaluated on the performance parameters.

B. Budget

9. All the Network Co-operating Centers should send their requirement of budget till March 2021 and unspent money to the Lead Centre for proper utilization of the budget.
10. Salary and arrear of enhanced salary of SRFs and salary of contractual Lac culture attendant should be paid within this financial year.
11. If required, pool the resources of both Network Projects of the institute for better monitoring and execution of objectives.

C. Administrative Matter

12. Keeping in view the continuous poor performance of Network Co-Operating Centre at PJTSAU, Hyderabad, it was recommended to close the centre.
13. Keeping in light the good performance of Voluntary Centre, ANGRAU, Guntur, it was recommended to upgrade the status to Network Co-Operating Centre.
14. Proposal received from ICAR-CAFRI, Jhansi to include it as Network Co-Operating Centre was recommended to include it initially as Voluntary Centre.

Twelfth Annual Workshop of AINP on HPVA of NRG

The 12th Annual Workshop of Network Project on 'Harvesting, Processing and Value Addition of Natural Resins and Gums' (NP-HPVA of NRGS) was held during December 22-23, 2020 via Virtual Online Platform (Co-ordinated by lead Centre ICAR- IINRG, Ranchi) to review the annual progress of the Network Project centres and to discuss the technical programmes for the year 2021–22.

The meeting started with the welcome address by Dr. N Prasad, Coordinator, Network Project on HPVA of NRGs. Dr. K. K. Singh, ADG (Farm Engineering), ICAR, Delhi and Dr. K. K. Sharma, Director, ICAR-IINRG, Ranchi addressed the participants present on Virtual Platform from different collaborating centres.

Dr. N Prasad presented the Coordinator's Report and ATR on recommendations of 11th Annual Workshop. He also presented an overview of the Network Project and briefed the objectives of the Project and also the number of methodologies/techniques, process/products, and technologies/patents developed or transferred by the PIs of Network Project to the interested farmers/stakeholders.

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

- Book on "Guar Gum Post Harvest Technology and Value Addition" VNMKV, Parbhani
- Manual on "Bore Hole Method of Resin Tapping", YSPUHF, Solan.
- Black Dammar Cone Dhoop, KAU, Thrissur
- DVD on Success Story of "Black Dammar based Agarbatti", KAU, Thrissur
- Mid Term Review Report of All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums: ICAR – IINRG, Ranchi.

Technical Session

After the inaugural session and the remarks of the dignitaries, PIs & Co-PIs of the Network Project centres presented the progress for the year 2019 - 20 and technical programme for the year 2021–22 in the Technical Sessions Chaired by Dr. KK Singh, ADG (Farm Engineering) and Co-chaired by Dr. KK Sharma, Director, ICAR-IINRG, Ranchi.

Business Session

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

- All the coordinating centre should submit technical and financial report in time.
- All the coordinating centres should acknowledge ICAR for providing fund in their publications/ products/technology developed.
- Budget allocated to the coordinating centres, under the project, should be fully utilized with proper planning.

Concluding Session

The concluding session was chaired by Dr. K Alagusundaram, DDG (Engineering). Dr. K.K. Singh, ADG (Farm Engineering) and Dr. KK Sharma, Director, ICAR-IINRG were also present in the session and gave their concluding remarks based on two days' deliberations in the Workshop.

Dr. K Alagusundaram, DDG (Engineering), ICAR, Delhi addressed the delegates. In his address, he emphasized that Social and Economic impact of developed technologies/ products on farmers/stakeholders should be documented in form of book/booklets/folder and sent to the Council. He suggested to improve the value of natural resins and gums multiple times by processing, product development and extracting high value compounds present in these or their by-products. He further suggested scientist to develop practice of out of box thinking in formulating new research project. A plan of action for the project should be developed with realistic targets and a timeline including a commercialization plan for developed technologies/ products.

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

- Processing and value addition of NRGs should be taken up on priority in next plan period.
- Social and economic impact on status of farmers/ stakeholders through intervention of the project may be prepared at each cooperating centre for their commodity.
- Future plan of action for the project should be developed with realistic targets and timeline including commercialization plan for developed technologies/ products.
- Impact assessment of the scheme may be included in the activities under the project.
- Products/technologies developed under the project based on different commodities assigned to centres should be documented in form of book/booklets/ folder.
- Cooperating centre should have complete value chain for assigned commodity (resin/gum) to their centre.
- Processing and value addition activities for resin/gum should be enhanced under the project.

Organisation of 12th Annual workshop of AINP on HPYA of NRG. through online mode.

Meetings of Important Committees

Institute Research Council (IRC)

The Institute Research Council (IRC) meetings were held on July 16-17, 2020 under the Chairmanship of Dr. KK Sharma, Director, ICAR-IINRG, Ranchi. During the meetings, the research progress of ongoing projects (17), RPP-III (01) and new project proposals (03), exploratory studies (2) under six core programmes, were discussed thoroughly and approved/adopted by the House. The following points emerged out:

- Head of Division should devote not less than 50% of time in Divisional management and Project coordination and 25% for planning/monitoring activities as PC, Network Project. Remaining time may be devoted to research project of their discipline.
- No scientist should be associated in more than 3 projects as PI or Co-PI as its mandatory to allocate at least 25% of time in each project with relaxation to those who are handing externally funded projects.
- Remaining 25% of the time should be utilized for other assigned activities/assistance in research projects without being associated/Extension/MGMG/Swachh Bharat/Member of important committees.
- Contribution of each scientist associated with the project must be clearly defined in RPP-I.
- The duly completed RPP-I, RPP-II, RPP-III & RPP-IV must be submitted to PME Cell by 31.10.2020.
- Late submission of RPPs and other time bound reports like Annual Report, Quarterly Monitoring Targets, Monthly Report etc. must be reported in APAR of the scientist by Head of the Division concerned.

In the end, Member-Secretary extended sincere thanks to the Chairman for his valuable scientific inputs to improve upon the present research activities of the individual scientist, thereby, Institute as a whole.

Research Advisory Committee (RAC)

Twenty-seventh meeting of the RAC, IINRG was held on 08-09 July, 2020 on the virtual platform in the Chairmanship of Dr. Pitam Chandra, former ADG (PE) & former Director, ICAR-CIAE, Bhopal. Following members were present:

- Prof. RN Jagtap, Prof-Head, Institute of Chemical Technology, Mumbai
- Dr. Suresh Walia, Emeritus Scientist, ICAR-IARI, New Delhi
- Dr. Subhash Chander, Professor and PS, ICAR-IARI, New Delhi
- Dr. Sanjaya K. Dash, Dean, OUAT, Bhubaneswar
- Dr. Kanchan K. Singh, ADG (FE), ICAR, New Delhi
- Dr. KK Sharma, Director, ICAR-IINRG, Ranchi
- Dr. NK Sinha, PS, ICAR-IINRG, Ranchi : Member Secretary

Major recommendations given by RAC are as follows:

1. The models may be developed for correlation of weather parameters with lac production.
2. The biodegradation study of lac may be outsourced for accelerated degradation analysis.
3. Low cost, on-farm technologies for processing and value addition of NRGs may be developed.
4. Success stories may be documented, published and distributed among the concerned departments of lac growing states. Social media resources should be used to disseminate the cultivation and processing technologies and also the products developed by the Institute.
5. Outcome of the completed research projects in the form of recommendations should be passed-on to the TOT Division and same should be taken up for on-farm demonstration involving the inventor as Co-PI.
6. Trainings on value addition of lac in bangle making should be taken up by the institute for women empowerment.
7. All the natural gums and resins in their purest forms may be exhibited in the museum along with their natural sources. The museum may be updated with new products and technologies annually or every two years to maintain the up-to-datedness.
8. The Report on 'Current Status, trends and future prospects of NRG production, processing and value addition in India & Overseas' may be updated.
9. IPM interventions at the farmers' fields in KVK should be supported through the linkages with service providers so that required amounts of the same may be made available as per need.
10. KVK should train farmers in preparation of bio-pesticides with locally available materials *i.e.* neem oil and other extract *etc.* to make the rural economy self-sufficient and sustainable.



Organisation of Research Advisory Committee meeting. through online mode.

Institute Management Committee (IMC)

The 54th Meeting of the Institute Management Committee (IMC) was convened in the *Kusmi* Conference Hall of the Institute on February, 28, 2020. The following members were present in the meeting:

1. Dr. KK Sharma, Director, ICAR-IINRG, Ranchi — Chairman
2. Dr. Pannalal Singh, Pr. Sc. Nominee of ADG (AE), ICAR, New Delhi — Member
3. Dr. AK Thakur, Pr. Sc., NINFET, Kolkata — Member
4. Dr. Bikash Das, Pr. Sc., ICAR RCER RC, Ranchi — Member
5. Sri SC Lal, Sr. AO (Actg.), ICAR-IINRG, Ranchi — Member Secretary

Invited Members

Dr. Nirmal Kumar, Pr. Sc. & In-charge, TOT Division, IINRG, Ranchi

Dr. MF Ansari, Principal Scientist & In-charge, PPD Division, IINRG, Ranchi & Incharge, F&AO, IINRG, Ranchi

Dr. VD Lohot, Scientist, In-charge, LP Division, IINRG, Ranchi

Dr. RK Yogi, Scientist & In-charge, PMEC, IINRG, Ranchi

Dr. A Mohanasundaram, Scientist, IINRG, Ranchi

Shri Anil Kumar Yadav, Estate Officer, IINRG, Ranchi

Shri Abhishek Kumar, Assistant & In-charge, Admin-III Section, IINRG, Ranchi

Shri Kameshwar Oraon, Assistant, , IINRG, Ranchi

1. Welcome Address by the Member Secretary

The meeting started with the welcome address by the Member Secretary, IMC and formal introduction of the members and the invitees.

2. Introductory remarks by the Chairman

Dr. KK Sharma, Chairman, Institute Management Committee and Director, ICAR-IINRG, Ranchi welcomed the members present in the meeting.

3 (a) Presentation on Research achievements of the Institute

Dr. R.K. Yogi, Scientist and In-charge, PMEC presented the research achievements of the Institute.

3 (b) Presentation on Scientific topic

Dr. A. Mohanasundaram, Scientist, IINRG delivered a lecture on the topic 'Tritrophic interaction in lac Ecosystem: Semiochemical approach'.

3 (c) Presentation on Financial Status of the Institute

The Finance & Accounts Officer, IINRG presented the financial status of the Institute.

3 (d) Report on Status of Establishments by Admin-I

The status of establishment was presented by Shri S.C. Lal, I/c Sr. Administrative Officer. On this it was advised to make correspondence for filling – up the vacant posts under different categories.

4. Confirmation of the proceedings of 53rd meeting of IMC held on 21st December, 2018

The IMC was apprised of the approval of the recommendations made by the Management Committee in its 54th meeting held on 18th June, 2019.

5. Agenda for 54th meeting of IMC

- 5 (a) Strengthening of existing bituminous road length 3000 meter including repair of damage base

in 800 meters length and providing 80 mm thick CC paver block in 450 mm width on both side of road in the main campus of the Institute. CPWD has submitted Preliminary estimate amounting Rs. 1,82,17,000/- (One Crore, Eighty-two Lakhs, Seventeen Thousand) only. Since the amount is more than 150 Lakhs, the recommendations of IMC is required for approval of the Competent Authority, ICAR.

After discussion, IMC recommended the proposal.

- 5(b) Fencing of boundary walls of Institute Research Farm (IRF) in approx 2000 meters to avoid the theft cases.

  After discussion, IMC recommended to obtain first the estimate for the same and get its approval under the EFC.

6. Information regarding IJSC and Grievance Cell

IJSC: The IMC was appraised that meetings of Institute Joint Staff Council (IJSC) were called during the reporting period invariably.

Grievance Cell: By nomination of members under different categories, the Grievance Cell of the Institute has been reconstituted. It was recommended to call a formal meeting of the newly constituted Grievance Cell.

7. Any other item with permission of Chair

Under any other item also it was discussed how to get the vacant posts of the Institute under the administrative and SSS categories. On this it was suggested to make proposals and forward to the Council.

8. Vote of thanks by Member Secretary, IMC

The meeting ended with a vote of thanks by the Member Secretary, IMC.

Distinguished Visitors

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

Sl. No.	Name	Designation/Organization	Date Visited
1.	Mr. Anoop	Bharat Gyan Vigyan Samiti (BGVS), Ranchi	22.01.2020
2.	Mr. DDPathak	B.D.O., Namkum	24.01.2020
3.	Dr. DB Sudhakar	PS, ICAR-IIHR, Bengaluru	24.01.2020
4.	Mr. Alamgir Alam	Minister, Jharkhand Government	13.02.2020
5.	Prof. Pankaj Kr. Chaturvedi	Principal, Jharkhand Law College, Ranchi	26.02.2020
6.	Dr. SK Das	ERS Team Leder, ICAR-NDRI, Karnal	27.02.2020
7.	Mr. Hemant Soren	Chief Minister, Jharkhand Government	05.05.2020
8.	Mr. TUK Singh	GM, HEC Ltd., Hatia, Ranchi	10.09.2020
9.	Mr. Sanjay Mishra	Sampadak, Prabhat Khabar, Ranchi	30.09.2020
10.	Mr. Chandan Kr. Sinha	SP, Anti Corruption Bureau	02.11.2020
11.	Mr. PK Prasad	Jt. Secretry, Govt. of Jharkhand	14.12.2020

Shri. Hemant Soren, Hon'ble Chief Minister Jharkhand at IINRG Lac Museum

Shri. Sanjay Seth, Member of Parliament, Ranchi and Shri. Alamgir Alam, MLA, Pakur and Minister of Parliamentary Affairs, Rural Development and Panchayati Raj, Jharkhand at IINRG

Support Services

Institute Research Farm (IRF)

Resource Generation

Brood-lac/ Scra-plac (₹)	Fuel Wood (₹)	Water + Fuel charges (₹)	Lac host plant seeds and seedlings (₹)	Other farm pro-duce (₹)	Total (₹)
7,47,830	6800	400	3,16,866	60,665	11,32,561

Infrastructure Development

- A new plot (Plot no. 41 part) of size 15m x 60m was developed for raising *Flemingia macrophylla* for experimental and seed purpose (Fig. 1).
- Paths of 10 feet width along the North and North-West boundary of IRF were made using JCB machine
- Internet connection was re-established at IRF office. New computer and equipments with communication facilities were procured for working through e-Office and video conferencing.

Fig. 1. New plot of *F. macrophylla*

Nursery Management

- *Bhalia* (3 kg), Semialata (30 kg) seed were produced and *Khair* (3 kg), *Galwang* (5 kg), *Ber* (3.5 kg), *Ghont* (3 kg) and *Kusum* (3 kg) were collected from different trees
- 1220 *F. semialata*, (plot no.55, 63 and 64) 20 *Ber* (LIFS plot no. 55) and 90 *Kusum* seedlings (plot no 33-40 and 42-49) were transplanted for gap filling.
- Bio-composting by utilizing leaves and cow dung for nursery purpose was done and the biocompost manure is being used in the nursery.
- *Semialata* seedlings (2280 nos.), *Ber* seedlings (450 nos.), *Calliandra* seedlings (330 nos.) and *Semialata* seeds (250 g) were provided to scientists for research purpose.
- Seeds and seedlings of lac host plants were sold to farmers, KVK and other organizations. Details are as under:

Lac host plant	Quantity
Semialata seedlings	5370 Nos .
Semialata seeds	2.8 kg
Bhalia seeds	0.5 kg
Kusum seedlings	744 Nos .
Calliandra seedlings	225 Nos.
Ber seedlings	30 Nos .
Galwang seeds	5.2 kg

Farm Management

- Despite the Covid-19 scenario and lockdown, viewing the importance of essential farm management and lac culture activities, IRF remained operational implementing all the prescribed guidelines from the institute.
- Executed field related experimental work of the scientists of LPD, TOT and PPD Division including IRF activities as per their requirements.
- Inputs like fertilizers, farm yard manure, farm machinery like tractors with ploughing implements, power tiller and irrigation facilities were provided to the scientists for maintaining their research plots.
- More than 30 kg of *F. semialata* seeds could be collected by the successful management of pod fly through appropriate and periodic insecticide sprays.
- Infestation of white fly for the first time on *F. semialata* was observed which was managed by spray of systemic insecticides Imidacloprid and Thiamethoxam @ 0.5 ml per lit of water. Further study needs to be done on the methods for the control of white fly on plants inoculated with lac.
- Weeding, cleaning and lime application mixed with chloropyriphos on approx. 5000 lac host plants and other trees.

- The production of vermicompost is being done at IRF in plot no. 24A and produced around 100 kg. It is being applied on vegetable crops grown at IRF. Vermiwash is being sprayed on the nursery plants for improving their robustness and health.
- Wheat (var. HD-2967) & mustard were sown in 1 hectare each in the unutilized plots of IRF for resource generation (Fig. 2). 1754.5 kg Wheat & 301 kg Mustard seeds were harvested and sold from which revenue of Rs. 48,635 was generated from IRF.

Fig. 2. Threshing of harvested wheat from unutilized plots

- Lac Integrated Zaid crop production**:** Vegetable crops *viz.* bottle gourd, bitter gourd, cucumber, long melon (*kakadi*), ridge gourd (*jhinga*), sponge gourd (*nenua*) and okra were grown in integration with lac inoculated *Ber* trees. The produce was sold for resource generation (Fig. 3).

Fig. 3. Lac integrated zaid crop production

Lac Culture

- 2217 kg of *Kusmi* broodlac was harvested and 2045 kg inoculated on *Kusum* (245 nos.), *Ber* (555 nos.) and *F. semialata* plants for both summer and winter *kusmi* crops. Similarly, 270.5 kg of *Rangeeni* broodlac was harvested and 178 kg inoculated on *Palas* (53 nos.) and *Ber* (110 nos.) for both *baisakhi* and *katki* crops.
- 96.5 kg scrapped lac and 239.5 kg broodlac were provided to scientists for research purpose.
- 1042 kg *kusmi* scraplac, 90 kg *rangeeni* scraplac and 419.8 kg seedlac was sold to different lac traders through open auction for the purpose of revenue generation.

Soil Amendment

Green manuring was done using *Dhaincha* and *Sanai*, 120 kg each, in *Kusum* (plot no. 33-49) and *Ber* (plot no. 17-29) for soil amendment (Fig. 4 and 5).

Fig. 4. Green manuring with Sanai at *ber* plots

Fig. 5. Green manuring with Dhaincha at *kusum* plots

Quality Evaluation Laboratory

During the period under report, a total number of 274 samples (68 outside and 206 internal) of lac, lac-based products and Natural Gums were received from Govt. organizations, Private Industries and different Divisions of the Institute. Total 955 (100 outside and 855 internal), tests were carried out, earning a sum of Rs. 55,873/- (Fifty-

five thousand eight hundred seventy-three rupees) only from external source and Rs. 60,000/- (Sixty thousand rupees) only from the institute projects. Samples of institute projects, costing Rs. 4,80,499/-, were tested in the Quality Evaluation Laboratory.

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:

- Submission of various time-bound reports:
  - Cabinet Monthly Report to ADG (FE) by 20th of every month
  - Monthly brief updates on progress to DDG (FE) by 20th of every month
  - Half Yearly Progress Report (HYPM)
  - Quarterly Targets & Achievements
  - DARE report, Annually
  - Annual Plan Outcome Budget
  - Preparation & submission of Annual Training Programme for the Year 2020-21 for all the employees of the Institute to the Council
  - Preparation & submission of Annual Physical and Financial Targets and Achievements (April, 2019 to March, 2020) of all the employees of the Institute to the Council
- PME Cell conducted Institute Research Council (IRC) Meeting on July 16-17, 2020
- Maintenance of Research Project Files: Institute (17), ICAR-Network Projects (02), ICAR-ICRAF (01), ICARDBT (01) and Inter-Institutional (ICAR-IIAB & IINRG) (01), (ICAR-RCER & IINRG) (01), (ICAR-IIHR & IINRG) (01), KVK Khunti – (1)
- Processing of research papers & popular articles for various Journals submitted by the scientists
- Processing of papers submitted by the scientists / staff for conferment of Awards/Honours/ Recognitions etc., to them
- Processing of papers submitted by the scientists for their participation in National/International Conferences/Symposia
- Coordination for conducting RAC, IMC & Director's Conference
- Coordination for HRD Programmes for all the employees (Scientists, Technical & Administrative) of the Institute
- PME Cell provides different services like:
  - LAN and Internet Connectivity to the divisions & sections of the Institute
  - E-mail services
  - Annual Maintenance of Computer Systems, Local Area Networking (LAN), EPBAX, Biometric Devices & CCTVs
  - Maintenance of web-based Data Base for Personnel Management Information System (PERMISNET), Enterprise Resource Planning (ERP) and Project Information Management System (PIMS), E-Office, Support for PFMS.
  - Regular updating of Institute's website with all general information, events, tenders, interviews etc.
  - Quarterly updating of CIC website with all relevant information/statements as required under the provisions of RTI Act, 2005 and processing of requests received under RTI
  - Reply of Parliament questions and any other last minute reply required to be submitted to SMD.

Library and Documentation Centre

The library of the Institute is playing 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 well as lac/gums/resins industrialists from other part of the country.

Advance/Full Text/Abstracts access of more than 3900 journals from several publishers have been made available online through *Consortium for e-Resources in Agriculture* (CeRA) to our scientists during the year. Our library is also connected with World eBook Library (WEL) facilitates by National Digital Library (NDL), New Delhi from this year.

All regular institute publications (Annual Reports, Newsletters, Lac-Resins-Gums Statistics, Laksha, Dorothy Norris Lecture Series etc.) since beginning and Research Articles/ Bulletins are available in PDF form for the internal users. Annual Reports, Newsletters, Lac-Resins-Gums Statistics, Laksha, Dorothy Norris Lecture Series are also uploaded on ICAR-Krishi Portal.

Revenue of Rs. 8,089.00 was generated from the sale of publications during the year. The library also continued the exchange of institute publications with the scientific institutions in and outside 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 received

- Foreign Periodicals (Gratis/exchange) -05
- Indian Periodicals (Gratis/exchange) -06

Library holdings (as on 31/12/2020)

Documents	Additions	Total Holdings
Books	04	6982
Bound Journals	-	21634
Annual Reports	84	3465
IS-Specification	-	184
Thesis	-	13

Estate Section

The following services are being provided by Estate section

- Security of institute premises
- Power and water supply to offices and residential quarters
- Civil and Electrical maintenance of office buildings and residential quarters
- Assistance in engineering research work
- Infrastructure development work in the institute
- General maintenance and upkeep of institute premises

Works (Civil) taken up through CPWD during the year 2020

- Roof treatment of Palas conference hall
- Aluminum glazed partition in hall of PPD
- Construction of PCC road from LPD to guest house
- Construction of PCC road from submersible pump to type IV quarter
- Renovation of Biotechnology Laboratory of LPD
- Renovation/ repair of septic tank of type – III (5 & 6) quarter

Works (civil) taken up departmentally during the year 2020

- Distempering, plastering, putty, PCC work, enamel painting, primer in type II (26 & 28) Quarter, guard post and Main gate in PDU campus
- Distempering, Weather coating, enamel painting and primer in Type V (3 & 4) Quarter
- PCC work for closing the drains of Type IV(D/S) quarters in Main campus
- Brick work, putty work, plastering, distempering, primer and enamel painting in Quality Evaluation Laboratory

Electrical work

- Maintenance of electrical installation of office buildings and residential quarters
- Maintenance of Genset and associated panels, transformer, overhead LT lines
- Maintenance of street lights and associated panels
- Electrical renovation of Type-III (14-17) Quarter of PDU Campus
- Electrical renovation of Pilot plant building

General maintenance

The work is being outsourced and is monitored by estate section so as to ensure that the work is done satisfactorily as per our scope of work.

Jobs entered in job register

- Plumbing & water supply - 278
- Electrical work - 420
- Carpentry work - 364
- Welding work - 72
- Turner work & other related work - 350

Most of above works have been completed satisfactorily

Health Centre

The Institute has a functional Health Centre in the campus under the Chairmanship of Dr. M.F. Ansari (PS). Dr. Kailash Prasad and Dr. (Mrs.) Reema K Khalkho have been providing their services as a part time Medical Officers (AMAs) on contractual basis on alternate days in the center. Most of the medical cases are being handled in the centre itself and complicated cases are referred to authorized CGHS hospitals and pathology clinics in

the city for expert diagnosis and treatment. The Health Centre is equipped with routine instruments to handle general/minor dressing, first aid, physical examination of patients, measure B.P., pulse, height, weight, blood sugar, etc. In the year 2020, 4016 patients were registered and treated in the health centre. A total of 48 patients were advised for medical rest and were issued medical fitness. The Center has a computerized inventory system, facilitating retrieval of records like issue of medicines, date of receiving, unregistered patient along with the near date of expiry of medicine, etc. This ultimately helps the AMAs in taking better decision while prescribing medicines. Most of the medicines prescribed by AMAs were made available to the patients from the Health Centre itself. Apart from attending to regular employees, pensioners, and contractual staff of various on-going research projects, medical treatment are also provided to trainees and laborers on humanitarian grounds, in case of emergency and casualty.

During the year under report, several steps were taken to improve the system and patient handlings were streamlined.

Institute Technology Management Unit (ITMU)

Er. SK Pandey, Sc. worked as I/c, Institute Technology Management Unit (ITMU) under NAIF scheme through which following work were done in 2020

- Response to FER w.r.t. Patent application 580/KOL/2011 on Group-specific primers for identification of *Kerria* species was filed in patent office through our old attorney M/s Seenergi IPR, Kolkata, January 24, 2020.
- Demonstration of Institute technologies were done in Institute stall during Kisan mela-cum-Technology and Machinery demonstration Mela organised at IINRG, Ranchi, February 13-14, 2020.
- Complete specification of patent application (Application no. Temp/E1/9172/2019-KOL) on natural gum based nanocomposite hydrogel having antibacterial and wound healing effects and a method of preparation thereof was processed and filed in patent office Kolkata through attorney M/s Anjan Sen and Associates, Kolkata, March 3, 2020.
- Details of 05 shortlisted ICAR-IINRG, Ranchi technologies compiled as per format required by DDG (Engg.) useful in COVID crisis and sent it.
- Details of compiled 10 number of technologies given to Nodal officer, IINRG for uploading on Krishi portal.
- Details of revenue generated in the last five years 2015-20 through process and products training, licensing compiled and sent to PME cell for sending this information to headquarter.
- Provisional patent application submitted by Dr. N. Thombare on "Natural resin based novel non-drying adhesive: Preparation and application in insect trap" was processed through ITMU, IINRG, Ranchi and patent application was filed on 07.05.2020 in patent office Kolkata through attorney M/s Anjan Sen and Associates, Kolkata. Application no. 202031019392 (TEMP/E-1/21 121/2020-KOL)
- Feedback/suggestion was given on exclusive licensing proposal of CIAE, Bhopal as comment on this was sought by SMD (Engg.)
- One patent application 580/KOL/2011 on "Group-specific primers for identification of Kerria Species" processed through ITMU was granted patent on 30.06.20 from patent office with Patent no. 339906 dated 25.04.2011
- Participated in meeting with DDG (Engg.) and two ADGs on 22.07.2020 w.r.t. impact assessment of Institute technologies and presented technologies commercialization and impact of this in the meeting from Institute side
- Participated in online Meeting with DDG (Engg.) for finalizing proforma for Impact assessment of Engineering Technology organized by SMD (Engg.), August 20, 2020.
- Details of 20 numbers of Institute technologies compiled and sent to CA, IINRG for forwarding to SMD as required by them for publication of mechanization technologies of ICAR.
- Information related to 3rd party impact evaluation of Institute technologies was compiled for forwarding to SMD which included top impacting 10 numbers of Institute technologies, list of technology generated before 2017 and transferred/commercialized during 2017-2020 and list of technology generated during 2017-2020.
- Information on list of 20 numbers of entrepreneurs collected who got training on lac processing/products for sending to SMD w.r.t. impact study of Institute technologies (ICAR technologies impact study) in October 2020.
- Filled proforma for 3rd party evaluation of Institute technology by consultant engaged in impact study compiled for forwarding to SMD/consultant.

- Worked in the team constituted in the Institute for assisting consultant for impact study of Institute technologies conducted by ICAR, provided details of technology, aleuritic acid, lac processing unit, bleached lac, lac dye etc., related documents, gathered information from previous trainees of Institute on process and products, October, 2020.
- Information pertaining to ITMU, IINRG, Ranchi for DARE/ICAR Annual report 2020-21 prepared and sent to IP&TM, New Delhi, October, 2020.
- Information w.r.t. Proceeding of meeting related to "Ease of doing business from ITMU & ABI, IINRG prepared and sent to PME Cell as per email letter of SMD, November 27, 2020.
- Organised one ITMC meeting, December 29, 2020.
- Patent application 1435/KOL/2013 "Pharmaceutical composition for treatment of leukemia prepared from lac dye and method for its synthesis" filed on December 19, 2013 was granted patent on December 2, 2020, Patent No. 352879.

NAIF Scheme Component-II: Agri - Business Incubation at ICAR-IINRG, Ranchi

Pandey SK, Sc. worked as PI, ABI project and following work was carried out by him in the year 2020

- Information brochure, registration form for registering as incubatee at Agri-Business Incubation centre, ICAR-IINRG and list of technologies prepared and compiled for uploading Institute website and printing in brochure form.
- Charges for registration in ABI, office space and other facilities rentals fixed and office order in this regard issued.
- One firm M/s Indolacca Shellac Industries Pvt. Ltd., W.B. recently established in 2018 has been registered in June 2020 under category firm/company for Agri-business Incubation on aleuritic, bleached lac and Isoamrettolide for presently one-year period in F.Y. 2020-21.
- 03 persons related to Jharkhand skill mission, JOHAR, Jharkhand, state Govt. Jharkhand and one entrepreneurs Mr. BN Tiwari, Tripti enterprises, Ranchi visited ABI, Centre, ICAR-IINRG, Ranchi for getting information on Agri-business incubation at ICAR-IINRG, Ranchi.
- Information pertaining to ABI, IINRG, Ranchi for DARE/ICAR Annual report 2020-21 prepared and sent to IP&TM, New Delhi in October 2020.
- ATR on Director's conference comment on technology incubation at ICAR-IINRG was prepared & sent to PME cell, December 30, 2020.

Agro-meteorology Unit

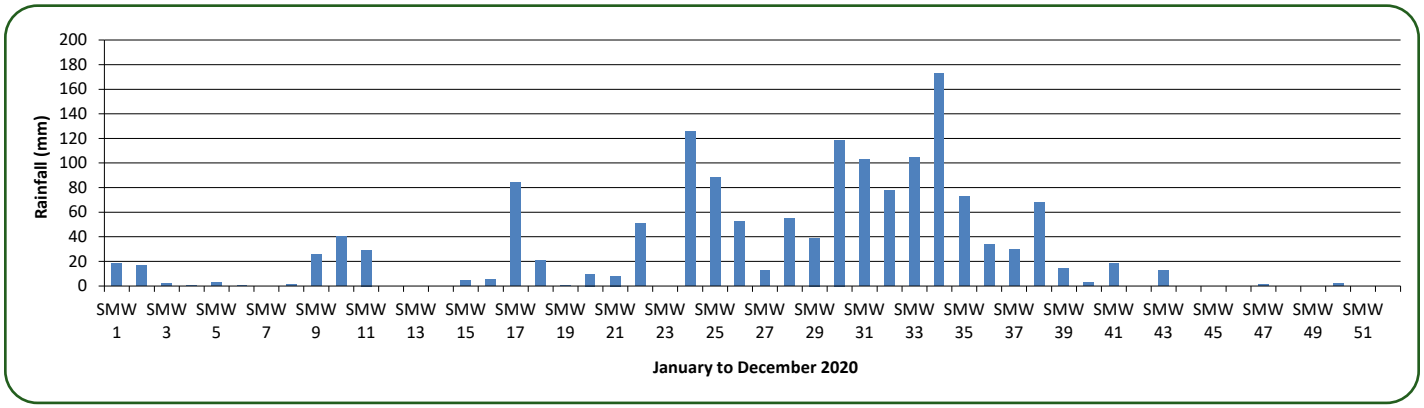
Agro-meteorology Unit of the Institute is situated at 23^0 23' N latitude, 85^0 23' E longitude at 650 m altitude. During the year 2020, different weather parameters were recorded and updated daily as well as weekly at the Institute website. Month wise weather data, daily Self Recording Rain Gauge (SRRG) sheets and daily rainfall data for the year were sent to India Meteorological Department (IMD), Kolkata. The monthly mean relative humidity (RH%), mean temperature (^{0}C) and total rainfall (mm) is given in the Table. Weekly analysis of rainfall has been presented in Figure.

Hottest and coldest months of the year were May and January with mean monthly temperature maximum at 34.07 ^{0}C and minimum at 8.01 ^{0}C, respectively. Maximum temperature for the year was recorded on 25th May (39.5 ^{0}C), while the minimum temperature was recorded on 10th February (3 ^{0}C). During July, mean relative humidity (RH) was the maximum at 8:30 hours (86.77%), with 86.58 per cent in the 14:30 hours, while the minimum RH was observed at 14:30 hours (64.30), with 69.23 per cent in the 8:30 hours in the month of April. Total annual rainfall was 1522.9 mm. It is pertinent to say that 24th August received maximum daily rainfall i.e. 79.4 mm. Maximum monthly rainfall was observed in August (494.2 mm), whereas lowest rainfall occurred in the month of November (0.80 mm) of the Calendar Year 2020.

Mean monthly meteorological data recorded at the agro-meteorological unit of the Institute during 2020

Month, 2020	Temperature		Relative Humidity (%)		Rainfall (mm)
	Min 8:30 am	Max 2:00 pm	Max 8:30 am	Min 2:00 pm	
January	8.01	21.52	81.74	72.77	40.3
February	8.02	23.95	75.59	64.34	5.4
March	13.26	28.04	75.42	69.23	91.2

Month, 2020	Temperature		Relative Humidity (%)		Rainfall (mm)
April	17.15	32.95	69.23	64.3	106.8
May	20.05	34.07	71.71	65.42	37.6
June	21.37	29.67	84.8	82.77	305.1
July	21.97	29.75	86.77	86.58	225.2
August	21.6	28.83	86.68	84	494.2
September	21.24	30.38	80.77	74.67	180.7
October	18.35	29.52	74.48	73.03	33.8
November	10.89	26.17	72.27	65.77	0.8
December	7.35	23.51	69.1	67.84	1.8
Total Annual Rainfall (mm)					1522.9



Weekly distribution of rainfall for the year, 2020

Project 1.4.001: Assessment, Diffusion and Adoption of Crop Production and NRGs Technologies

A. Trials conducted during the year 2020

1. Findings of OFTs conducted

(i) OFT-1: Drought tolerant varieties of paddy

Yield loss of paddy observed as major problem in adverse situation due to non availability of quality seed. Testing of drought tolerant varieties of paddy was done involving five farmers to overcome this problem (Fig. 9.1). Three improved varieties of paddy were tested at farmer's field and found all tested verities were significantly better than farmer's local variety. Variety *Swarna Shreya* performed best with net return of Rs. 68,730 per hectare with BC ratio of 3.4:1. However, *Sahbhagi* was at par with *Swarna Shreya* with BC ratio of 3.3:1 (Table 9.1). Hence, *Swarna Shreya* and *Sahbhagi* variety of paddy seed may be recommended for cultivation in climatic situation of Khunti district.

Fig. 9.1: Field view of OFT on drought tolerant varieties of paddy

Table 9.1: Yield component of paddy along with economic return

Technology option	No of trials	Yield component			Disease/ insect pest incidence (%)	Yield (q/ha)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ ha)	BC ratio
		No. of effective tillers/hill	No. of spikelet per panicle	100 grain wt.(g)						
Sahbhagi	5	11	192	2.56	5	46.0±0.98	20000	86862	66862	3.3:1
Swarna Shreya	5	12	194	2.43	4	47.5±0.98	20000	88730	68730	3.4:1
IR64 DRT	5	13	190	2.78	6	40.0±0.98	20000	75654	55654	2.8:1
Local	5	9	145	2.35	8	22.0±0.98	20000	41096	21096	1.1:1
CD at 5%						3.02				

(ii) OFT-2. Integrated weed management in paddy

Lack of proper weed management in paddy leads to 30-40% grain yield reduction. To augment this problem integrated weed management in paddy was initiated (Fig. 9.2) involving 11 farmers. Two treatments, hand weeding (20 DAT and 40 DAT) followed by Butachlor @ 1.0 kg/ha (3-5 DAT) *fb.* and 2,4 D @ 400 g/ha (25-28 DAT) had higher grain yield, but higher B:C ratio of 1.8:1 was observed (Table 9.2) in chemical treatment with Butachlor @ 1.0 kg/ha (3-5 DAT) *fb.* 2,4 D @ 400g/ha (25-28 DAT) among all treatments.

Fig. 9.2: Training and demonstration of weed management of paddy

Table 9.2: Yield component in weed management of paddy along with economic return

Technology option	No. of tri-als	Yield component			WCE (%) at 90 DAS	Grain Yield (q/ha)	Straw Yield (q/ha)	Cost of cultiva-tion (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BC ratio
		No. of effective tillers/ hill	No. of spikelet per pan-icle	100 grain wt.(g)							
Manual weeding sometimes (FP)	11	7.46	8.52	1.87.	-	27.0	29.45	25000	53018	28018	1.1
Two hand weeding (20 and 40 DAT)	11	14.25	11.22	2.08	78.2	44.3	52.42	34000	87639	53639	1.6
Butachlor @1.5 kg/ ha (3-5 DAT)	11	11.55	9.35	2.00	54.3	34.5	42.43	28000	68464	40464	1.5
Butachlor @1.0kg/ ha (3-5 DAT) *fb* &2,4 D @400g/ha (25-28 DAT)	11	12.32	10.55	2.04	69.4	40.4	49.80	29200	80190	50990	1.8
CD (0.05)	-	2.36	2.55	0.92	-	2.21	2.84	542	3510	1755	

(iii) OFT – 3: Pest management in paddy

Major problem of insect pest like yellow stem borer, gall midge, leaf folder, gundhi bug, BPH, and termite, *etc.* observed which reduces crop yield by 30-40%. To minimize the losses due to attack of insect pest integrated pest management (IPM) in paddy crop was tested at 3 farmers' field (Fig. 9.3). Clipping of seedling at transplanting was cost effective technology to control major insect infestation in paddy with B:C ratio 2.2:1 (Table 9.3). However, it can also be controlled by chemical treatment of Flubendiamide 39.35% M (Fame) and Chlorantraniliprole 18.5% SC (Coragen) which is at par with cultural control.

Fig. 9.3: Training and demonstration of pest management of paddy

Table 9.3: Grain yield in different insect management practices in paddy

Technology option	trials	Insect infestation (no. /m²)				Grain Yield (q/ha)	Cost of Cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BC ratio
			Natural Enemy	Dead heart	White head					
FP (No use of pesticide)	3	Before	5.7	4.3	3.3	27.0	18000	50436	32436	1.8
		After	7.0	5.0	5.0					
TO-1: Cultural control (Clip the seedling))	3	Before	5.7	5.3	3.3	33.5	19500	62578	43078	2.2
		After	4.3	1.7	2.3					
TO-2: Behavioural (phero-mone traps)	3	Before	5.0	5.3	3.3	38.2	23000	71358	48358	2.1
		After	6.7	6.7	4.3					
TO-3: Fame (Flubendiamide 39.35%)	3	Before	5.3	5.0	3.7	40.35	23000	75374	52374	2.3
		After	1.3	1.3	1.3					
TO-4: Coragen (Chloran-tra-niliprole 18.5% SC)	3	Before	5.0	4.7	4.3	40.9	24000	76401	52401	2.2
		After	1.3	1.0	0.7					
CD (0.05)	To		0.89	1.01	0.56					
	Time		0.57	0.64	0.35					
	Inter		1.26	1.42	0.79					

(iv) OFT-4: Pest management in winter *kusmi* lac

Yield loss due to lac insect predators/parasitoids and deterioration of broodlac quality identified as major problem in lac cultivation. Recent technology of pest management strategies tested on *ber* trees of 19 farmers for winter *kusmi* lac (Fig. 9.4). Broodlac dipping with Fipronil @1.5 ml per lit of water for 10 minutes before inoculation followed by scientific practice of lac cultivation gave maximum broodlac yield with B:C ratio of 2.7:1 as compared to farmers' practices (Table 9.4).

Fig. 9.4: Training and demonstration of pest management in winter *kusmi* lac

Table 9.4: *Kusmi* broodlac yield in improved management practices

Technology	Beneficiaries	Yield (kg/ha)	Gross (Rs/ha)	Net (Rs/ha)	Cost (Rs/ha)	BC ratio
TO-1: Broodlac dipping with Fipronil @1.5 ml per lit of water for 10 to 15 minutes + Scientific practice	19	4870	1461058	1061358	399700	2.7:1
FP: No broodlac dipping + Farmers' practice	19	2404	721154	346154	375000	0.9:1

(v) OFT-5: Mechanization of paddy threshing

Higher manpower requirement under traditional method of paddy threshing (Fig. 9.5) was observed as a major problem. To motivate farmers for adopting efficient machinery in paddy threshing, foot (pedal) operated paddy thresher and motor operated paddy thresher, demonstrations was done at seven farmers' field (Fig. 9.6 and 9.7). Motor operated paddy thresher was found suitable for paddy threshing with minimum time and manpower requirement to achieve higher threshing capacity, if electricity availability is not a problem. However, foot (pedal) operated paddy thresher may be one of the alternate options for paddy threshing to achieve higher threshing capacity with reduced time (Table 9.5).

Fig. 9.5: Traditional method of paddy threshing

Fig. 9.6: Foot (pedal) operated paddy thresher

Fig. 9.7: Motor operated paddy thresher in operation

Table 9.5: Time management and cost reduction in mechanization of paddy threshing

Technology option	No. of trials	Threshing efficiency,%	Capacity, kg/h	Grain straw ratio	Time requirement (threshing paddy crop per hectare), h	Manpower requirement (threshing paddy crop per hectare)	Labor reduction (man days)/ha	Cost reduction (Rs./ha or Rs./ Unit) @ Rs. 300/- day per man-power
Foot (Pedal) operated paddy thresher	07	96.95	87.75	1:1	33	10	17	5100
Motor operated paddy thresher	07	95.86	250.00	1:1	10	4	40	12000

(vi) Station trials of mustard.

Jharkhand has low average productivity of 970 kg/ha in mustard as compared to national productivity of 1151 kg/ha. Soil of Jharkhand is acidic and farmers were not adopting recommended practices for mustard cultivation. This trial was conducted to know the effect of lime, sulphur and boron on yield and quality of seeds with ten treatments (Fig. 9.8) in recommended mustard variety (Pusa Mustard 30) as detailed in Table 9.6.

Fig. 9.8: Field view of station trial of mustard and data collection

Table 9.6 Details of treatments for stationed trial of mustard

Treatments		Details
T_1	:	Control (No fertilization)
T_2	:	Farmers practice (N:P:K :: 21.4:19.6:5.9 kg/ha)
T_3	:	Recommended NPK (N:P:K :: 80:60:40 kg/ha)
T_4	:	Recommended NPK + Lime @ 4 q/ha
T_5	:	Recommended NPK + Sulphur @ 20 kg/ha
T_6	:	Recommended NPK + Boron @ 1 kg/ha
T_7	:	Recommended NPK +Lime @ 4 q/ha + Sulphur @ 20 kg/ha
T_8	:	Recommended NPK +Lime @ 4 q/ha + Boron @ 1 kg/ha
T_9	:	Recommended NPK + Sulphur @ 20 Kg/ha + Boron @ 1 kg/ha
T_{10}	:	Recommended NPK + Lime @ 4 q/ha + Sulphur @ 20 kg/ha + Boron @ 1 kg/ha

Maximum grain yield was obtained in T_{10} treatment (11.53 q/ha) followed by T_9 (10.84 q/ha) and T_4 (10.19 q/ha). Grain yield in rest of the treatments except farmers' practices and without fertilizer was at par with best treatment (Table 9.7). The data showed that even with the application of lime, farmers can harvest optimum grain yield which was significantly higher than state average productivity and at par with national average yield.

Table 9.7: Grain yield along with other yield attributing traits in mustard

Treatments	Plant height(cm)		Number of primary branch		Number of siliqua per plant		Biological yield (Kg)		Straw yield (Kg/plot)		Grain yield (Kg/ha)	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
T_1	103.40	4.02	1.60	0.00	29.47	3.25	4.84	1.73	2.05	0.78	299	111.5
T_2	137.80	11.40	2.20	0.12	47.40	7.22	6.87	1.03	3.03	0.42	412	56.0
T_3	154.93	4.78	2.93	0.13	72.13	1.24	15.56	1.80	6.85	0.92	909	60.5
T_4	148.53	19.89	3.13	0.41	64.20	4.29	11.65	2.90	5.42	1.64	1019	108.6
T_5	156.67	4.82	3.33	0.07	112.13	17.65	12.04	1.89	5.66	0.68	744	170.8
T_6	164.67	3.17	3.00	0.31	73.20	5.37	15.23	1.86	5.95	0.53	975	49.4
T_7	162.07	5.03	3.47	0.13	95.13	1.91	14.84	3.93	6.52	1.50	854	140.7
T_8	159.53	11.66	3.13	0.29	105.80	26.63	13.56	1.60	6.36	0.95	965	86.8
T_9	147.13	12.38	2.80	0.23	86.27	11.96	14.83	1.03	5.20	1.14	1084	54.7
T_{10}	151.40	12.90	3.47	0.18	66.80	5.39	13.91	3.65	5.60	1.46	1153	309.9
SE(m)	9.41		0.23		10.77		2.23		1.14		132	
C.D. 5%	28.18		0.69		32.25		6.68		N/A		395	
C.V.	10.97		13.68		24.79		31.32		37.40		27	

2. Findings of FLDs conducted

A total 8.2 hectare area of farmers field sown with two varieties (*Sahbhagi* and *Swarna Shreya*) of paddy during the year 2020 out of that *Sahabhagi* variety of paddy sown in 3.4 hectare area of 41 farmers' fields at Ken toil, Diyankel and Manhatu villages of Khunti district and *Swarna Shreya* variety of paddy sown in 4.8 hectare area of 40 farmers' fields at Churgi, Ken toil, Diyankel and Manhatu villages of Khunti district (Table 9.8) and observed that *Sahbhagi* and *Swarn Shreya* yielded more than 100% better grain yield compared to farmers' local variety.

(i) IPA-203 variety of pigeon pea was sown in 8.0 hectare area of 25 farmers' field during the year 2019 at Silda, Kherkai and Kachchabari villages of Khunti district and yielded 40.7% higher yield in comparison to farmers' local variety (Table 9.8).

(ii) 24 farmers adopted scientific lac cultivation practices at Murhu, Raniya, Torpa and Arki villages of Khunti district during the year 2019 and 100 trees were inoculated with 90 kg *Kusmi* broodlac. The technology of scientific lac cultivation showed 44.86% higher broodlac yield than farmers' practice (Table 9.8).

(iii) Dharni variety of ground-nut was sown in 1.0 hectare area of 21 farmers' fields at Kelo village of Khunti district during the year 2020 and yielded 34.61% higher yield than local variety (Table 9.8).

(iv) Pusa Bold variety of mustard seed was sown in 1.5 hectare area of 5 farmers' fields at Silda block of Khunti district during the year 2019 and yielded 52.26% higher yield compared to local variety (Table 9.8).

(v) During the year 2019, GNG-1958 variety of chick pea was sown in 6.0 hectare area of 8 farmers' fields at Churgi, Banaitili, Kota, Kherkai and Diyankel villages of Khunti district and yielded 27.74% higher yield than local variety (Table 9.8).

(vi) Green gram variety (IPM 2-3) was sown in 6.0 hectare area of 30 farmers' fields at Balalaung, Jhatni, Churgi, Diyankel and Kachchabatri villages of Khunti district during summer season of 2020 and 32.99% higher yield obtained compared to local variety used by the farmers (Table 9.8).

Table 9.8: Economic yield along with locations, area, beneficiaries *etc*

Crop	Year	Locations	Name of technology demonstrated	No. of Farmers	Area (ha)	Yield (q/ha)		% Increase
						Demo	Check	
Paddy	2020	Ken toil, Diyankel and Manhatu	Sahbhagidhan	41	3.4	39.92	19.51	104.61
Paddy	2020	Churgi, Ken toil, Diyankel and Manhatu	Swarn Shreya	40	4.8	38.25	18.62	105.42
Pigeon pea	2019	Silda, Kherkai and Kachchabari	IPA-203	25	10	21.68	15.41	40.69
Lac	2019	Murhu, Raniya, Torpa and Arki	*Kusmi* broodlac	100	0.32	23.38	16.14	44.86
Groundnut	2020	Kelo	Dharni	21	1	23.14	17.19	34.61
Mustard	2019	Silda	Pusa Bold	5	1.5	11.13	7.31	52.26
Chickpea	2019	Churgi, Banaitili, Kota, Kherkai and Diyankel	GNG 1958	8	6	19.57	15.32	27.74
Green gram (Summer)	2020	Balalaung, Jhatni, Churgi, Diyankel and Kachchabatri	IPM 2-3	30	6	10.40	7.82	32.99

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 वरि. तकनीकी अधिकारी (रा.भा.), एक अंशकालीन टंकक तथा एक अंशकालीन पदचर कार्यरत हैं। संस्थान में राजभाषा संबंधी क्रिया–कलापों की समीक्षा के लिए संस्थान के निदेशक की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति गठित की गई है, जिसमें विभागों/अनुभागों के अध्यक्ष, सदस्य के रुप में शमिल हैं तथा सहायक मुख्य तकनीकी अधिकारी (रा.भा.) सदस्य सचिव हैं ।

संस्थान 'क' क्षेत्र में है, इसे राजभाषा अधिनियम की धारा 10(4) के अर्न्तगत केन्द्रीय बजट में अधिसूचित किया जा चुका है। संस्थान के सात अनुभागों को शत प्रतिशत कार्य हिन्दी में करने हेतु विनिर्दिष्ट किया गया है एवं प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को अपना–अपना कार्य हिन्दी में करने हेतु व्यक्तिशः आदेश दिये गये हैं। राजभाषा नियम के प्रावधानों के अनुपालन एवं दैनिक कार्य में हिन्दी के प्रयोग में प्रगति लाने तथा इसे सर्वग्राह्य बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैः–

संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी तथा बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई। वार्षिक रिपोर्ट के हिन्दी संस्करण का प्रकाशन (पी डी एफ रूप में), राजभाषा की वार्षिक पत्रिका लाक्षा का प्रकाशन, कार्यालय आदेश, परिपत्र, ज्ञापन, निविदा इत्यादि एवं पत्राचार हेतु विभिन्न सामग्रियों का आवश्यकतानुसार अनुवाद। हिन्दीतर अधिकारियों और कर्मचारियों को हिन्दी शिक्षणे 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 हैंः

- 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 अथवा सक्रिय सहयोग करना।
- प्रचार सामग्रियों के हिन्दी रूपान्तर एवं समारोहों के समाचार संकलन एवं मीडिया प्रबंधन का कार्य
- विभागीय विषय पर तकनीकी शब्दावली का निर्माण।
- हिन्दी में वैज्ञानिक गोष्ठी के साथ–साथ प्रशासनिक तथा तकनीकी वर्ग के लिए कार्यशाला का आयोजन।
- निदेशक महोदय की अध्यक्षता में वर्ष 2020 में संस्थान राजभाषा कार्यान्वयन समिति की चार तिमाही बैठकों का आयोजन निम्नलिखित तिथियों को किया गया तथा प्रगति की समीक्षा की गई। तिमाही रिपोर्ट एवं कार्यवृत परिषद सहित अन्य संबंधित कार्यालयों में प्रेषित की गईः

  (क) दिनांक–17.02.2020 (ख) दिनांक–19.05.2020

  (ग) दिनांक–25.08.2020 (घ) दिनांक–16.01.2021

जिसके अन्तर्गत निम्नलिखित प्रमुख चर्चायें हुईं तथा सर्वसम्मति से निर्णय लिए गएः–

- संस्थान में हिन्दी में मूल रूप से पत्राचार बढ़ाने के लिए नकद पुरस्कार योजना का अनुपालन।
- वार्षिक कार्यक्रम 2019–20 एवं 2020–21 के प्रस्ताव पर चर्चा।
- गृह पत्रिका लाक्षा–2020 का प्रकाशन।

- वर्ष 2020–21 के लिए नकद पुरस्कार योजना लागू करना एवं वर्ष 2019–20 के प्रतिभागियों के लिए पुरस्कार का निर्धारण।
- नगर स्तरीय हिन्दी संगोष्ठी/कार्यशाला का आयोजन।
- जैविक खेती, स्वास्थ्य संबंधी विषय पर हिन्दी कार्यशला/व्याख्यान का आयोजन।
- द्विभाषी मुहरों का निर्माण।
- द्विभाषी नामपट्ट की व्यवस्था।
- लाक्षा–2019 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 एवं प्रौ. ह. विभाग के प्रशिक्षण प्रकोष्ठ को सम्पूर्ण कार्य हिन्दी में करने हेतु विनिर्दिष्ट करना।

राजभाषा प्रकोष्ठ की उपलब्धियां–2020

- "प्राकृतिक राल एवं गोंद– भा.प्रा.रा.गों.सं. समाचार पत्रिका" का सम्पूर्ण अनुवाद किया गया एवं आउटसोर्सिंग द्वारा सम्पूर्ण वार्षिक रिपोर्ट का अनुवाद कराया गया।
- संस्थान की वार्षिक हिन्दी पत्रिका लाक्षा–2020 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 (डिक्टेषन) देने के लिए पुरस्कार योजना संस्थान में लागू की गई है।
- लाक्षा–2019 के सर्वश्रेष्ठ आलेख के चयन के लिए समिति गठित कराई गई तथा सर्वश्रेष्ठ आलेख का चयन कर लेखकों को पुरस्कार प्रदान किया गया।
- सरकारी कार्यों को मूल रूप से हिन्दी में करने हेतु संस्थान में नकद पुरस्कार योजना लागू की गई, इसमें तकनीकी एवं प्रशसनिक वर्ग के कुल 11 अधिकारियों/कर्मचारियों को पुरस्कार प्रदान किए गए।

कार्यक्रमों का आयोजन

- मौलिक कर्तव्य, भूमि संबंधी कानून एवं उसमें सुधार विषय पर दिनांक–26.02.2020 को हिन्दी कार्यशाला सह व्याख्यान के आयोजन में सहयोग किया गया।

हिन्दी दिवस समारोह–2020

संस्थान में राजभाषा अधिनियम के अनुपालन एवं कार्यालय कार्य में राजभाषा हिन्दी के प्रयोग में उत्तरोत्तर वृद्धि के लिए दिनांक–01.09.2020 से 30.09.2020 तक हिन्दी चेतना मास का पालन किया गया। इसके अन्तर्गत दिनांक–30.09.2020 को अपराह्न 02.30 बजे हिन्दी दिवस समारोह का आयोजन किया गया।

हिन्दी दिवस समारोह के अवसर पर मुख्य अतिथि के रूप में उपस्थित श्री संजय मिश्र, स्थानीय संपादक, प्रभात खबर, कोकर औद्योगिक क्षेत्र, राँची ने कहा हिन्दी में स्थानीय शब्दों को भी लाया जाना चाहिए तथा उन्होंने कहा कि वैज्ञानिक साहित्य को भी समान रूप से प्रतिष्ठा मिलनी चाहिए। श्री मिश्र ने बताया कि केवल साहित्यकार होना ही हिन्दी के प्रसार के लिए आवश्यक नहीं बल्कि इसका व्यवहारिक प्रयोग होना चाहिए। श्री मिश्र ने बताया कि हिन्दी की चेतना में ही राष्ट्रीय एवं सांस्कृतिक चेतना समाई हुई है। उन्होंने कहा कि कृषि संस्थानों में हिन्दी का प्रयोग सराहनीय है।

इस अवसर पर विशिष्ट अतिथि डॉ रेणु सिन्हा, विभागाध्यक्ष, हिन्दी विभाग, निर्मला महाविद्यालय, डोरंडा, राँची ने सभा को संबोधित करते हुए कहा कि कहने के लिए हिन्दी राजभाषा है, लेकिन व्यवहार में स्थिति बहुत अनुकूल नहीं है। कार्यालय कार्यों में हिन्दी को वांछित स्थान नहीं मिला है। उन्होंने हिन्दी के प्रचार प्रसार में स्वर्गीय अटल जी एवं स्वर्गीय सुषमा स्वराज के योगदान की सराहना की।

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। डॉ शर्मा ने बताया कि यहां कराया एवं ग्वार का सबसे ज्यादा उत्पादन होता है तथा यह जनजातिय समुदाय के लोगों की आजीविका से जुड़ा है। उन्होंने अनुवाद दिवस की याद दिलाते हुए भावानुवाद पर जोर दिया।

हिन्दी चेतना मास की अवधि में दिनांक– 02 व 03 सितम्बर 2020 को हिन्दी टिप्पण, प्रारूप लेखन, निबंध, अंताक्षरी, पर्याय एवं विपरीतार्थक शब्द इत्यादि प्रतियोगिताओं का आयोजन किया गया। डॉ राजकुमार योगी, डॉ नन्द किशोर ठोंबरे, डॉ अर्णब राय चौधुरी, श्री अश्विनी गर्ग, श्री शरत चन्द्र लाल इत्यादि को पुरस्कार प्रदान किया गया। इसके साथ ही समारोह में लाक्षा–2019 में उत्कृष्ठ आलेख का पुरस्कार भी प्रदान किया गया।

कार्यक्रम का संचालन डॉ अंजेश कुमार, सहायक मुख्य तकनीकी अधिकारी एवं धन्यवाद ज्ञापन डॉ सतीश चन्द्र शर्मा, वरिष्ठ 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।

हिन्दी दिवस समारोह में श्री संजय मिश्र, स्थानीय संपादक, प्रभात खबर, कोकर औद्योगिक क्षेत्र, राँची

Budget

Budget allocation and utilization during Financial Year 2020-21

Head of Expenditure	Other than NEH & TSP		NEH/SCSP		Total	
	Approved RE	Expenditure	Approved RE	Expenditure	Approved RE	Expenditure
IINRG			SCSP	SCSP		
Grant-in-aid Capital	176.30	176.11	56.80	56.79	233.10	232.90
Grant-in-aid Salaries	1255.57	1255.52	0.00	0.00	1255.57	1255.52
Pension	227.10	227.10	0.00	0.00	227.10	227.10
Grant-in-aid-General	500.00	490.70	40.00	39.98	540.00	530.68
Total	2158.97	2149.43	96.80	96.77	2255.77	2246.20
NWP ON HPVA of NRG			NEH			
Grant-in-aid Capital	13.00	12.88	0.28	0.28	13.28	13.16
Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
Grant-in-aid-General	152.26	152.25	0.00	0.00	152.26	152.25
Total	165.26	165.14	0.28	0.28	165.54	165.42
NWP ON CLIGR			NEH			
Grant-in-aid Capital	20.00	19.92	0.28	0.28	20.28	20.20
Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
Grant-in-aid-General	161.00	161.00	18.50	18.50	179.50	179.50
Total	**181.00**	**180.91**	**18.78**	**18.78**	**199.78**	**199.69**

REVENUE GENERATION TARGETS & ACHIEVEMENTS		
Financial Year	**Target for the financial year**	**Revenue Generated**
2020-21	**0**	**34.71**

All figures are in lakhs

Personnel

Details of scientific, technical, administrative and supporting staff (including KVK) as on December 31, 2020

Scientific	Sanctioned strength	In position
R.M.P.	1	1
Pr. Scientist	3	0
Sr. Scientist	8	5
Scientist	30	25
Total	**42**	**31**
Technical		
Category-I	43	24
Category-II	23	15
Category-III	6	0
Total	**72**	**39**
Administrative		
Sr.A.O.	1	1
F & AO	1	0
AAO	2	2
Private Secy.	1	1
Security Officer	1	1
J.A.O.	1	0
P.A.	2	0
Assistant	11	7
Sr. Clerk	5	1
Steno Gr. III	2	1
Total	**27**	**14**
Skilled Support Staff		
S.S.S.	43	31
Cadre	**Sanctioned post**	**In position**
Scientific	42*	31
Technical	72	39
Administrative	33	14
Supporting	43	31
Total	**237**	**115**

*Including R.M.P.

PERSONNEL	
Dr. KK Sharma	Director
LAC PRODUCTION DIVISION	
Dr. S Ghosal, Pr.Sc. & I/c Head	Agronomy
Dr. NK Sinha, Pr. Sc.	Seed Technology
Dr. VD Lohot, Sr. Sc.	Plant Physiology
Dr.(Ms.) Thamilarasi K, Sr. Sc.	Agril. Biotechnology
Dr. A Mohanasundaram, Sc.	Agri. Entomology
Sri Asish Kr.Raut, Sc.	Agril. Entomology
Sri SK Srivastava, Sc.	SWCE
Ms. Shruti Sinha, Sc.	Agril. Biotechnology
Ms. LC Langlentombi, Sc.	Agroforestry
Mr. Rajgopal NN, Sc.	Agril. Entomology
Dr. Achintya Pramanik, Sc.	Agril. Entomology
Er. Pradosh Kumar Paramguru, Sc.	S.W.C.E
Mr. Sandeep Kumar, Sc.	Plant Biochemistry
Sri SK Tripathi, STA	F/F Tech. group
Ms. Naaserah Zeesan, TA	F/F Tech. group
Mr. Vidyapati Vidyakar, TA	Lab.Tech. group
Mr. Harihar Singh, TA	F/F Tech. group
Sri Anmol Dan Kindo, Technician	Lab.Tech. group
Sri SK Yadav	Private Secretary
PROCESSING & PRODUCT DEVELOPMENT DIVISION	
Dr. N Prasad, Pr.Sc. & Head	A.S.P.E.
Dr. MZ Siddiqui, Pr. Sc.	Agril. Chem.
Dr. MF Ansari, Pr. Sc.	Agril. Chem.
Er. SK Pandey, Sc.	Mech. Engg.
Dr. SC Sharma, Sc.	F.M.& Power
Dr. AR Chowdhury, Sc.	Agril. Chem.
Dr. N Thombare, Sc.	Agril. Chem.
Dr. CJ Mate, Sc.	Agril. Chem.
Sri Md. Ali, Sc.	Agril. Chem.
Er. Ranjit Singh, Sc.	A.S.P.E.
Er. Ms. Priyanka Sakare, Sc.	A.S.P.E.
Dr. Palmei Gaibimei, Sc.	A.S.P.E.

Sri Ajay Kumar, STA	Lab. Tech. group
Sri RK Rai, STA	Lab. Tech. group
Sri Anup Kumar, STA	Lab. Tech. group
Sri Binod Kumar, STA	Lab. Tech. group
Sri Dewbrath Hari, TA	Lab. Tech. group
Sri Haraprasad Naiya, TA	Lab. Tech. group
Sri Lokesh Meena, Technician	Lab. Tech. group

TRANSFER OF TECHNOLOGY DIVISION	
Dr. Nirmal Kumar, Pr.Sc. & Head	Agril. Extension
Dr. J. Ghosh, Pr.Sc.	Gen. & Plant Breeding
Dr. SKS Yadav, Sc.	Agril. Chem.
Dr. RK Yogi, Sc.	Agril. Economics
Sri Rahul R Bakade, Sc.	Plant Pathology
Sri P Patamajhi, ACTO	F/F Tech.group
Sri AK Sinha, ACTO	F/F Tech. group
Sri SB Azad, TO	F/F Tech. group
Sri Madan Mohan, STA	F/F Tech. group
Md. Tariq Zaman, TA	F/F Tech. group
KRISHI VIGYAN KENDRA, KHUNTI, *RANCHI*	
Dr. J Ghosh, Pr.Sc.	Gen.& Plant B. & I/c KVK
Smt. Laxmi Kumari	Assistant
Sri Ranjan Choudhary	S.M.S.
Sri Aashutosh Prabhat	Agromet. Observer
HEALTH CENTRE	
Dr. MF Ansari	Pr. Sc. & I/c
Dr.Reema Khalkho	PMO
Dr. Kailash Prasad	PMO
Sri CK Singh, TO	Medical & Paramed. group
QUALİTY EVALUATION LAB	
Dr. MF Ansari	Pr. Sc. & I/c
Sri BK Singh	STA
INSTITUTE RESEARCH FARM	
Dr. A Mohanasundaram	Sc. & I/c
Sri Satish Kumar	TO
Sri Sunil Kumar Mukherjee	STA
Sri Akash Sinha	TA
Sri Jhirga Oraon	Sr. Technician

ESTATE SECTION	
Sri AK Yadav, SO.	W. & Engg.group
Sri HL Bhakta, TO	W. & Engg.group
Sri Binay Kumar, T.O.	W. & Engg.group
Sri Arjun Sharma, STA	W. & Engg.group
Sri RK Ravi, STA	W. & Engg. Group
Sri K Tirkey, STA	W. & Engg. group
Sri PVD Tirkey, STA	W. & Engg. group
Sri RK Singh, Sr. Technician	W. & Engg. group
Sri AK Sharma, Sr. Techician	W. & Engg. group
Sri MahavirMahto, Sr. Technician	W. & Engg. group
Sri Sukra Ekka, Sr. Technician	W. & Engg. group
Ms. Laxmi Kumari	Asstt.
PME CELL	
Dr. MZ Siddiqui, Pr.Sc. & I/c	
Sri Dipankar Ganguly, ACTO	Lab.Tech.group
Sri Sunil Kumar, STO	Lab.Tech.group
AUDIT & ACCOUNTS SECTION	
Sri KameshwarOraon, Asstt.	
Sri Arjun Gope, Asstt.	
ADMIN. I SECTION	
Sri Mahesh Kumar Khubdikar	Sr.Admin.Officer
Sri SC Lal	AAO
Sri KM Kumar	Assistant
Sri Bandhu Mahto	U.D.C.
ADMIN.II SECTION	
Sri Raghunath Mahto	DDO
Sri RK Toppo	Assistant
Sri KP Kashi	Assistant
ADMIN.III SECTION	
Sri Abhishek Kumar	Assistant

RAJBHASHA PRAKOSTH	
Sri Binod Kumar	STO & I/c
DIRECTOR OFFICE	
Sri Hari Vilas	PA to Director
LIBRARY	
Sri Binod Kumar	STO

VEHICLE POOL	
Sri Arvind Kumar, TO	W. & Engg.group
Sri Mandeshwar Singh, TO	W. & Engg.group
Sri RK Yadav, TO	W. & Engg.group
Sri Bandi Lakra, Sr. Technician	W. & Engg.group

JOINING
Smt. Manju Kumari has joined to the post of S.S.S. on 27.01.2020 (on compassionate ground).
Dr. Palmai Gaibimai has joined to the post of Scientist on 04.04.2020
Sri Paradosh Kumar Parmaguru has joined to the post of Scientist on 04.04.2020
Sri Dharmendra Singh has joined to the post of Technical Assistant(Tractor Driver) on 14.09.2020
Sri Rahul R. Bakade, has joined to the post of Scientist on 17.09.2020
Dr. Achintya Pramanik has joined to the post of Scientist on 19.09.2020

PROMOTION
Dr. V.D. Lohot, Sr. Scientist promoted to the next higher RGP on 08.01.2019

MACP
Sri Dinu Ranjan Gorait, SSS on 20.10.2020
Sri Banful Lakra, SSS on 20.10.2020
Smt. Janki Devi, SSS on20.10.2020

TRANSFER
Sri Ashwani Garg, FAO relieved from ICAR IINRG, Ranchi on 20.10.2020 to join at ICAR-NBSS&LUP, Nagpur

RETIREMENT
Dr. Sanjay Srivastava, Ex-Pr.Sc. on 31.01.2020
Sri Mani Mahto, Ex-SSS on 31.01.2020
Sri Chandradeep Mahto, Ex-SSS on 31.01.2020
Dr. Anjesh Kumar, ACTO on 31.10.2020

DEATH
Late Samal Kumar, Ex-Asstt. On 26.11.2020
Late Mahtosh Linda, Ex-SSS on 25.02.2020

Appendix

Annexure 1. Farmers' training programme on "Scientific lac cultivation, processing and utilization"

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of partici - pants
January	1.	KVK, Chiyanki, Palamu under SC-Sub-Plan	Jharkhand	06.01.20-10.01.20	33	-	33
		Private- Dhemaji, Assam (AAU)	Assam	08.01.20-10.01.20	01	-	01
February	2.	CGMFP, Jashpur, Chhattisgarh	Chhattisgarh	10.02.20-14.02.20	31	-	31
March	3.	JSLPS-JOHAR, Jharkhand	Jharkhand	04.03.20-08.03.20	17	34	51
	4.	Forest department, Jharkhand	Jharkhand	16.03.20-20.03.20	36	06	42
September	5.	Forest Research Centre for Eco-Rehabilitation, Prayagraj, U.P.	U.P.	22.09.20-24.09.20	02	-	02
Total					120	40	160

Annexure 2. Lac based handicraft making training under skill development (off-campus)

Month	Course No.	Sponsoring Organization & Venue	State	Period	M	F	No. of parti-ci-pants
	1	PVUNL, Patratu, Ramgarh. Panchayat Bhawan, Hesla, Partatu, Ramgarh	Jharkhand	05.12.20 to 28.12.20	-	20	20
Total					-	20	20

Annexure 3. Schedule Caste Sub-Plan (SC SP)

Camp No.	Venue (Village& block)	District – State	Dated	Male	Fe-male	No. of Par-ticipants	Remarks
1	Chandaghashi, Namkum	Ranchi,, Jharkhand	24.01.20			50	Live stock (17 pig Unit) distributed among 17 selected Schedule Cast members under Schedule Cast Sub Plan.
2	KVK, Hazaribagh	Hazaribagh, Jharkhand	28.01.20			65	Live stock (20 goat Unit) distributed among 20 selected Schedule Cast members under Schedule Cast Sub Plan.
3	KVK, Peterwar, Bokaro	Bokaro, Jharkhand	29.01.20			60	Live stock (20 goat Unit) distributed among 20 selected Schedule Cast members under Schedule Cast Sub Plan.
4	KVK, Diyankel, Khunti	Khunti, Jharkhand	06.02.20			70	Live stock (21 goat Unit) distributed among 21 selected Schedule Cast members under Schedule Cast Sub Plan at Arki, Khunti.

Camp No.	Venue (Village& block)	District – State	Dated	Male	Female	No. of Participants	Remarks
5	Ormanjhi, Namkum	Ranchi, Jharkhand	13.02.20			75	Live stock (23 goat Unit) distributed among 23 selected Schedule Cast members under Schedule Cast Sub Plan.
6	KVK, Chatra	Chatra, Jharkhand	25.02.20			125	Live stock (20 goat Unit, 20 poultry unit and 20 pig unit) distributed among 60 selected Schedule Cast members under Schedule Cast Sub Plan.
7	KVK, Palamu	Palamu, Jharkhand	26.02.20			130	Live stock (30 goat Unit and 30 poultry unit) distributed among 60 selected Schedule Cast members under Schedule Cast Sub Plan.
8	KVK, Garhwa	Garhwa, Jharkhand	27.02.20			200	Live stock (14 pig Unit, 50 poultry unit and 30 duck unit) distributed among 94 selected Schedule Cast members under Schedule Cast Sub Plan.
9	KVK , Bengabad, Giridih	Giridih, Jharkhand	18.03.20			80	Live stock (38 goat Unit) distributed among 38 selected Schedule Cast members under Schedule Cast Sub Plan.
10	KVK, Hazaribag	Hazaribag, Jharkhand	21.03.20			50	Live stock (18 goat Unit) distributed among 18 selected Schedule Cast members under Schedule Cast Sub Plan.
11	Koyanra, Banaie	Khunti, Jharkhand	21.07.20	12	04	16	Demonstration of dipping technology of broodlac and distributed Broodlac to each lac farmers.
12	Koynara, Banaie, Rania	Khunti, Jharkhand	19.08.20	-	16	16	Demonstration of spraying and distribution of insecticides and fungicides to the lac farmers
13	Koynara, Banaie, Rania	Khunti, Jharkhand	19.09.20	10	06	16	Demonstration of spraying and distribution of insecticides and fungicides to the lac farmers
14	KVK, Garhwa	Garhwa, Jharkhand	23.09.20			35	Live stock (35 goat unit) distributed among 35 selected Schedule Cast members under Schedule Cast Sub Plan.
15	KVK, Garhwa	Garhwa, Jharkhand	24.09.20			75	Live stock (25 pig unit, 25 sprayer and 25 farm tool kit) distributed among 75 selected Schedule Cast members under Schedule Cast Sub Plan.
16	KVK, Chiyanki, Palamu	Palamu, Jharkhand	23.12.20			225	Vermin bed- 100, Sprayer- 50 and Farm tool kit- 75 distributed among 300 selected Schedule Cast members under Schedule Cast Sub Plan
17	KVK, Chatra	Chatra, Jharkhand	24.12.20			300	Vermin bed- 100, Sprayer- 100 and Farm tool kit- 100 distributed among 300 selected Schedule Cast members under Schedule Cast Sub Plan
Total						**1588**	

Annexure 4. On-farm motivational/ supplementary training programme on lac cultivation

Camp No.	District, State	Nominating Agency	Venue (Village, Block)	Dated	M	F	No. of Participants
1.	Hazaribag, Jharkhand	SUPPORT, Hazaribag	Farmer's Production Office, Simra, Hazaribagh	04.01.20	02	37	39
2.	Palamu, Jharkhand	KVK, Palamu	Phulwaria, Rabda, Satbarwa, Palamu	24.11.20	24	36	60
Total					**26**	**73**	**99**

Annexure 5. On-campus one-day orientation programme on natural resins and gums

Camp No.	District, State	Nominating Agency	Dated	M	F	No. of Participants
1	Palamu, Jharkhand	Progressive farmers	06.01.20	33	-	33
2	Palamu, Jharkhand	KVK Palamu under SC Sub Plan	07.01.20	15	09	24
3	Hazaribag, Jharkhand	St. Columbus College, Hazaribag	11.01.20	19	18	37
4	Ranchi, Jharkhand	Sangeeta Foundation, Ranchi	13.01.20	13	05	18
5	Ranchi, Jharkhand	Gagari, Ormanjhi under SC Sub Plan	14.01.20	04	14	18
6	Ranchi, Jharkhand	Chandaghashi, Namkum under SC Sub Plan	22.01.20	11	10	21
7	Khunti, Jharkhand	KVK Khunti under SC Sub Plan	29.01.20	15	05	20
8	Ranchi, Jharkhand	Marwari College, Ranchi	11.02.20	12	14	26
9	Ranchi, Jharkhand	Forest department, Mahilong, Ranchi	12.02.20	62	08	70
10	Ranchi, Jharkhand	YBN University, Ranchi	13.02.20	05	05	10
11	Ranchi, Jharkhand	KVS, Namkum	15.02.20	20	13	33
12	Ranchi, Jharkhand	IFP, Lalgutua, Ranchi	28.02.20	22	04	26
13	Ranchi, Jharkhand	Syngeeta Foundation, Ashok Nagar	28.02.20	13	02	15
14	Ranchi, Jharkhand	Forest department, Ranchi	02.03.20	30	05	35
15	Gumla, Jharkhand	Progressive farmers	17.03.20	34	06	40
16	Ranchi, Jharkhand	Progressive farmer from Forest department, Ranchi	20.03.20	60	21	81
17	Ranchi, Jharkhand	Progressive farmer, Ranchi	12.06.20	01	-	01
18	North 24 Parganas	Progressive farmer, Bairakpoor	12.06.20	01	-	01
19	Palamu, Jharkhand	Progressive farmers, Palamu	29.08.20	02	01	03
20	Kolkata, West Bengal	Progressive farmers, Kolkata	27.10.20	02	02	04
21	Ranchi, Jharkhand	Students	18.12.20	02	-	02

Camp No.	District, State	Nominating Agency	Dated	M	F	No. of Participants
22	Ranchi, Jharkhand	Army Officials	21.12.20	01	02	03
23	Ranchi, Jharkhand	ICAR-IINRG, Namkum, Ranchi	25.12.20	42	-	42
Total				**419**	**144**	**563**

Annexure 6. Front Line Demonstration (FLD)

Camp No.	Venue (Village & Block)	District, State	Date	Male	Female	Total	Observation
1	Besradih, Bundu	Ranchi, Jharkhand	20.07.20	-	10	10	Demonstration of dipping technology of broodlac and distributed 5 kg. broodlac to each lac farmers.
2	Gabhediya, Bundu	Ranchi, Jharkhand	20.07.20	-	05	05	-do-
3	Tinjhariya, Bundu	Ranchi, Jharkhand	20.07.20	-	05	05	-do-
4	Banaburu, Bundu	Ranchi, Jharkhand	20.07.20	-	05	05	-do-
5	Gumpila, Torpa	Khunti, Jharkhand	21.07.20	-	11	11	-do-
6	Patpur, Torpa	Khunti, Jharkhand	21.07.20	-	05	05	-do-
7	Sargela, Torpa	Khunti, Jharkhand	21.07.20	-	04	04	-do-
8	Jiki, Bhandra	Khunti, Jharkhand	25.07.20	-	05	05	-do-
9	Chanditoli, Bhandra	Khunti, Jharkhand	25.07.20	-	05	05	-do-
10	Remta, Siladon	Khunti, Jharkhand	25.07.20	-	10	10	-do-
11	Patpur and Sargela Torpa	Khunti, Jharkhand	14.08.20	-	10	10	Demonstration of spraying and distribution of insecticides and fungicides to the lac farmers
12	Gumpila and Jaria Torpa	Khunti, Jharkhand	14.08.20	-	10	10	-do-
13	Besradih and Gab-hediya, Bundu	Ranchi, Jharkhand	17.08.20	-	10	10	-do-
14	Tinjhariya and Banaburu, Bundu	Ranchi, Jharkhand	17.08.20	-	10	10	-do-

Camp No.	Venue (Village & Block)	District, State	Date	Male	Female	Total	Observation
15	Jiki and Chanditoli Bhandra	Khunti, Jharkhand	18.08.20	-	10	10	-do-
16	Remta, Siladon	Khunti, Jharkhand	18.08.20	-	10	10	-do-
17	Patpur and Sargela Torpa	Khunti, Jharkhand	22.09.20	-	10	10	3rd spraying on *aghani* crop in *ber*.
18	Gumpila and Jaria Torpa	Khunti, Jharkhand	22.09.20	-	10	10	-do-
19	Jiki and Chanditoli Bhandra	Khunti, Jharkhand	23.09.20	-	10	10	-do-
20	Remta, Siladon	Khunti, Jharkhand	23.09.20	-	10	10	-do-
21	Tinjhariya and Banaburu, Bundu	Ranchi, Jharkhand	24.09.20	-	10	10	-do-
22	Besradih and Gabhediya, Bundu	Ranchi, Jharkhand	24.09.20	-	10	10	-do-
Total				-	**185**	**185**	

Annexure 7. Lac crop surveillance conducted

Camp No.	Village (Block)	District, State	Date	Crop	Observation
1.	Farmer Producer organization, Simra	Hazaribag, Jharkhand	04.01.20	*Kusmi* crop on *Butea monosperma*	Farmers inoculated kusmi (Aghani-2019-20) crop on ber and crop is good.

Annexure 8. Awareness cum village survey programme for impact assessment of the stakeholders under capacity building programme

Camp No.	Village (Block)	District, State	Date	Beneficiaries	Non-beneficia-ries	Village Mukhiya	Total
1	Etti, Murhu	Khunti, Jharkhand	28.02.20	05	01	-	06
2	Siyakel, Murhu	Khunti, Jharkhand	28.02.20	04	-	-	04
3	Osnkiyan, Murhu	Khunti, Jharkhand	28.02.20	01	-	-	01
4	Koira, Murhu	Khunti, Jharkhand	28.02.20	01	-	-	01
5	Sidhukaranjtoli, Murhu	Khunti, Jharkhand	28.02.20	01	-	-	01
6	Lapunghatu, Arki	Khunti, Jharkhand	29.02.20	04	-	-	04
7	Toner, Murhu	Khunti, Jharkhand	29.02.20	03	01	-	04
8	Kochang, Arki	Khunti, Jharkhand	29.02.20	03	-	-	03

Camp No.	Village (Block)	District, State	Date	Beneficiaries	Non-beneficia-ries	Village Mukhiya	Total
9	Balo, Murhu	Khunti, Jharkhand	13.08.20	02	01	-	03
10	Salga, Murhu	Khunti, Jharkhand	13.08.20	07	01	-	08
11	Bichagarh, Karra	Khunti, Jharkhand	21.08.20	01	-	-	01
12	Chapitoli, Karra	Khunti, Jharkhand	21.08.20	02	01	-	03
13	Dahu, Rania	Khunti, Jharkhand	01.09.20	02	01	-	03
14	Jathi Dahu, Rania	Khunti, Jharkhand	01.09.20	04	-	-	04
15	Koinara, Rania	Khunti, Jharkhand	01.09.20	02	-	-	02
16	Dimbukel, Rania	Khunti, Jharkhand	04.09.20	03	-	-	03
17	Bishunpur, Torpa	Khunti, Jharkhand	04.09.20	05	-	-	05
18	Gumpila, Torpa	Khunti, Jharkhand	08.09.20	04	01	01	06
19	Latoli, Torpa	Khunti, Jharkhand	08.09.20	04	01	01	06
20	Gaurbera, Torpa	Khunti, Jharkhand	11.09.20	05	01	01	07
21	Siladon, Khunti	Khunti, Jharkhand	15.09.20	05	01	01	07
22	Nihaldih, Khunti	Khunti, Jharkhand	18.09.20	11	01	-	12
23	Kumai, Chakradharpur	W. Singhbhum, Jharkhand	05.10.20	03	01	-	04
24	Ichhakoti, Chakradharpur	W. Singhbhum, Jharkhand	05.10.20	01	01	-	02
25	Xavier nagar, Chaibasa	W. Singhbhum, Jharkhand	06.10.20	01	-	-	01
26	Hind Chowk, Chaibasa	W. Singhbhum, Jharkhand	06.10.20	01	-	-	01
27	Asantaliya, Sonua	W. Singhbhum, Jharkhand	06.10.20	01	01	01	03
28	Hakagui, Manoharpur	W. Singhbhum, Jharkhand	07.10.20	02	-	-	02
29	Rajaparam, Bandgaon	W. Singhbhum, Jharkhand	08.10.20	04	01	-	05
30	Jonko, Bandgaon	W. Singhbhum, Jharkhand	08.10.20	04	01	-	05
31	Allondi, Khunti	Khunti, Jharkhand	13.10.20	02	01	-	03
32	Tarosiladon, Khunti	Khunti, Jharkhand	13.10.20	05	-	-	05
33	Chukru, Khunti	Khunti, Jharkhand	14.10.20	02	-	-	02

Camp No.	Village (Block)	District, State	Date	Beneficiaries	Non-beneficia-ries	Village Mukhiya	Total
34	Goutampi, Tonto	W. Singhbhum, Jharkhand	09.11.20	01	01	-	02
35	Asanpet, Majhgaon	W. Singhbhum, Jharkhand	10.11.20	01	01	-	02
36	Bichaburu, Hatgamahria	W. Singhbhum, Jharkhand	10.11.20	01	-	-	01
37	Hindikudi, Jhinkpani	W. Singhbhum, Jharkhand	11.11.20	01	-	-	01
38	Jatiya, Nowamundi	W. Singhbhum, Jharkhand	11.11.20	01	01	-	02
39	Pasubhatu, Khuntpani	W. Singhbhum, Jharkhand	12.11.20	01	-	-	01
40	Kundruhatu, Khuntpani	W. Singhbhum, Jharkhand	12.11.20	02	01	-	03
41	Rangalbera, Goilkera	W. Singhbhum, Jharkhand	12.11.20	01	01	-	02
42	Bippa, Goilkera	W. Singhbhum, Jharkhand	12.11.20	01	01	-	02
43	Osangi, Anandpur	W. Singhbhum, Jharkhand	13.11.20	01	02	-	03
44	Tati, Angara	Ranchi, Jharkhand	27.11.20	03	-	-	03
45	Sarjomdih, Angara	Ranchi, Jharkhand	27.11.20	07	01	-	08
46	Jaradih, Angara	Ranchi, Jharkhand	28.11.20	10	01	-	11
47	Gutidih, Angara	Ranchi, Jharkhand	21.12.20	-	-	01	01
Total							**169**

Annexure 9. Participation in Exhibition/Kisan Mela

Sl.	Name of the programme with venue	Date	Male	Female	Total	Participated by
1.	Block level kisan mela cum exhibition-2020, Torpa Block Ground, Torpa, Khunti	22.12.20	196	235	431	Dr. J Ghosh, Sh. P Patmajhi, Sh. Ashutosh Prabhat
Total			**196**	**235**	**431**	

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भाकृअनुप - भारतीय प्राकृतिक राल एवं गोंद संस्थान
Namkum, Ranchi - 834010 (Jharkhand)
नामकुम , राँची - 834010 (झारखण्ड)
Phone : +91-651-2260117, 2261156 (Director)
E-mail : director.iinrg@icar.gov.in
Website : https://iinrg.icar.gov.in