



Jul-
Sep
2023

NATIONAL SUGAR INSTITUTE KANPUR – 208017 (U.P.) INDIA



Institute was full of activities during the period with the commencement of academic session 2023-24. Teaching being at the top of agenda, other activities related to research & development and consultancy continued and no. of papers presented in various conferences, seminars and conventions. Institute staff and research fellows bringing laurels been conferred prestigious Noel Deerr Gold Medal, Bansi Dhar Gold Medal, DSTA Medal and STAI Silver Medal for their exemplary research work.

Campus recruitments give a measure of the health of the sugar industry and institute remained the first choice of sugar & distillation companies and machinery manufacturers. By September 2023, out of the total students available, more than 60% got placements in reputed companies.

The sugar season 2023-24 to commence from October 2023 and amidst reports of drought from Maharashtra and few adjoining states, the sugar production is slated to be lower this year. As regards ethanol, with the developed capacity, there is dire need to search alternate feed stocks for ensuring capacity utilization and meet blending requirements. Institute is all set for the "International Conference & Sugar Expo" being organized on 11-12th October 2023 jointly with UP Sugar Mills Association and to be attended by experts from about 12 countries. Do join us.

Looking towards meeting you during the conference. Best wishes for New Sugar Season 2023-24.

**Narendra Mohan
Director**

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ACADEMIC COUNCIL MEET:

Meeting of Academic Council of the institute was held on 5th July, 2023 under the Chairmanship of Director, NSI to discuss about changes in course structures considering New Education Policy, on reviewing structure of few courses to suit sugar industry requirements and for ensuring filling of seats.



WORKSHOP ON INTELLECTUAL PROPERTY RIGHTS:

To commemorate "**National Intellectual Property Festival**", a workshop on "**Intellectual Property Rights**" was organized at National Sugar Institute, Kanpur on 7th July, 2023. Chairman & Managing Director, National Research Development Corporation, Director, NSI, other experts from Department of Scientific & Industrial Research and Patent Office etc. addressed the delegates on importance of IPR's and commercialization of developed technologies. The workshop was attended by scientists & experts from other institutes and universities.

EXECUTIVE DEVELOPMENT PROGRAMME:

Executive Development Programme was organized by National Sugar Institute, Kanpur on virtual platform from 12th to 14th July, 2023.



Experts discussed about "**Ethics & Values in Organization**", "**Sugar Industry- Beyond Sugar**", "**Models of Ethanol Production**" and on "**Ethanol from Maize**". The programme was attended by about 150 executives including those from overseas companies.

ORIENTATION PROGRAMME:

"**Orientation Programme**" was organized for the new entrants admitted during academic session 2023-24 at National Sugar Institute, Kanpur on 8th August 2023.



The programme was graced by Shri Alok Saxena, Executive Director, M/s Gobind Sugar Mills, Aira, Lakhimpur Kheri. Director NSI, Education In-charge, Controller of Examination & Hostel Wardens addressed and briefed the

students about hostel rules, academic calendar and discipline to be followed.

EXPERT LECTURES & INTRACTIVE SESSION:

a. Expert lectures for the benefit of students of Sugar Technology ANSI (ST) and Alcohol Technology (DIFAT) were delivered by two alumni of National Sugar Institute, Kanpur who have made their marks in the sugar industry, Mr. Amit Negi, General Manager (Production) and Mr. Narendra Rawat, Manager Distillery, M/s. Dalmia Bharat Sugar & Ind. Ltd., Unit – Nigohi, District – Shahjahanpur, U.P. at the institute on 9th August 2023.



The marathon sessions, each of about two hours duration provided valuable

insights to the students about sugar & ethanol production.

- b. Mr. K Jagadeesh, Sugar Technologist delivered lecture at National Sugar Institute, Kanpur on 11th August 2023. He conducted two sessions of almost five hours for the benefit of Sugar Technology students on the topics related to "**Good Laboratory Practices**" and "**Chemical & Quality Control**".



- c. National Sugar Institute, Kanpur organized an interactive session conducted by Dr. (Mrs.) Divya Chaudhary, Director, Jagran Institute of Management.



She addressed final year students of various courses at the institute on 24th

August 2023 on "**Personality Development**" & "**How to Prepare for Interviews**".



WORLD BIOFUEL DAY:

"**World Biofuel Day**" was celebrated at National Sugar Institute, Kanpur on 10th August 2023.



Various technical aspects of production of bio-energy from various sources available in the sugar industry were also discussed. Faculty members also discussed opportunities and challenges in production of CBG from press mud and other agro-waste. Economics of various models of bio-energy production in sugar industry was also discussed.

NATIONAL NUTRITION WEEK:

National Sugar Institute, Kanpur celebrated **“National Nutrition Week”**, during which a Cooking Competition on the theme **“Eat Right, Be Bright”** was organised by the Cultural Society of National Sugar Institute, Kanpur on 2nd September 2023. Students and research scholars exhibited their cooking skills in preparing millets and sweeteners based dishes. Dr. Seema Jaiswal & Ms. Kanak Gupta, Nutritionist acted as judges & distributed prizes.



RESEARCH WORK:

1. Studies on Sweet Sorghum Bagasse (SSB) value addition: The experiment related to fractionation of individual

component of the SSB (cellulose, hemicellulose, lignin) and analysis of CMF has been attempted. Along with the experimental work, literature survey related to CMF (SSB) was also been carried out. The purification of 5-Chloromethyl furfural (CMF) synthesized from sweet sorghum bagasse derived cellulose has been completed and the isolated yields using toluene is about 15% & with chloroform as 35%.

2. Cane juice syrup study for shelf-life and production of alcohol: Syrup Samples were collected from three different factories i.e; M/s Dalmia Bharat Sugar & Ind. Ltd., Unit – Jawaharpur, M/s Dalmia Bharat Sugar & Ind. Ltd. Unit - Nigohi, & M/s DCM Shriram Ind. Ltd., Unit – Ajbapur. After recording initial parameters like °brix, pol, purity, TRS etc. the samples were kept at room temperature to assess the shelf life of the syrup. It was observed that after six month of storage, the results obtained indicate hardly one unit TRS drop in samples with higher brix (75.3^o & 73.2^o initially recorded) and drop of almost 4 unit TRS in both the samples with lower °brix 71^o & 65^o (initially recorded).

3. Comparative study on polarization by using lead, non-lead, clarificants and NIR polarimetry: The study involved measuring polarization at 589 nm & 880 nm wavelength using both lead & Carrez reagents. While using the Carrez reagent at 880 nm for three samples of B heavy, an average decrease of 0.38 unit in pol % & 3.44

units in purity was observed. However, at 589 nm the polarization was not within the acceptable range in case of using Carrez reagent. Additionally, the colour (IU) of B heavy molasses was also analyzed after using both clarificants. The colour reduction in three samples was significantly higher i.e. 67.03% in case of using lead sub acetate, however colour reduction was only 23.88% while clarification was done by Carrez reagent. Data compilation related to study on polarization by using lead & non-lead clarificants on B-Heavy molasses from different organization is under progress. Study on cane juice samples shall be carried out in October month on availability of matured cane from farm.

4. Production of Invert syrup directly from sugarcane juice and Raw sugar:

2 batches of medium invert sugar were prepared from raw sugar (271 IU). One batch was dosed with monk fruit extract (98% pure) while the other batch was dosed with Stevia extract (99 % pure). Quarterly analysis of parameters such as Brix%, Pol%, Purity, RS%, TRS%, Color (IU) is being carried out.

The liquid sugar samples are kept at 3 different temperatures (@ 15 °C, 28 °C and 32 °C) to observe changes such as microbial growth, crystal formation etc. No specific changes are seen in the samples kept at different temperatures in five months, neither microbial growth nor any type of crystal formation is observed in the stevia sample of liquid sugar kept at 28 °C

and monk sample kept at 15 °C formed a hazy, which upon reheating disappear.



5. Shelf life study of press mud: Ten press mud samples from sugar factories situated in UP, Bihar, Haryana and Chhattisgarh were collected and stored keeping almost the environment as exists at the factory front.

10 Raw + 10 Treated sample of press mud of each factory are being analyzed for parameters, such as, pH, total solids (moisture content), ash content, total volatile solids (TVS), lignin and total convertible volatile solids (TCVS) on monthly basis. As observed that degradation (Fungal Growth) is occurring after six month of storage in both raw as well as treated press mud samples. Other observation being:

- pH of the raw press mud was observed to be in the range of 6.49 – 7.31 while that for PM stab (treated sample) was observed to be in the range of 4.72 – 6.62.
- The total solids for raw press mud and treated press mud were in the range of

88.7 – 90.2 % and 22.4 – 26.3% respectively.

- The ash content of the stored raw and treated press mud samples were in the range of 29.48 – 36.75 % and 5.22 – 8.23% respectively.

6. Shelf life study of Vitamin-A fortified sugar: Vitamin A fortified raw sugar samples (amorphous sugar) prepared by co-crystallization process and dosing vitamin A @ 15.5 – 16.8 µg/g of vitamin A per gm of sugar is being analyzed for vitamin A content on monthly basis using vitamin A analyzer to observe the reduction of vitamin A content over the storage since May 2023. The observation was indicated % reduction in vitamin A content of sugar over five months of storage to be about 27 %.

7. Comparative study of the activated bio-char from sugar cane bagasse and Sweet Sorghum bagasse in decolorization of sugar melt [Extended to Effluent]: Physical Chemistry department has already worked on decolourization of sugar melt using activated bio-char from sugar cane and Sweet Sorghum bagasse.



Now this is extended to the treatment Sugar Factory Effluent (later to the Distillery effluent also). To undertake this problem, preliminary trials have been done which have shown the reduction of COD to about ¼th to the initial value, monitoring for other parameters is going on.

8. Conversion of wastewater into Potable water through Bioremediation Technique: On the basis of the results obtained after the treatment of both effluent and the condensate, the innovative technique developed on laboratory scale proved to be efficient enough to treat condensate and effluent for getting portable quality water. The technique not only gives good quality water at the end but also ensures appreciable removal of impurities at each stage of treatment.



9. Essential Oil Extraction from Sugarcane Molasses: A trial of Hydro-distillation with different ratio is being conducted to analyse the various characteristics of the extracted essential oil. Study shall also be made

about their chemical composition and evaluation of its antioxidant and antibacterial activities.

RESEARCH PAPERS:

1. A research paper entitled **“Bio-refinery Approach for the Production of Vanillin from Sweet Sorghum Bagasse”** by Narendra Mohan, Chitra Yadav & Mamta Shukla published in Annual Convention of The South Indian Sugarcane & Sugar Technologists' Association (SISSTA).
2. A research paper entitled **“Target E20-Sustainability”** by Dr. Seema Paroha, Ashok Kumar and D Swain published in 81st Annual Convention of Sugar Technologists' Association of India (STAI).
3. A research paper entitled **“Advent of Effective Bio Additive Treatment Methodology for Preservation of B-Heavy Molasses”** by Narendra Mohan, Mr. Srikanteshwara, Anushka Akash Kanodia and Shruti Shukla published in 81st Annual Convention of Sugar Technologists' Association of India (STAI).
4. A research paper entitled **“Sweet Sorghum: A Wonder Crop”** by Shalini Kumari, Mamta Shukla, Shruti Shukla and Himanshu Mishra published in 81st Annual Convention of Sugar Technologists' Association of India (STAI).
5. A research paper entitled **“Comparative Study of Activated Biochar from Sugarcane Bagasse and Sweet Sorghum Bagasse in Decolorisation of Sugar Melt”** by Shalini Kumari, Sudhanshu Mohan and Narendra Mohan, published in 81st Annual Convention of Sugar Technologists' Association of India (STAI).
6. A research paper entitled **“Biofuel Roadmap-Role of Indian Sugar Industry”** by Narendra Mohan, published in **“Sharkara”** [APRIL-JUNE 2023, VOLUME: 55, NO. 01].
7. A research paper entitled **“A Study of B Heavy Molasses to be used as Edible Molasses”** by Narendra Mohan, Ashok Garg, V.P. Singh & M.P. Singh sent for publication in International Conference of National Sugar Institute, Kanpur during 11th - 12th October 2023.
8. A research paper entitled **“Study of Nutrition & Therapeutic Aspects of Spirulina & Basil for Production of A Nutrition & Healthier Sugar”** by Narendra Mohan & Rajesh Singh sent for publication in International Conference of National Sugar Institute, Kanpur during 11th -12th October 2023.
9. A research paper entitled **“Bioremediation based Innovative Technique for Treatment of Wastewaters from Sugar Industry”** by Neelam Chaturvedi, Sudhanshu Mohan & Narendra Mohan sent for publication in International Conference of National Sugar

Institute, Kanpur during 11th -12th October 2023.

10. A research paper entitled **“Use of Alternate Clarifying Agents for Cane Juice Clarification”** by Narendra Mohan & Mohit Kumar sent for publication in International Conference of National Sugar Institute, Kanpur during 11th -12th October 2023.

11. A research paper entitled **“Sweet Sorghum for Biofuel Production in Sub Tropical India”** by AV Umakanth, Ashok Kumar, Ananthalakshmi Ranganathan, Seema Paroha and D Swain sent for publication in International Conference of National Sugar Institute, Kanpur during 11th -12th October 2023.

MoU SIGNED:

1. National Sugar Institute, Kanpur signed MoU with CSJM University, Kanpur on 21st July 2023.



This will enable lateral entry of pass outs of Diploma in Quality Control & Environment Science course in M.Sc.

(Environment Science & Technology) II Year conducted by the University. Students thus to get Master's degree and then they can take further research programmes too.

2. National Sugar Institute, Kanpur signed MoU with M/s PT PG Rajwali, Indonesia in a ceremony organized at Surabaya, Indonesia on 24th July 2023 for providing training to the technical manpower & consultancy for efficiency enhancement and modernization of their sugar units.



CONSULTANCY:

Requests for availing consultancy services of the institute were received and also provided to various sugar factories ethanol & other allied units on various technical matters relating to diversion of B Heavy molasses/syrup, validation of ETP's, preparation of DPR's, validation of no increase in pollution loads in ethanol units upon enhancement in capacity etc.

Sr. No.	Factory Name
1	M/s Shri Sangam Sahkari Sakkare Karkhane Niyamit, Belgavi, Karnataka

2	<i>M/s Balrampur Chini Mills Ltd., Gularia, Lakhimpur, U.P.</i>
3	<i>M/s U. P. Sugar Mills Cogen Association, Lucknow, U.P.</i>
4	<i>M/s Dalmia Bharat Sugar Mills Ltd., Unit - Jawaharpur, Sitapur, U.P.</i>
5	<i>M/s Bajaj Hindustan Sugar Ltd., Unit - Budhana, Muzaffarnagar, U.P.</i>
6	<i>M/s Bajaj Hindustan Sugar Mills Ltd., Unit - Khambhar Khera, Lakhimpur Kheri, U.P.</i>
7	<i>M/s Madhuvan Sugars Pvt. Ltd., Kalaburgi, Karnataka</i>
8	<i>M/s Avadh Sugar & Engineering Ltd., Unit - Hargaon, Sitapur, U.P.</i>
9	<i>M/s Dhampur Bio-organics Limited, Unit - Meerganj, Bareilly, U.P.</i>
10	<i>M/s Dhampur Bio-organics Limited, Unit - Asmoli, Sambhal, U.P.</i>
11	<i>M/s Kisan Sahkari Chini Mills Ltd., Sneh Road, Najibabad, Bijnor, U.P.</i>
12	<i>M/s Indian Potash Limited, Distillery Unit - Muzaffarnagar, U.P.</i>
13	<i>M/s Dalmia Bharat Sugar & Industries Ltd., Distillery Unit -Nigohi, Shahjahanpur, U.P.</i>
14	<i>M/s DCM Shriram Ltd., Distillery Unit - Ajbapur, Lakhimpur, U.P.</i>
15	<i>M/s Triveni Engineering Ind. Ltd., Unit - Ramkola, Kushinagar, U.P.</i>
16	<i>UP State Sugar Corporation Ltd., Lucknow, U.P.</i>
18	<i>Sir Shadi Lal Distillery & Chemical Works, Muzaffarnagar, U.P.</i>

ANALYTICAL SERVICES:

Besides analysis of sugar & sugar house products, ethanol and effluents etc., Institute offers testing of Ethyl Alcohol based Sanitizer in its sophisticated, most modern NABL accredited analytical laboratory and other laboratories of the institute.

Testing of bagasse for determination of GCV and lime for various constituents also taken up during the period. Analytical services were rendered to following:

Sr. No.	Factory Name
1	<i>M/s Bisalpur Kisan Sahkari Chini Mills Ltd., Bisalpur, U.P.</i>
2	<i>M/s The Ganga Kisan Sahkari Chini Mills Ltd., Unit - Morna, Muzaffarnagar, U.P.</i>
3	<i>M/s Sravasti Kisan Sahkari Chini Mills Ltd., Unit - Nanpara, Bahraich, U.P.</i>
4	<i>M/s Kisan Sahkari Chini Mills Ltd., Sathiaon, Azamgarh, U.P.</i>
5	<i>M/s Triveni Engineering & Ind. Ltd., Unit - Khatauli, Muzaffarnagar, U.P.</i>
6	<i>M/s Kisan Sahkari Chini Mills Ltd., Sampurna Nagar, Lakhimpur Kheri, U.P.</i>
7	<i>M/s HPCL Biofuels Ltd., Unit - Lauria, W. Champaran, Bihar</i>
8	<i>M/s Dhampur Sugar Mills Ltd., Unit - Dhampur, Bijnor, U.P.</i>
9	<i>M/s Govind Sugar Mill, Aira Estate, Lakhimpur Kheri, U.P.</i>
10	<i>M/s H.P.C.L. Biofuels Ltd., Unit - Sugauli, Bihar</i>

11	<i>M/s White Gold Agro Products, Assam</i>
12	<i>M/s The Kisan Sahkari Chini Mills Ltd., Kaimganj, Farrukhabad, U.P.</i>
13	<i>M/s Triveni Engineering & Industries Ltd., Deoband, Saharanpur, U.P.</i>
14	<i>M/s Rudra Bilas Kisan Sahkari Chini Mills Ltd., Bilaspur, Rampur, U.P.</i>
15	<i>M/s Magadh Sugar & Energy Ltd. (Bharat Sugar Mill), Gopalganj, Bihar</i>
16	<i>M/s Gobind Sugar Mill, Aira Unit of Zuari Industries Ltd, L. Kheri, U.P.</i>

OUR OTHER ACTIVITIES:

1. Session on "**Sahaj Yog**" was conducted for the benefit of staff at the National Sugar Institute, Kanpur on 3rd July 2023. Such sessions to be conducted regularly now for staff and students regularly as measure for stress relieving to lead a peaceful and meaningful life.



2. Team led by Director, NSI, Kanpur visited a Sugar Unit -PT PG Rajwali, Malang, Indonesia to advice on reducing sugar

losses during processing, energy conservation and quality control on 25th July 2023.



3. Students of M.Sc. (Food Technology), Central Food Toxological Research Institute, Mysuru visited the National Sugar Institute, Kanpur to get insight of sugar production and quality. Theory & practical classes were conducted for them besides giving exposure about unit operation in Experimental Sugar Factory.



4. Officials of M/s Dhampur Sugar Mills Ltd., Mr. Anant Pandey, Chief Executive Officer and Mr. Ishaan Goel, General Manager, visited the National Sugar Institute, Kanpur on 3rd August 2023, to discuss modalities for

technology transfer for producing value-added products from by-products of the sugar industry.



5. Named after one of the Ex-Director of the institute and a renowned Sugar Engineer, Late N. R. Khariawala, Indoor Sports Complex inaugurated by Prof. Narendra Mohan Director, NSI, Kanpur on 6th August, 2023 after renovation. It has facilities for gymnasium and other indoor sports including badminton and table tennis.



6. National Sugar Institute, Kanpur celebrated 77th Independence Day on 15th August 2023. The Council of Students Activities organized a colourful cultural programme showcasing Indian traditional dances, patriotic songs and variety of other events performed by the students.

Tiranga Yatra also organized on the eve of the Independence Day at National Sugar Institute, Kanpur.



7. राष्ट्रीय शर्करा संस्थान में "शिक्षक दिवस" समारोह, का आयोजन दिनांक 5 सितम्बर 2023 को किया गया।



समारोह में संस्थान के छात्रों की वैज्ञानिक समिति के उपाध्यक्ष ने संस्थान के शिक्षकों के प्रति अपना आभार व्यक्त करते हुए उनसे जीवनपर्यंत पथ-प्रदर्शक की छात्रों की क्रिया-कलाप परिषद द्वारा इस अवसर पर जहाँ संस्थान के वरिष्ठ शिक्षकों का सम्मान किया गया वहीं छात्र और शिक्षकों के बीच में बेहतर समन्वय स्थापित करने हेतु कई प्रतियोगितायें भी आयोजित की गयीं।

8. Director National Sugar Institute, Kanpur along-with team of NSI conferred Noel Deerr Gold Medal, Bansi Dhar Gold Medal and STAI Silver Medal by Secretary (F&PD) for developing innovative process techniques and value added products from waste of sugar industry during the Annual Convention of STAI held on 6th-8th September 2023 at Travancore International Convention Centre, Kerala.



9. Director and other scientists of ICAR-Indian Institute of Sugarcane Research, Lucknow visited National Sugar Institute, Kanpur on 13th September 2023 and discussed about, working jointly on developing low cost technology for producing 2G ethanol from bagasse and other crop residues.



10. राष्ट्रीय शर्करा संस्थान में “विश्वकर्मा पूजा” का दिनांक 17 सितम्बर 2023 को आयोजन सोल्लास संपन्न हुआ। इस अवसर पर दुनिया के पहले शिल्पकार एवं वास्तुकार को नमन किया गया। संस्थान के निदेशक एवं अन्य कर्मियों और छात्र-छात्राओं ने इस अवसर हवन एवं भगवान् विश्वकर्मा की आरती समारोह में भाग लिया गया।



11. Director, National Sugar Institute, Kanpur felicitated at the Conference on Integrated Strategy for Green Renewable Energy held at Pune by Shri Sharad Pawar, Hon'ble Member of Parliament in the presence of Shri Dinesh Jagdale, Joint Secretary, Ministry of New & Renewable Energy, Government of India on 18th September 2023 for his exemplary work on developing green energy from sugar industry.



12. During the first phase of campus recruitment drive conducted by the institute, 90 students got employment in reputed machinery manufacturing, sugar and alcohol companies. Reputed organizations like Balrampur Chini Mills Ltd., Mawana Sugar Works, EID Parry Ltd, Wave Sugar Industries Ltd, ISGEC Ltd, Chandigarh Distillers and Bottlers Ltd, Magadh Sugar and Energy Ltd and ADS Spirit etc. recruited the students from various streams.



13. Prof. Narendra Mohan, Director NSI, Kanpur conferred **“Technical Excellence Award”** while Mr Anup Kanaujia, Assistant Professor got second best paper prize during the Annual Convention of Deccan Sugar

Technologists Association held at Pune on 24th September 2023.



14. Director NSI, Kanpur visited M/s Pagnism Innovations Pvt. Ltd., Sangli on 26th September 2023 and saw the encouraging results achieved during initial pilot plant scale trials for producing green hydrogen from compressed bio-gas. National Sugar Institute to work further with M/s Pagnism Innovations Pvt. Ltd., for production of green hydrogen in sugar factories.



15. Blood donation camp was organized at the National Sugar Institute, Kanpur on 27th September 2023. Officer, staff and students were participated in the camp and 38 units blood was donated.



16. सरकारी कामकाज में हिंदी को बढ़ावा देने के उद्देश्य से दिनांक 14 सितंबर से 28 सितंबर 2023 तक हिंदी पखवाड़े का आयोजन किया गया। जिसका समापन समारोह दिनांक 29 सितम्बर 2023 को संपन्न हुआ। हिंदी टिप्पण आलेखन, हिंदी आशुलिपि, हिंदी टंकण, हिंदी निबंध, हिंदी व्याख्यान इत्यादि हेतु पुरस्कार प्रदान किए गए।



17. राष्ट्रीय शर्करा संस्थान, कानपुर में 15 सितम्बर से 02 अक्टूबर तक स्वच्छता पखवाड़ा मनाया गया, इसी के उपलक्ष्य में संस्थान ने कई प्राथमिक विद्यालयों, बाजारों, घनी वस्तियों, एवं अन्य स्थानों पर स्वच्छता गतिविधियों को लेकर व् स्पेशल कैंपेन 3.0 लांच किया गया एवं स्वच्छता व् पर्यावरण संरक्षण के प्रति जागरूक किया गया।

18. Swachhata oath administered to staff and students at the National Sugar Institute, Kanpur on 26th September 2023. Thereafter, the staff

and students launched a campaign to educate people about importance of Swachhata, particularly, personal hygiene.



Distribution of cotton bags was also made in the areas of high footfalls to create awareness about plastic pollution.