From President's Desk……

Microbial Gums – a way forward

Gums are polysaccharides and polysaccharide derivatives, mainly composed of sugars like glucose, fructose and mannose. Gums are easily soluble in water and can easily form a viscous solution, even at a lower concentration. Sources of gums include: plant origin gums, seaweed origin gums and microbial origin gums. Plant based gums include guar gum, Arabic gum, karaya gum, salai gum, dammar gum, etc.;seaweed based gums include agar, alginic acid, carrageenan, etc. microbial gums include xanthan, welan, gellan, pullulan, curdlan and bacterial cellulose.

Microbial gum such as Xanthan is produced by the bacterium *Xanthomonascampestris*, Welan gum by the genus *Alcaligenes* and Gellan gum by *Sphingomonaselodea*. Microbial gums are categorized as generally recognized as safe (GRAS) materials by the Food and Drug administration and are widely used in food and pharmaceutical industries. They are basically uncharged or ionic polymers and used as gelling, viscous, thickening and stabilizing agents and food additives in food industries and for binding and slow release in pharmaceutical industries. For instance, xanthan gum helps in bringing the desired texture to the food materials such as ice cream, stabilizes the food material by preventing oil separation and aids in suspending the solid particles in the food and brings stickiness to the dough in gluten free baking. Their microbiological stability, adhesion, cohesion, wettability, solubility, transparency and mechanical properties made them as an excellent edible films or coatings. They have the potential to improve the shelf life of the edible products. Besides food and pharmaceuticals, they find applications in various other fields. Gelan gum is used as alternative for agar, a gelling agent in microbiological growth medium and welan gum is used as a rheology modifier in cement manufacturing. Xanthan gum is used to thicken drilling mud in oil industries. In tissue engineering, xanthan gum is used to construct hydrogels and scaffolds which in turn lead to three dimensional tissue formations. Microbial gums are the best suitable alternative to the biohazardous plastic in the form of biodegradable packaging films.

Microbial gums are produced by the fermentation technique using suitable substrates rich in carbohydrates with the specific bacterial species.Production of microbial gums is season independent and carried out in stirred tank reactors as a batch cultivation. Since they are produced in fermenters, it comparatively takes less time and space andit is highly amenable for purification. They can be up scaled to produce larger quantity in lesser space compared to other gums. Among the microbial gums, xanthan gum is the most traded gum in India accounting for an export worth about 30000 USD in 2015-2016 and about 80000 USD in 2015-2016. These figures clearly indicate that there is a high potential for the inland production of this gum. Research are underway in the country to reduce the cost of production by using cheaper substrates and also from agricultural wastes such as sugarcane molasses and whey. On the other hand, industrial production requires high technical expertise and engineering skills. Research on genetically modifying the respective bacterial species involved in microbial gum fermentation for increasing the production and also to improve the process is the need of the hour. These interventions would lead our country self-reliant in the field of microbial gums.

National Scenario of NRGs: An outlook

Non-Wood Forest Products (NWFPs) based on their chemical composition may be classified in three categories namely natural resins, natural gums and gum resins. Natural resins are solid or semi-solid materials, usually a complex mixture of organic compounds called terpenoides, which are insoluble in water but soluble in certain organic solvents. Resins are secretion of several plants, particularly coniferous trees.

NRGs of commercial importance like lac (*Kerria lacca*(Kerr)), pine resin (*Pinus roxburghii* Sarg.), *guar* gum (*Cyamopsis tetragonoloba* L.), gum *karaya* (*Sterculia urens* Roxb.), *dhawada* gum (*Anogeissus latifolia* Roxb.), tamarind gum (*Tamarindus indica* L.), char /*piyar* gum (*Buchanania lanzan* Spreng.) and *babool* gum (*Acacia nilotica* L.) are produced in our country. India holds a lions' share in international trade over some of the NRGs such as lac, gum *karaya* and *guar* gum.

Resins are used in the production of varnishes, adhesives and food glazing agents. These are also used as raw material for synthesis of incense and perfume. This group of natural resins includes lac secreted by an insect *K. lacca* (Kerr) and plant originated products like rosin, copal and dammer. Solidified resin from which the volatile terpene components have been removed by distillation is known as rosin. Natural gums are polysaccharides of natural origin, capable of causing a high viscosity in the solution. Most often these gums are found as exudates from woody elements of plants or in seed coatings. In the food industry these are used as thickening, gelling and emulsifying agents and stabilizers.

These are also used as adhesives, binding agents, crystal inhibitors, clarifying agents, encapsulating agents, flocculants, foam stabilizers, swelling agents, etc. Natural gums can be classified according to their origin. Firstly, tree exudates e.g., gum arabic, gum ghatti, gum tragacanth, gum *karaya*, *guar* gum, locust bean gum, chicle gum, dammar, mastic gum, psyllium gum and spruce gum. Secondly, originated from seaweeds e.g., agar and carrageenan and thirdly, produced by bacterial fermentation e.g., gellan gum and xanthum gum. They can also be classified as uncharged or ionic polymers (polyelectrolyte).

Gum-resins are the natural mixtures of gums and resins in variable proportions therefore possess properties of both the groups. They contain traces of essential oils and are partly soluble in water. They have a penetrating and characteristic odour and taste and obtained from the plants. Olibanum/salai gum (*Boswellia serrata*), *guggal* (*Commiphora wightii*), myrrh, asafoetida, etc. are the major gum resins of national importance.

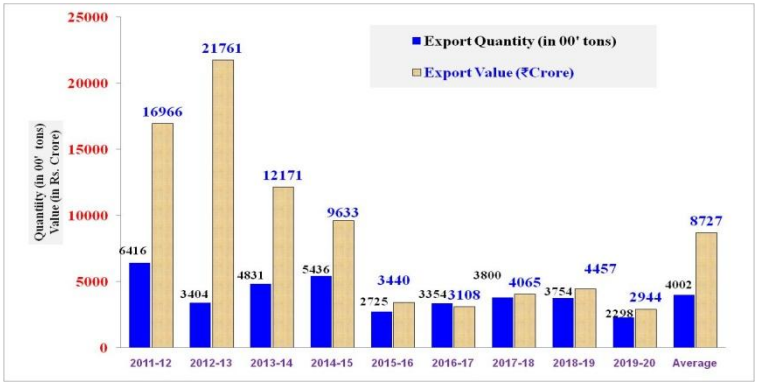

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Fig. 1: Export flow of lac, natural gums, resins and gum-resins from India during the decade

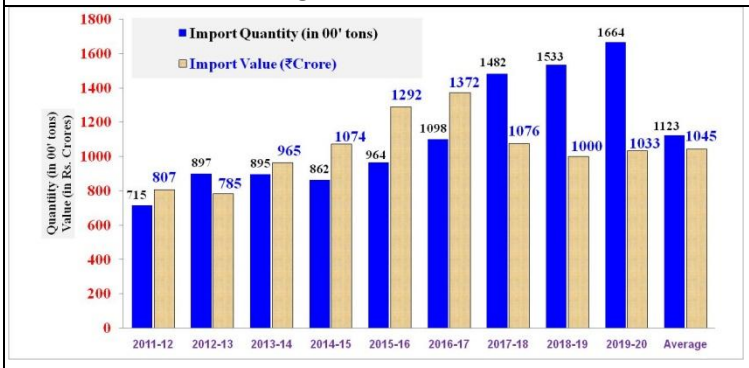

Fig. 2: Import flow of lac, natural gums, resins and gum-resins in India during the decade

According to The Ministry of Commerce and Industry Government of India, the average international trade aggregation of lac, natural gums, resins and gum-resins during the decade was about ₹100 Billion.

Out of this, the export aggregation of lac, natural gums, resins and gum-resins the decade was about ₹90 Billion. A decadal data (2011-12 to 2019-2020) on EXIM aggregation of lac, natural gums, resins and gum-resins were analyzed and presented in Fig.1 and Fig. 2. Since 2013-14, deceleration in the value of export aggregation was observed and stagnation was found in the value of import aggregation during the similar period.

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Lac based folk medicine use by tribal communities of Assam

Kerria chinensis (Mahd.) is predominant in North East India particularly in Assam. Whereas, *K. lacca* (Kerr, 1782) is predominant in almost all the lac growing states of India and is commercially exploited for its good quality. In last couple of years, extensive field surveys were carried out under Network Project "Conservation of Lac Insect Genetic Resources" by Assam Agricultural University, Jorhat throughout Assam and West Bengal for gathering information about lac insect and its host plants, biodiversity associated with lac insect complex, climatic suitability and wider prospects in cultivation of lac insect.

During survey, a few lac based Indigenous Technical Knowledge (ITKs) were found prevailing amongst the farming communities of Assam. Majority of tribal people of Assam cultivate lac and are dependent upon some ITKs due to their socio economic conditions. Three lac based ITKs related to medicinal use of lac were recorded from farmers of West Karbi Anglong, East Karbi Anglong, Goalpara, Golaghat and Jorhat district of Assam.

Fig.3 : Demonstration on lac use as pain relief (Lorulangsu village, East Karbi Anglong)

More than 12% tribal farmers of Assam uses lac as curative medicine against rheumatic pain and other body/joint pain by massaging lac powder mixed with mustard oil on the afflicted areas of the body or by applying the mixture of lac and water to the affected areas. Lac encrustation is boiled in water and allowed to cool for a while and the extract is applied on body to remove itching of skin reported by 10% farmers of Assam. More than 4% farmers of Assam revealed that a small piece of lac is mixed with lukewarm water by crushing and a glass of such water is drunk to get relief from stomach ache.

Literature also reveals the use of lac in Unani medicine for curing obesity, hyper-lipidemia, renal, jaundice, back-ache, premature ejaculation, leprosy, cough, hemi-plegia, asthma, haemoptysis, epilepsy, chicken pox, ulcerations, worm infestation and palpitation. Since from time immemorial lac has been used for curing various diseases which are still ractice by tribal people in their folk medicine. Thus it is proven that lac has some medicinal properties which should be validated scientifically for extensive use.

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Adding value to Minor Forest Products – An initiative by Bhat family

Majority of the non timber forest products (NTFPs) *viz.,* honey, kokum, amla, soapnut, jamun *etc* which are abundant in Uttar kannada district of Karnataka are underutilized. There is an ample scope to utilize these which is done by Shri. Ganapathi R. Bhat and his family from a remote village in Honnavar Taluk of Uttara Kannada District who ventured into small home scale processing unit in 2007 with the ancestral knowledge on processing and medicinal value of indigenous under exploited minor forest fruits.

In the beginning they prepared 20 Kg Kokum Syrup and started selling in the local market. Now they are producing nearly 84 tonnes of value added products like squashes, juices and syrup using kokum (*Garcinia indica*), brahmi (*Bacopa monnieri*), amla (*Emblica officinalis*), local ginger, pineapple, honey, *Cynadon dactylon*, jamun (*Syzygium cumini*) *etc.* All the raw materials are from local varieties and organically grown. Today, the value addition venture which they have started with initial investment of Rs.5000/- has reached to Rs. 1.00 Crore per annum and net income has increased from Rs. 3,000/- to Rs. 1.25 Lakhs per month.

The products are sold throughout Karnataka in the brand name "Swastik" with PFA license and has broad market linkage with Kadamba, a co-operative society located at Sirsi. The technical source is from ICAR KVK, Uttar Kannada, Sirsi, Khadi Gramodyoga Sangha, Nanjangood, Mysore and Kadamba Marketing Souhardha Sahakari Ltd., Sirsi. This value addition enterprise has spread to neighboring village and Bangalore. Mr. Ganapathi Bhat regularly exhibits his value added organic products during Flower Show, Lalbagh, Bangalore, Krishi Melas of different Agriculture Universities. Mr. Bhat received many recognitions and also awarded with Innovative farmer award 2016 from IARI, New Delhi.

Mr. Ganapathi R. Bhat is a proud young entrepreneur who is a best example of Mahatma Gandhiji's Gram Swaraj dream for the prosperous India. Many farmers/farm women, extension personnel's from various departments, scientist from different universities regularly visit his cottage industry and appreciated the efforts of Bhat family for providing commercial value to the under exploited local minor forest fruits which have medicinal and nutraceutical value.

Fig.4: Visit of Dignitaries to KVK promoted Entrepreneur Stall

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Fig.5: Occurrence of lac insect and its collection in Jammu

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Network Project on Conservation of Lac Insect Genetic Resources Helped Dwindling Lac Insect Populations to Bounce Back In Jammu Region

The occurrence of lac insect in Jammu was highly threatened and in order to conserve this insect in the region, its scientific conservation was initiated in the year 2007 in collaboration with IINRG, Ranchi. Later in the year 2011 a new project on lac conservation and cultivation was implemented with the help of DBT, New Delhi. Looking forward the potential of lac cultivation in Jammu, SKUAST-J was included as Networking center of NPCLIGR-Ranchi.

Prior to the implementation of conservation measures, the natural lac occurrence was hardly observed, however systematic intervention are new indicatory partial success of community measures. Baseline survey data collected from various areas revealed the occurrence of 8 races of lac which were multiplied under *insitu* and *exsitu* condition. About 7593 plants were reinoculated for natural spread of lac on various hosts with sufficient brood quantity (830 kg). For the last 13 years, the natural occurrence of lac has increased substantially from 2.1 to 13.5 per cent. Besides, a gene bank is being operated for conservation of available germplasm. The issues related to dwindling population were addressed through appropriate integrated measures

Success Story of Lac Cultivation: Hazaribagh East Forest Division

Introduction: Smt. Pramila Devi, of Village Kailatanr, P.OKheskari, Thana- Saria, Dist, Giridih (Jharkhand) is as Para Teacher employed at her village Kailatanr. Her husband Sri Narayan Dev Verma is serving as a teacher in the same village. They have three daughters and a son. She is about 45 years old and she is a graduate in Social Science and History

Background: The source of livelihood of Smt. Pramila Devi was agriculture before she was employed as para teacher. A well educated and a graduate, she had always been actively searching for a part timeengagement to improve her income.

In the mean time family expenses increased and she felt that the income from teaching job is insufficient and she can't do well with the meager income. Therefore she began to search another job. When she came to know about "Lac Cultivation" being promoted by Bagodar Territorial Range, at Saria, Pramila Devi was enlightened with a new ray of hope.

Ultimately Smt. Pramila Devi having a golden dream in mind, reached Range office of Bagodar territorial Range, at Saria and requested local forest officers to help her to get trained in Lac Cultivation so that she can have a alternative arrangement for increasing her livelihood means. Local Forest Officer appreciated her zeal and determination to do support her family, assured that she will get all possible help for her economic upliftment from the department.

Training: It was in the year 2016, when the Forest Department (Hazaribagh East Forest Division) started training programs on Lac Cultivation, and Smt. Pramila Devi attended the programme with full enthusiasm. Moreover she also motivated other women of her village to attend the training.
The Forest Department organized several other training programmes to uplift economic status of villagers on the topic like: Method of Lac cultivation and process of making different products from Lac, process of making bangles, process of making pickle from *Mahua* Flowers and making of incense sticks (*Agarbattis*) etc. Smt. Pramila Devi attended all the training programmes and she got well trained in making various products from Minor Forest Produce. She was so enthusiastic that, apart from trainings at local level she was also sent to attend training programmes organinised at IINRG(Indian Institute of Natural Resins and Gums), Namkum,Ranchi on topics of high quality production of Lac and scientific techniques of Lac cultivation. As a result she got completely convinced on how to improve income by lac cultivation and processing.

Cultivation of Lac: After getting trained in lac cultivation Smt. Pramila Devi, now became well skilled for culture of lac. She was provided with essential equipments like Secateurs, axe, insecticide, sprayers, etc. from Forest Department, Hazaribagh East Forest Division in order to facilitate cultivation of lac.
In the year 2017, she inoculated *Palas (Butea monosperma)* host trees available in her"Raiti tarn" land (upland) with brood lac and continued her teaching job. As a result of her first attempt she had harvested about 60 to 65 kg of scrap lac that she sold to Lac centre of Forest Department (Hazaribagh East Forest Division) at Saria, and earned a net profit of Rs. 10,000.00. Afterwards she started producing Lac bangles, (Button Lac), "*Chapra*" Lac and other value added products of lac, and she earned profit by selling these produces. Result of initial success was very encouraging.
Her dream came true. Consequently every year she is inoculating lac on host trees and making additional income of Rs. 30 to 35 thousand/season. With this additional income she now able to send her children to town for better education and to meet requirements of her family.

Sale of Produce: After successful rearing and harvesting of lac, the village women folk started making Lac products for daily use. In this matter Sri Narayan Deo Verma her husband helped her. Smt. Pramila devi and all other women members of the self help group taking help of Sri Narayan Deo verma started making lac bangles. In the beginning they sold the bangles locally in the village.
Afterwards they got market in neighboring villages. With the increase in demand during season of marriages and festivals the women self help groups started manufacturing more lac bangles. Group members earn on an average 25000 to 30000/month. Now they have market for their products in towns and Vikas Mela stalls. Also they have reached big markets. They get orders from shopkeepers of towns and they became economically stable.

Fig.6 : Smt. Pramila Devi in training & exhibitions with lac based handicrafts

Inspiration: Smt. Pramila Devi motivated other women of her village to become economically self dependent by doing lac cultivation. She told them about techniques of Lac Cultivation and income accruing out of it and she formed two women self help groups namely "Gayatri Lac Cultivation group" and "Maa Bhawani Lac rearing Self Help Group".

In this way Smt. Pramila Devi crossed boundaries of village to reach town and District head quarters. Smt. Pramila Devi is also interested towards forest protection. She along with her fellow members of women self help group actively involves in forest protection and improvement.

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Promising native bees make nest in cashew plants

Cashew, *Anacardium occidentale* L. is a cross pollinated commercial tree nut crop. Though male and hermaphrodite flowers are present in same inflorescence, the arrangement of male and female reproductive parts of the flowers and sticky nature of pollen grains necessitates help of insects for successful pollination and fruit set in cashew. Bees including wild bees play a major role in cashew pollination.

Wild bees play key ecological service in most ecosystems, but they are often neglected or underestimated. Surveys conducted at ICAR- Directorate of cashew research, Puttur resulted in location of nests of several stem nesting bees belonging to Apidae in the thin dried stem portions or cut ends of cashew sticks. The nests of bees recorded in cashew sticks include, *Braunsapis mixta* (Smith), *B. picitarsis* (Cameron), *B. malliki* Reyes, *Ceratina hieroglyphica* Smith and *C. binghamii* Cockerell. These bees are important pollinators of cashew, besides honey bees. Presence of circular neat hole at the entrance of dried sticks is an indication of occupancy by these stem nesting bees. The size of nest and the diameter of entrance hole vary with species. The diameter of entrance hole of *C. binghammii* was larger (2.5mm- 3.0 mm), and was smaller for *Ceratina* spp. (undetermined). *Ceratina* bees mass provide their grubs with pollen bread, while *Braunspis* bees are progressive provisioners. Presence of nests was commonly seen on the trees having pruned cut ends, compared to unpruned trees. Thus, avoiding the destruction of dried sticks and creation of smooth cut ends in the sticks exposing soft pith by light pruning will surely encourage these bees to make nests and breed in them. Thereby these bees can be conserved effectively.

Fig.7: Holes at the entrance indicates bee nests

Fig. 8: *Ceratina hieroglyphica* at its nest entrance

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***Guggul* corridor of India: A ground report of large scale *guggul* plantation drive in Chambal ravines**

The ecological status of *Guggul* plants[*Commiphora wightii* (Arnott.) Bhandari] has scaled down in recent decades from Rare Endangered and Threatened (RET) to Data deficient category of plants in India. This slow growing valuable medicinal plant, naturally found in the semi-arid and arid areas remain leafless for almost 8 months during the year. The plant yield medicinally important oleo-gum-resin from its 2mm thin bark. Wide gap between high demand(25,000mt) of guggul gum against lesser 10-50mt) supply is the reason for destructive tapping and its rapid loss.

Chambal ravines

Sharp, steep, mud hillocks is the characteristic features of Chambal ravines that spread across three states - Madhya Pradesh, Rajasthan and Uttar Pradesh. The ravine in MP cover 68,833 ha) .Extreme weather conditions and sharp cliffs susceptible to soil erosion. Scanty vegetative cover leave the expose ground to solar radiation and evaporation.One of our study revealed that in the month of September , the soil moisture in the ravine vary from 18 to 26.1 %, while NPK and soil organic carbon were 225,28,280 and 6 kg per ha respectively. Constrained translocation of these nutrients from the moisture deficit soil to roots may be one of the reasons for poor plant growth in the ravines. Such dry and loose soil are prone to termites, which is very well evident in Chambal ravines.

Guggul corridor of India

Rajasthan, Madhya Pradesh and Gujarat are three states in India with maximum Guggul plants. Creation of a Guggul corridor along these three states are in pipeline. Large scale guggul plantation requires quality seedlings. Seed(drupe) collection from distantly located thorny Guggul plants in ravines is difficult, poor fruiting and seed germination are three major constraints for large-scale development of Guggul seedlings.

Seed and seedlings of Guggul

JNKVV Centre of AINP on HPVA of NRG working on Guggul is coordinating with NMPB, Industry, Department of Forest and NGO sharing the scientific information generated to overcome the three challenges. Large scale drupe collection and establishment of nursery is on a war-foot to meet the target set for 5 lakh guggul seedlings for plantation in MP during July2021. This shall be one of the visible indicators of the project outcome in next decade.

Fig.9: Guggul seeds

Fig.10: Guggul seedlings at nursery

Seed technology shared

Good germination can be achieved by segregating heavy and dark coloured seeds from the lighter ones by simple visual as well as water immerse methods. In a seed lot the dark seeds were found to vary from 29 to 35 %. The mean 100 seeds weight varied from 4.17g (current year seeds) to 4.63g (one year old seeds). Sowing of dark seeds after soaking for 24 hours in perforated polythene bags filled with a mixture of light soil, vermi-compost or FYM and soil microbes (*Trichoderma viride,Mycorrhiza* and *Asperigillus*) germination over 56% with better seedling length (11.67 cm)

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Obstacles in adopting modern agricultural implements in Chotanagpur plateau region

The tribal population of Jharkhand is mainly dependent on agriculture and manual labour for its livelihood. The tribal population of Ramgarh district is about 21 %. Most of the tribal farmers in the Chotanagpur plateau region own small and fragmented lands. Traditionally the land was occupied by tribals, but gradually it was transferred by the governments to coal mining and mineral exploration companies.

The tribal agricultural system still has more share of human and animal power than mechanical power. Traditionally, farmers in the region have been using many small tools and implements for agricultural operations that have been locally developed and manufactured according to their needs. Traditional devices are those that were invented in ancient times and have been used for many years. These devices have been used till recently and are used in some places till today to increase agricultural production. Most of the tools of tribal farmers are made of bamboo, wood and iron by local artisans. But now gradually they have started adopting factory-made standardized equipment which are also economical. Traditional farming tools of tribals can be used by both men and women. Each tool is used for a particular agricultural work such as land preparation, sowing, weeding, irrigation, harvesting, post-harvest processing and transportation of agricultural produce.

A survey was carried out in the tribal areas of Ramgarh district to collect information about the traditional agricultural implements currently in use. The purpose of the study was to document these traditional tools and technology, as these traditional tools and technologies are on the verge of extinction with the advent of modern equipments and technology. A conclusion was made by the farmers about the major hurdles in adopting agricultural machines and suggestions were made to improve agricultural mechanization.

The survey was conducted in the villages of Aarabasti, Badka Chumba, Bahatu, Pipratand, Amradag, Gandhaunia, Govindpur and Gargali in Ramgarh district (average elevation 337 msl) which are tribal dominated. A total of 250 houses were selected in eight villages. Information related to the indigenous equipment used by them in agricultural practices was collected through specially prepared questionnaire format and group discussion.

Traditional instruments were listed along with parameters such as their dimensions, tool width, construction material, weight etc. Ten possible barriers and six suggestions from farmers for improving agricultural mechanization services were listed after reviewing reliable sources such as the nearby Krishi Vigyan Kendras, NGOs and heads of *panchayats*.

The head of the household selected was interviewed through a pre-planned format. The odds of adopting agricultural mechanization were measured on a four point scale, namely the most severe, severe, least severe and barrier free, scoring 4, 3, 2 and 1 respectively. Suggestions were measured on a three-point scale, namely agree, neutral and disagree, scoring 3, 2 and 1, respectively. Tabulation, sorting and statistical analysis were performed. The mean score for each obstacle was calculated and ranked.

Farmers' land holdings and agricultural mechanization models

The pattern of land holdings is effective in the use and adoption of agricultural machines. Most of the tribal farmers (82 %) in the surveyed villages had small holdings. 16 % farmers had 2–4 hectares of land and only 2 % farmers had 4–10 hectares of land. Family size is also an important factor as family members work as laborers on their own farm. Of the households surveyed, the small family size (1–4) was only 16 % while the majority of the family (68 %) was of 5 to 8 family members

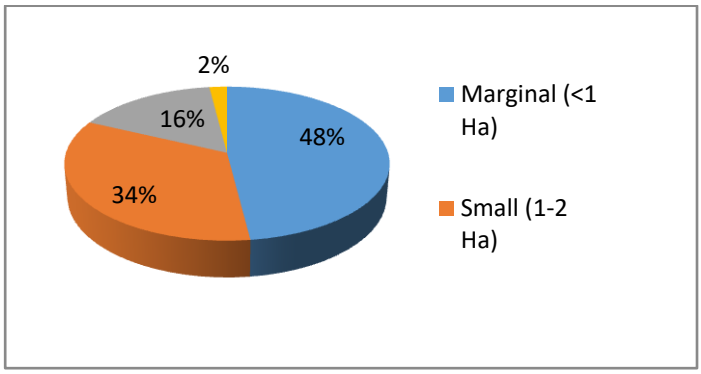

Fig.11: Land holdings of the regions' farmers

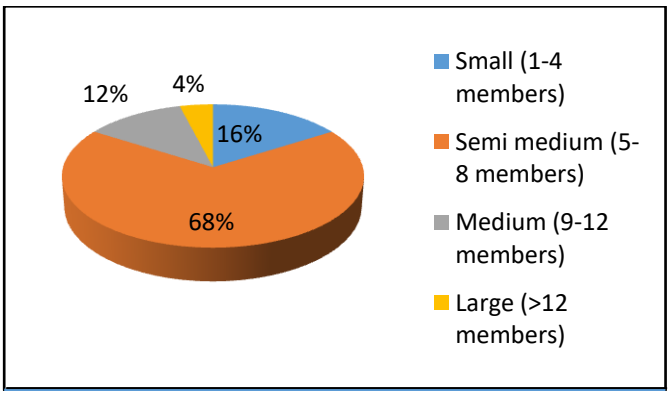

Fig.12: Family size of the regions' farmers

Model of use of traditional agricultural equipment by farmers

A large number of farmers of the area use tools like hoe, *Hasua*, *Khurpi*, axe, *dauli etc*. About 90 % of the farmers using ox and desi plough for plowing. Most of the farmers (72 %) had a pair of bullocks and they also rented bulls to other farmers. However, some (18 %) farmers had only one bull. Families that had a native plow also had a wooden plank. About 14 % of the farmers are renting a *desi* plough with bullock at a fee of Rs 200-400 per day.

Model of use of advanced agricultural machines by the farmers

Modern advanced equipment like sprayers, cultivators, rotavators, electric motors, threshers etc. are being used by some farmers. According to the farmers, the use of tractors and power tillers has increased in the area since the last five years. They explained about the shortage of labor during the cropping season. However, out of 250 farmers, only 29 (11.60 per cent) farmers had tractors or power tillers.

Most farmers hired a tractor or power tiller with the plough. Most of the farmers (48 %) were in favor of taking a tractor for the farm on rent. The fare of tractor along with plough in this area was around 700 to 800 rupees per hour. However, only 18 (7.20 %) and 17 (6.80 %) farmers have cultivators and rotavators. About 22 % of the farmers hired rotavators to prepare the field. The rent of the rotavator in the area is around 900 to 1200 rupees per hour. More than 60 % of the farmers had a knapsack sprayer.

Irrigation pump is an important tool used by farmers; it is available with about 30 % farmers while about 9 % farmers took it on rent during the crop season. The fare for the electric pump was Rs 100 to 200 per hour. The diesel pump fare was 400 to 500 rupees per hour in which diesel charge is included. About 6 % of the farmers took a rented tractor trailer. However, only 3 % of the farmers surveyed had a trailer. Its fare is 400 to 500 rupees per trip.

Obstacles in adopting advanced agricultural implements in the region

Of the several obstacles identified by the farmers, the ones in the "most severe" category were small size of land (86 %), lack of facilities for repair and maintenance of agricultural implements (85.33 %), lack of complete holdings in one place (79.33 %) due to plateau area, and the difficulty in getting expensive farm equipment and loans from banks (78.67 %).

Then, the barriers faced by the tribal farmers in the category of severe bottleneck were listed, which according to the farmers were lack of information about new machines (27-33 %), poor economic condition (20 %) and low availability of power (19-33 %). The constraints were then listed in the less severe category, which included lack of knowledge about specific machines and unavailability of road to farms (26.67 and 18 % respectively). Problems were ranked based on the average, where the small size of the land was ranked first with a score of 3.77 out of 4.

Lack of large agricultural land at one place makes the use of agricultural machines very expensive. Non-availability of road to the field was ranked lowest (2.70) and placed in the less severe category.

Fig.13: Traditional agricultural equipment

Fig.14: Advanced agricultural machines

Suggestions for farmers to improve the situation of agricultural mechanization

Most of the farmers were in line with suggestions such as programs for skill development (95.33 %), establishment of custom hiring centers (95.33 %), agricultural mechanization fair (90.67 %) and training programs for awareness about agricultural machines (90 %). The suggestions based on the average were listed in the order of highest to least score in which the training program for skill development got an average score of 2.95 out of 3 and was placed first. Facility for easy loan repayment from the bank has been given a minimum score of 2.86.

Conclusion

Tribal farmers are still using indigenous tools and equipments as they are cheap, economical and easily available in the village. However, the use of modern equipment through custom hiring in tribal areas is increasing. Tractor cultivators (48 %) are the most commonly rented equipment among farmers. In the survey, farmers have listed small size land as the biggest barrier to the adoption of agricultural mechanization. Also, they suggested that it is very important to provide training to the farmers towards improving the mechanization situation in the villages

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