



PROCEEDINGS OF NATIONAL WEB SYMPOSIUM ON 'RECENT ADVANCES IN BENEFICIAL INSECTS, NATURAL RESINS AND GUMS HELD ON 25-26 FEBRUARY 2021'

ICAR-Indian Institute of Natural Resins and Gums (IINRG) and Society for Advancement of Natural Resins and Gums (SANRAG) jointly organized the National Web Symposium on 'Recent Advances in Beneficial Insects, Natural Resins and Gums' virtually in partnership with Entomological Society of India, All India Coordinated Research Project on Honeybees and Pollinators and Dr. B. Vasantharaj David Foundation on 25-26 February 2021.

The inauguration of the symposium was graced by Dr. T Mohapatra, Secretary DARE and DG, ICAR, Dr. T R Sharma, DDG (Crop Science) and Dr. K K Singh, ADG (Farm Engineering). A total of 423 registered delegates attended the symposium wherein 17 lead papers by eminent workers of respective fields, 64 oral papers and 101 poster presentations were made.

Dr. T Mohapatra, Secretary DARE and DG, ICAR Chief Guest on the occasion emphasized upon the importance of beneficial insects and natural resins and gums especially lac and also the parasitoids and predators in organic agriculture. He urged the researchers, particularly, young investigators to take up the studies on biosystematics, genomics and epigenomics of pest resistance, evolution of the parasitoids and predators in relation with the pests, adaptation of the pests to withstand environmental changes. He highlighted few examples of beneficial insects such as control of papaya mealy bugs by parasitoids, exploration of bumble bees in deploying them for pollination in natural field conditions and protected horticultural systems and possibility of utilizing the locusts as edible insects. He stressed the importance of habitat restoration for the conservation and deployment of beneficial insects and proper economic analysis to convince the policy makers for the promotion of beneficial insects. He insisted that this symposium would discuss the beneficial insects in totality, bring out newer insights in the unexplored areas of beneficial insect farming and utilization, understanding the various aspects of the biology of insects and bringing about policy dimensions in promoting beneficial insects.

Dr. T R Sharma, DDG (Crop Science) complemented

IINRG on being the unique institute in dealing with lac. He informed that internationally, 1200 insect genome projects are registered in National Center for Biotechnology Information (NCBI), comprising 401 genome assemblies and 155 gene sets of annotated protein coding genes. However, at national level these numbers are meager and there is a pressing demand to take insect genomics forward, which is very important for carrying out studies on molecular mechanism of evolutionary biology, immunology, adaptation and others. He stated that in the present scenario a high priority is to be given to research on tritrophic interaction comprising of insect-crop plant-pathogen, molecular mechanism of insect resistance in crop plants, evolutionary biology of the insects, insect gut microbiome and genome sequencing of beneficial insects especially lac insects. To achieve laurels in these areas, collaboration across the divisions, domains, crops and systems is indispensable.

Dr. K K Singh, ADG (Farm Engineering) in his opening remarks mentioned that NRGs (Natural Resins and Gums) including lac form valuable means of subsistence, employment and cash flow to growers and collectors and serve as the raw materials for various industries and used in food, fodder and medicine. In 2016, India produced 8.43 lakh tons of NRGs, out of which 97% was guar gum and exported 2.72 lakh tons of NRGs worth 3440 crore rupees. Guar gum was the third largest agricultural commodity exported after rice and buffalo meat. He informed that we carry out only primary process and export raw and semi refined forms of NRGs and import the value added products, which is a precarious situation. In the recent years, IINRG in collaboration with other institutes in Engineering SMD has developed 50 cost effective and energy efficient tools, techniques and pilot plants for the production, processing and value addition of NRGs. Increase in sustainable livelihood security of rural and tribal people is possible through three pronged strategy that is (a) adoption of NRG sector by the Government, (b) declaring lac as an agricultural produce and (c) bringing these under Minimum Support System of Government of India.

The deliberations of the symposium revolved under the following seven theme areas:

- Systematics, conservation, insect behaviour and physiology
- Host-plant, insect and environmental interaction
- Crop improvement using innovative tools including biotechnology, nanotechnology, molecular approaches etc.
- Production system management and impact of climate change
- Potential of insects as food and medicinal resources
- Processing, application, value addition and export potential of NRGs
- Role of beneficial insects and NRGs in sustainable livelihood security

Theme wise Proceedings

Theme 1: Systematics, conservation insect behavior and physiology

The technical session was chaired by Dr. N K Krishna Kumar, former DDG (Horticultural Science), Indian Council of Agricultural Research, New Delhi and co-chaired by Dr. Chandish R Ballal, Former Director, National Bureau of Agriculturally Important Resources, Bengaluru.

Two lead lectures, 15 oral/ invited presentations and 33 poster presentations were made during the session. The first lead paper entitled “Recent Advances in Sericulture research and development” was presented by Dr. N K Krishna Kumar. He highlighted the current status of sericulture in India and pointed out that with the continuous efforts of research institutions of Central Silk Board, new technologies have been developed on all aspects of sericulture from soil to fabric in all the five types of silk and now the country has emerged as the leader in tropical sericulture. Progress made in production and productivity in the last two and half decades in all the five types of silk indicates the strong contributions of the improved technologies. Sericulture is now considered as the strong land-based activities for doubling the farmers’ income due to technological advancements in almost all spheres of sericulture activities and it is also a suitable avocation for rural development with high employment generation.

Second Lead Paper entitled “Conservation and utilization of beneficial insects” was presented by Dr. Chandish R. Ballal. According to her findings, biodiversity contributes to stability of the ecosystems and thus provides essential life support and is the basis of adaptation and evolution. It is realized that taxonomists, conservationists and biocontrol workers have a major role to play in protecting plant health, environment and thus human health. Research conducted at ICAR-NBAIR has pointed out the benefits of conserving the diversity of natural enemies and also the effects of combinations of natural enemies on pest suppression. Though majority of the studies point out that natural enemy richness enhances prey suppression, some of the studies do indicate that natural enemy diversity can even lead to weakened prey suppression due to factors like intraguild predation, behavioral interference and negative selection effects. Conservation of pollinators is important for increase of crop yield and quality of seeds. For on-farm conservation of pollinators, one approach is to set up pollinator gardens with diverse plant species, which can provide continuous source of food and nesting habitats for pollinators. This model can be replicated in different regions and states, in agro-ecosystems and in urban landscapes. Another approach to conserve pollinators is to create artificial nesting sites. Subterranean nesting behaviour of native solitary buzz pollinating bees like *Hoplonomia westwoodi* was studied at NBAIR, Bengaluru based on which artificial soil traps were set up to encourage their nesting in agricultural landscapes and polyhouses to conserve and utilize them in pollination. To ensure conservation and utilization of an array of important natural enemies and pollinators, advanced research is advocated on understanding and documenting biodiversity of pests, natural enemies and pollinators, measuring the role played by the specific or combination of natural enemies on specific target pest and participatory research based on interactions between farmers, researchers and crop advisors.

Following recommendations emerged from the deliberations of this theme:

- Elucidating the role of indigenous pollinators and solitary bees and studies on totality of pollinators including the effect of pollinators on yield and quality parameters, parasitism associated with pollinators particularly solitary bees are the need of the hour.
- Traditional and molecular techniques must

go hand in hand in revealing the ecology of pollinators and other beneficial insects.

- Ecological studies must be replicated in different locations so that they could be related and would give a broader spectrum of analysis.
- It was suggested to culture the new collections of lac insect population and include molecular systematics work along with traditional taxonomy in order to identify and evaluate their performance.
- Effect of pollinators on yield and quality parameters of cashew and the interventions required during the flowering time of cashew which would increase the yield and quality were suggested to be studied.

Theme 2: Host-plant, insect and environmental interaction

The technical session was chaired by Dr. Pradyumn Kumar, Former Director (Acting), Indian Institute of Maize Research, New Delhi and co-chaired by Dr. G K Mahapatro, Head, Indian Agricultural Research Institute Regional Station, Pune.

Two lead lectures, 13 oral/ invited presentations and 35 poster presentations were made during the session. Dr. Pradyumn Kumar gave a lead lecture on “Commercial production of biological control agents”. In this lecture he pointed out that there is a large gap between demand and supply of biocontrol agents. He stressed the importance of automation in the production of biological control agents and cited many examples of technological interventions which made the commercial production of biocontrol agents a viable and profitable venture. The production of biological control agents in rural areas is also likely to increase their acceptability among the farmers and at the same time offers employment opportunities in villages.

Dr. G K Mahapatro gave a lead lecture on “Termite – The smallest bioreactor, beneficial insect benign though!” Despite the well-known role of termites in entomophagy and zootherapy, termites have attracted less attention of researchers in India. Much of the termite research is focused on their control using hazardous chemicals. However, on the other hand, there is a lot of scope for this ecological engineer in research. Recent progress in metagenomic and metatranscriptomic research has illustrated the diversity of lignocellulolytic enzymes within

termite gut and their industrial applications (biofuel, bioplastics etc.). Agro-waste material can be turned into bio-ethanol with the technological interventions by utilizing the termite symbiont enzymes for saccharification. Concerted research endeavours are needed in Indo-African region (can include Australia as well) as the higher termites are of much ecological importance in these regions.

Following recommendations emerged from the deliberations of this theme:

- Considering the scope of quality biocontrol agents in organic agriculture and the tremendous requirement, automation in the production of biocontrol agents should be adopted and promoted.
- In the wake of new potential lac host plants identified, there is a need to assess the fitness and suitability of those host plants for the lac culture to increase productivity for doubling farmers’ income. Suitable cultivars of *Cajanus cajan* should be promoted for lac cultivation to get additional income from both lac and grain.
- There is a need to screen different beneficial insects for its use in different cropping system for environmental sustainability and safety.

Theme 3: Crop improvement using innovative tools including biotechnology, nanotechnology, molecular approaches etc

The technical session was chaired by Dr. R. Ramani, Former Director, Indian Institute of Natural Resins and Gums, Ranchi and co-chaired by Dr. S. Subramanian, Principal Scientist, Indian Agricultural Research Institute, New Delhi.

Two lead lectures, 6 oral/ invited presentations and 10 poster presentations were made during the session. Dr. R. Ramani delivered a lead lecture on “Definitive thoughts on research in lac sector”. The lecture revolved around the scope of research in lac production, processing and value addition sectors considering the recent advancements in different disciplines. In view of the cost and supply, specialty application areas in food, pharma, biomedical and cosmetic sectors would remain ideal future targets for lac products and application. Researchers are also looking for suitable substitutes for shellac, especially for food industry. Successful completion of the shellac safety studies currently in progress is critical so that the requirements laid down by

European Food Safety Authority are met for unhindered consumption and diversification of shellac uses.

Dr. S. Subramanian delivered a lecture on “Genomic approaches for unravelling the gut microflora of beneficial insects” in which he described the recent genomic studies carried out in his lab on the gut microflora of beneficial insects and their scope for commercial applications. His lab has studied the gut bacterial diversity of Italian bee, *Apis mellifera*, mulberry silkworm, *Bombyx mori*, Eri silkworm, *Samia ricini* and muga silkworm, *Antheraea assamensis*. The cellulolytic gut bacteria of muga silkworm could be utilized for preparation of probiotic consortia to enhance the growth and development of muga silkworm and as such to improve the productivity of muga culture in North Eastern India. Their studies detected the presence of an Actinobacteria, *Streptomyces noursei* which showed distinct antifungal activity against entomopathogenic fungi, *Metarhizium anisopliae* causing mucardine in silkworms. He emphasized that the functional characterization of gut bacteria may help in devising strategies for sustaining and harnessing the potential of beneficial microbiota from insects of commerce like honey bees, silkworms and lac insects.

Following recommendations emerged from the deliberations of this theme:

- Whole genome sequencing of the Indian lac insect, *Kerria lacca* (Kerr) and its infra specific forms can be taken up on a priority basis for bioprospecting of genes of economic importance.
- Role of gut microbes in determining the metabolic potential of insects is a potential area of research.
- Potential of insect gut microbes for developing probiotics and microbiome consortium can be explored for improvement of insect farming and development of novel processing technologies for bioproducts from insects of commerce.
- In lac insect cultivation, intensive lac cultivation under protected conditions and bio-rational pest management are the priority areas.
- A holistic microbiome approach is the need of the hour in lac sector.
- Applications of microbes/enzyme mediated techniques in processing of bleached lac and *in*

vitro production of aleuritic acid have a great scope at present.

- Application areas of shellac and aleuritic acid may be enriched in commercial scale taking into consideration of the present needs and modern technologies available.
- Collaboration/linkage with top-class research laboratories is not optional, but indispensable for effective strategic research demanding specialized equipment/facilities and expertise, especially in newer areas.

Theme 4: Production system management and impact of climate change

The technical session was chaired by Dr. Subhash Chander, Director, National Research Center on Integrated Pest Management, New Delhi and co-chaired by Dr. K K Sharma, Director, Indian Institute of Natural Resins and Gums, Ranchi.

Two lead lectures, 14 oral/ invited presentations and 28 poster presentations were made during the session. In the lead lecture on “Climate change impact on insect and pest management adaptation thereof” Dr. Subhash Chander emphasized on the effect of climate change on crop production including lac. The climate change affects phenology of lac insects as well as lac host plants. Weather parameters such as temperature, rainfall and CO₂ level etc. affect insect outbreak and crop growth. He discussed pest-weather model, simulation model and other models to predict the population dynamics and to link crops with pest population.

Dr. K K Sharma in the lead lecture on “Role of lac cultivation in providing livelihood: An overview of lac sector” described different strategies to improve livelihood of rural people particularly tribal people cultivating lac. He emphasized on the utilization of commercially viable and economically sound technologies in lac sector. Our nation still has tremendous scope for lac cultivation since lot of areas are not yet explored despite the presence of lac host plants. The untapped areas should be fully utilized to enhance lac production and also to create employment opportunity. There is a need to train more i.e., double than existing lac growers to improve the share. He also advocated adoption of lac based agro-forestry system in participatory mode to improve livelihood of lac growers. He urged that the Government needs to declare lac as an agriculture produce and declare minimum

support price for lac. Establishment of National Lac Development Board will also improve the condition and status of lac sector.

Following recommendations emerged from the deliberations of this theme:

- Lac Integrated Agro-forestry System in participatory mode should be promoted for the efficient utilization of land and water resources in addition to increasing the farm income.
- Appropriate integration of productive insect cultivation comprising of lac, seri and api culture with the existing cropping pattern would enhance the income of farmers. Climate resilient lac host plants need to be assessed for their fitness and suitability under various agro climatic zones and promoted for lac cultivation in the wake of doubling farmers' income.
- There is an urging need to study the effect of climate change on productivity of beneficial insects and screen different beneficial insects to adapt under changing climate conditions for environmental sustainability and safety.
- Identification of alternate host, water and soil management, selection of thermo tolerant varieties, crop insurance, weather based agro advisories, etc. are essential measures to mitigate the climate change effect in sericulture.

Theme 5: Potential of insects as food and medicinal resources

The technical session was chaired by Dr. Balraj Singh, Project Coordinator, All India Coordinated Research Project on Honeybees and Pollinators, New Delhi and co-chaired by Dr. Badal Bhattacharyya, Professor, Assam Agricultural University, Jorhat

Two lead lectures, 7 oral/ invited presentations and 11 poster presentations were made during the session. The first lead lecture by Dr. Balraj Singhon "Role of honey bees and other pollinators in enhancing the productivity and quality of crops" elaborated the benefits of essential pollination services rendered by honeybees and other native pollinators and also emphasized how our nutritional security might become uncertain in absence of such services. The second lead lecture by Dr. Badal Bhattacharyya on the interesting topic "Entomophagy for rural livelihood and nutritional security in India" explored the diversity of edible

insects and provided clear direction for promotion of commercial edible insect rearing in India.

Following recommendations emerged from the deliberations of this theme:

- The prospects of edible insect industry may be thoroughly explored by promoting their cultivation and commercialization through banking under start up schemes by Van Dhan/ Mudra Bank Yojana of the government. Trading of edible insects with South East Asian nations by the way of Act East Policy of Government of India would open new avenues for this potential yet less explored venture.
- Identification of edible insect fauna based on GPS based survey and their documentation through integrative taxonomy should be carried out.
- Efforts should be given to obtain "GI tag" of at least some promising edible insect species.
- Advanced "Nutritional and anti-nutritional profiling" of edible insects by following modern analytical techniques should be attempted. More investigations on "Safety standards" and "Shelf life" of edible insect powders by exploring modern food science practices and "Acute oral toxicity tests" should be done.
- "Edible Insect Industry" needs to be brought under the umbrella of "Cottage Industry" for reduction of the production, processing, transportation and marketing costs; for better access to credit facilities and training in hygiene food preparation; for business skill development; for obtaining licences and permits for marketing.
- Leading Universities/ colleges of North Eastern region should act as a pathfinder to initiate target oriented research. The North Eastern Council may act as one of the key players to give a boost to "Edible Insect Industry" for developing infrastructure, sensitizing the entrepreneurs and other stakeholders. Extracting proteins from insects to fortify human foods/ Ethnomedicine/ Pharma food/ Nutraceuticals. Research funding agencies like DBT, DST, ICAR may provide sufficient funds to carry out target specific research in this field.

Theme 6: Processing, application, value addition and export potential of NRGs

The technical session was chaired by Dr. Bangali Baboo, Ex-National Director, National Agricultural Innovation Project and co-chaired by Dr. K K Singh, Assistant Director General (Farm Engineering), Indian Council of Agricultural Research, New Delhi and Dr. Niranjana Prasad, Principal Scientist and Head, Processing and Product Development Division, ICAR – IINRG, Ranchi.

Three lead lectures, 11 oral/ invited presentations and 10 poster presentations were made during the session. During the deliberations, Dr. Bangali Baboo stressed that potential areas of application of the product developed should be taken into consideration and techno economic analysis required before proposing the project. He also mentioned that loss prevention and value addition are the need of processing. Dr. K K Singh emphasized that use of tools and equipments for production and value addition of NRGs should be promoted for better quality of produce, reduce drudgery with reduced manpower requirement. Dr. Niranjana Prasad stressed need of increasing karaya gum production adopting improved tapping method and increasing karaya trees to produce more gums.

Following recommendations emerged from the deliberations of this theme:

- The newly developed guar and Arabic gum based dietary fibres need to be compared with commercially available dietary fibres.
- Possibility may be explored for isolation and use of guar meal protein for human consumption.
- Biodegradation study of lac may be carried out at accelerated condition.
- Gum based films need to be compared with commercially available films for packaging applications.
- Genetically engineered organisms may be appropriately explored to produce resins and gums under laboratory conditions which in turn would decrease the over exploitation of gum yielding trees.
- Use of renewable energy for processing (e.g. Solar dryer) and value addition of NRGs may be encouraged to save energy which in turn would help the resource poor farmers and tribes involved in this sector.

- Techno economic analysis of the research programmes on value addition of NRGs is indispensable for the success of any products or processes developed based on NRGs.

Theme 7: Role of beneficial insects and NRGs in sustainable livelihood security

The technical session was chaired by Dr. C M Bajpey, Director, Central Tasar Research and Training Institute, Ranchi and co-chaired by Dr. V Sivaprasad, Director, Central Sericultural Research and Training Institute, Berhampore.

Four lead lectures, 13 oral/ invited presentations and 17 poster presentations were made during the session. In his lecture on “Conservation of biological control agents- parasitoids and predators for pest management services” Dr. Abraham Verghese threw light on biotic pressure, pesticide drift, pest management and control measures in papaya and guava and talked about the landscape manipulation, multicrops (heterocropping), retaining natural vegetation. Dr. C M Bajpey delivered a lecture on “Impact of climate change on tasar culture: Adaptation strategies”. In this lecture he emphasized the importance of tasar silk cultivation as a sustainable rural livelihood option, silkworm breed improvement and adverse impact of climate change in tasar silk, identification of alternate host, rearing of as an trees, water and soil management, selection of thermo tolerant variety etc. Dr. V Sivaprasad delivered a lecture on “Mulberry sericulture – Sustainable rural livelihood”. He pointed out that the mulberry silk production activities provide employment opportunities for around 1.2 million families in India across the value chain. Mulberry sericulture meets the several sustainable development goals of UN in providing livelihood security to the rural population especially women folk. The sector serves as a secondary agricultural activity to the large number of small/marginal farmers and a boon in water scarce/ stress areas as mulberry requires minimal water for irrigation. Central Silk Board is the leading sericulture R&D organization involved in developing cutting edge technology for mulberry sericulture farmers in India and extends all the technical support for the stakeholders.

Following recommendations emerged from the deliberations of this theme:

- Lac cultivation is important for socio economic upliftment of weaker section of the society as it contributes to the livelihood security

significantly. Therefore, Lac Integrated Agroforestry System may be promoted by state governments, SAUs and KVKs across the country wherein there is a high scope for lac cultivation.

- Landscape manipulation, multicrops (heterocropping), retaining natural vegetation for promoting bio control agents are the need of the hour.
- Identification of alternate host, water and soil management, selection of thermo tolerant variety, crop insurance, weather based agro advisories, etc. to mitigate the climate change effect in sericulture.
- Seri business enterprises and need based trainings may be encouraged. Private tasar seed production units should be promoted.
- Pollination enhancement through protected conditions may enhance the productivity, hence it may be promoted for horticultural crops.
- Gum producing trees need to be tapped scientifically through gum inducer technology for sustainable gum production.
- Managing Indian honey bee colonies in moringa orchard should be promoted for doubling the beekeeper's income.
- Natural resource base in the forest areas need to be conserved with effective implementation of stringent laws for encroachment and illegal cutting of commercially important trees.
- Existing infrastructure as well as manpower under capacity building and skill development programs needs to be doubled for extensive coverage of the stakeholders to achieve the targets through NRGs based knowledge footprints.
- Post Covid scenario demands the ICT interventions in the period of new normal to disseminate the Good Agricultural Practices (GAP) among different stakeholders of this secondary agriculture sector comprising of beneficial insects and NRGs for their improvement.

Recommendations of plenary Session

The plenary Session was chaired by Dr. R Ramani, Former Director, Indian Institute of Natural Resins and

Gums, Ranchi and co-chaired by Dr. V V Ramamurthy, eminent taxonomist and Former Professor at Indian Agricultural Research Institute, New Delhi.

Recommendations from all the theme areas were compiled and integrated area-wise for taking coherent action. These are:

A. Research thrust areas

- Elucidating the role of indigenous pollinators and solitary bees and studies on totality of pollinators including the effect of pollinators on yield and quality parameters, parasitism associated with pollinators particularly solitary bees are the need of the hour.
- Traditional and molecular techniques must go hand in hand in revealing the ecology of pollinators and other beneficial insects.
- Considering the scope of quality biocontrol agents in organic agriculture and the tremendous requirement, automation in the production of biocontrol agents shall be adopted and promoted.
- Identification of alternate host, water and soil management, selection of thermo tolerant varieties, crop insurance, weather based agro advisories, etc. are essential measures to mitigate the climate change effect in sericulture.
- The indigenous Muga silkworms may be explored and researched in a better way for their documentation, conservation and utilization.
- Whole genome sequencing of the Indian lac insect, *Kerria lacca* (Kerr) and its infra sub specific forms can be taken up on a priority basis for bioprospecting of genes of economic importance.
- Safety studies of edible insects and GI tags on indigenous edible insect species would take the edible insect industry to a new height.
- Potential of insect gut microbes for developing probiotics and microbiome consortium can be explored for improvement of insect farming and development of novel processing technologies for bioproducts from insects of commerce.
- Appropriate integration of productive insect cultivation comprising of lac, seri and api culture with the existing cropping pattern would enhance the income of farmers. Climate

resilient lac host plants need to be assessed for their fitness and suitability under various agro climatic zones and promoted for lac cultivation in the wake of doubling farmers' income.

- There is an urging need to study the effect of climate change on productivity of beneficial insects and screen different beneficial insects to adopt under changing climate conditions for environmental sustainability and safety.
- Genetically engineered organisms may be appropriately explored to produce resins and gums under laboratory conditions which in turn would decrease the over exploitation of the gum yielding trees.
- Use of renewable energy for processing (e.g. Solar dryer) and value addition of NRGs may be encouraged to save energy which in turn would help the resource poor farmers and tribes involved in this sector.
- Techno economic analysis of the research programmes on value addition of NRGs is indispensable for the success of any products or processes developed based on NRGs.
- Post Covid scenario demands the ICT interventions in the period of new normal to disseminate the Good Agricultural Practices (GAP) among different stakeholders of this secondary agriculture sector comprising of beneficial insects and NRGs for their improvement.

B. Development domain

- Lac Integrated Agro-forestry System may be promoted by State Governments, SAUs and KVKs wherein there is a high scope for lac cultivation.
- The prospects of edible insect industry may be thoroughly explored by promoting their cultivation and commercialization through banking under start up schemes by van Dhan/Mudra Bank Yojana of the government. Trading of edible insects with South East Asian nations by the way of Act East Policy of Government of India would open new avenues for this potential yet less explored venture.

C. Policy interventions

Declaration of lac as an agriculture produce: Lac

production has been categorized as a Non-Wood Forest Produce and income generated from production of lac is taxable. It discourages the progressive farmers to take lac cultivation on a larger scale. However, lac is no longer a Non-Wood Forest Produce simply collected by the forest dwellers. Lac Integrated Farming System Models are becoming popular among the farmers which have led to 15-20% increase in farming income through land use diversification. Agricultural and Village industry products including lac based value added products are presently covered under Vishesh Krishi and Gram Udyog Yojna (VKGUY) in the Foreign Trade Policy 2015-2020. Hence, there is an urgent need to declare lac as an agricultural produce and MSP for lac can also be declared under Agricultural category to accelerate its growth and livelihood potential.

Formation of National Lac Development Board:

India is the leading lac producer, processor and exporter country in the world. There are policy differences in all the states regarding the cultivation and marketing of the lac. It has been classified as nationalized or non-nationalized or monopoly item in different states. Research on lac is mandate of IINRG (ICAR, Ministry of Agriculture); most of the lac production still comes from forest / sub-forest areas (ICFRE, Ministry of Environment and Forests); Promotion and export of lac is looked after by SHEFEXIL (Shellac and Forest Products Export Promotion Council, Ministry of Commerce) and cultivated mostly by tribals (Ministry of Tribal Affairs) which sometimes creates difficult situation in developing holistic approach for promotion and development of lac / NRGs. Hence, a policy intervention at national level is required to address this differentiation. Keeping in view of above scenario, the National Lac Development Board (NLDB) under Ministry of Agriculture is likely to replace the exploitation with empowerment, tradition with modernity, stagnation with growth, transforming lac cultivation into an instrument for the development of rural people, checking migration of tribals for livelihood and to provide the much-needed fillip to accelerate the production of lac.

Conservation of beneficial insect resources and tribal farming systems:

The recent pandemic has taught us the importance of self-sustainability and our nation is also marching towards "Atmanirbhar Bharat". Conserving and utilizing our indigenous genetic resources are crucial in obtaining self-sustainability. The commercial insects such as lac insects, wild silk worms

and honeybees are important not only in commercial aspects but also in ecosystem conservation. For instance, tribals resist deforestation wherever lac is cultivated on forest trees. There is a great scope for research of these tribal yet remunerative produces. Hence, a project proposal on 'Tribal Produce' comprising of lac, wild silk, honey, edible insects and NTFPs including NRGs and formation of Tribal Farming Systems Research Institute may be submitted to Government of India for consideration and for improvement of this indigenous agricultural sector.

Integrated platform for advancement of all beneficial insects: Beneficial insects face lot of challenges due to climate change, pollution and other anthropogenic activities. The ecological service provided by pollinators such as honey bees is under continuous threat due to

climate change and extensive use of pesticides. Due emphasis may be given to the beneficial insects under a single umbrella for promoting research and addressing the problems of this sector. Hence, all the beneficial insects may be brought under the ambit of the SANRAG society, or a new suitable forum be constituted for the purpose of better interaction of scientists working on these insects and improvement of these valuable insects.

(Dr. K K Sharma)

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