



संशोधनेन संवृद्धिः

# Vasantdada Sugar Institute



46<sup>th</sup>  
ANNUAL REPORT  
2021-22



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ISO 9001:2015 Certified

## Vasantdada Sugar Institute

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## FOREWORD



The global sugar (raw value) output in 2021-22 season was 184.04 million tonnes as compared to previous season's production of 180.20 million tonnes. The stock to consumption ratio of sugar remained at 37.45%. During season, average raw sugar prices decreased from US\$ 432.54 (October 2021) to US\$ 414.46 per tonne (August 2022). But price of white sugar increased from US\$ 510.33 (October 2021) to US\$ 530.65 per tonne (August 2022).

Present indications are that global sugar production in forthcoming 2022-23 season will be 189.08 million tonnes with rise of 2.04 million tonnes over 2021-22 season. The rise in global output is entirely due to expected increase of sugar in Brazil, China & Thailand and strong increase in India.

The Indian sugar industry is having a huge opening stock of sugar of 8.39 million tonnes for the season 2021-22 and the production was 35.96 million tonnes (white value) which was 15.43% more than the last season mainly because of increase in sugar production in major states viz. Karnataka (34.38%), Maharashtra (28.00%), Tamil Nadu & Madhya Pradesh (23.60% each), Punjab (18.45%) and Gujarat (14.29%). It is expected that sugar production will decline by 3.50 million tonnes due to more diversion of B-heavy molasses and sugarcane juice for ethanol production. The country will move with carry forward sugar stocks of around 6.14 million tonnes.

Maharashtra produced 13.72 million tonnes (white value) of sugar during 2021-22 which was more by 28.95% as compared to the previous season (10.64 million tonnes). In the forthcoming season 2022-23, it is expected that state will produce 13.80 million tonnes of sugar. There will be a bumper sugarcane crop due to fairly good monsoon in last two years and sugarcane

area is expected to increase from 1.36 to 1.48 million ha (8.08%).

The Central Government has allocated mill-wise Maximum Admissible Export Quantity (MAEQ) of sugar for export to improve the liquidity position of sugar mills and to clear cane price dues of cane growers. The sugar mills in the country exported around 10.00 million tonnes till the end of August 2022 and exports are likely to touch 11.20 million tonnes. The quantitative restriction of 10 million tonnes on sugar exports has been recently relaxed by the government and allowed shipments of an additional 1.20 million tonnes in the current marketing year ending September. This has helped in improving liquidity of sugar mills by Rs 36,600 crore. This will enable mills to clear cane price dues of farmers which stood at around Rs 9,700 crore as on August 4, 2022.

I have been always of the view that, sugar mill, apart from producing only sugar, should bring about diversification in products and transform itself in to a complex producing by-products such as ethanol, bagasse based co-generation etc. Now, it has become a reality that industry is contributing substantially by producing value added products. The production of co-products like ethanol or alcohol does pose an issue of environmental concern. However, each mill has to address management of environmental problems in the context of overall sustainable development.

The Central Government has fixed target of 10% blending of fuel ethanol with petrol by 2021-22 and the country has achieved this target in May 2022, six months ahead of schedule. The Government has advanced the target of 20% blending from 2030 to 2025-26 which reduces dependence on crude oil. To meet this target, ethanol production capacity will have to be increased from 849 crore litres to 1,000 crore litres in 2025-26. There is a need to augment production capacity with sugar mills as well as necessary infrastructure and storage with Oil Marketing Companies (OMC).

Blending will provide an opportunity for the sugar industry to improve its financial status. However, it is also necessary to start thinking of what can be beyond ethanol, sugar and co-generation for the sugar sector. Fortunately, the sugar industry also generates plenty of biomass/wastes in the form of pressmud cake (PMC),

sugarcane bagasse (SCB), sugarcane trash (SCT), spent wash (SW) etc. It is desirable that each and every part of sugarcane as well as the wastes generated are valorized effectively.

Considering the valorization potential of SCB, co-generation is not the best option under the changing scenario of availability of low cost electricity from alternate sources. SCB and SCT can be valorized to form several value added products such as 2G bio-butanol, sustainable aviation fuels (SAF). CBG and chemicals such as lactic acid, succinic acid, gluconic acid, xylitol, lignin derivatives, potash based fertilizers etc. through a bio-refinery approach which can play an important role in county's energy requirement in future. VSI has completed a vWa project with Indian and UK partners with an aim to develop different value added products through biomass/wastes valorization from sugar industry.

The sugar industry has a potential to produce 0.375 million tonnes of CBG per annum with revenue of Rs.17000 million per annum.

On VSI front, Institute has acquired 51.33 ha land in Patharwala village, Tal. Ambad, Dist. Jalna. This land was fallow for more than five decades. The clearing of vegetative growth, leveling of land and layout of plots for sugarcane trials and cultivation has been completed. The water pipeline from river Godavari is being laid and will be completed. The development of main & internal roads and work of barbed wire compound are under progress. Since, this center will cater to the needs of sugarcane growers and sugar mills in Marathwada and Khandesh region, a complex has been planned to cover training & residential facilities, seminar halls, construction of laboratories, quality control facilities and production centers for different products. It is expected that this center will be self sufficient and function as an independent unit of the Institute for this region.

It has been also decided that Vidarbha region should have an independent center having all the facilities of research, training, extension and supply of inputs such as seed and agri-inputs. The Institute has been trying to identify a suitable land to establish such center for a pretty long time. The Vidarbha region, after the completion of Gosi Khurd irrigation project, 2.5 ha land will be irrigated and there is a tremendous potential for

cane cultivation. Sugarcane will be the right alternative for farmer growing crops like paddy, cotton or soyabean. The sugar mills in operation at present, will also be benefited. The search for the land is underway and it is expected that the activities of the development of this center will be undertaken immediately once the land is acquired.

The Institute is playing a proactive role in integrated nutrient and integrated disease & pest management through applications of Institute's liquid bio-fertilizers and bio-agents controlling different diseases & pests and maintaining soil and plant health.

The single row tractor drawn sugarcane planter developed by VSI in collaboration with M/s Rohit Krishi Industries, Pune was commercialized. The planter is useful for sugarcane planting at a distance of 5' and saves 50% cost on sugarcane planting as compared to manual planting.

The project was initiated to develop indigenous sugarbeet seeds by VSI in collaboration with USDA-ARS with aim to reduce the dependency on European countries for seed material. Ten sugarbeet lines received from USDA-ARS grown under controlled condition as per the standard protocol and guidance provided from USDA-ARS scientist. The Institute succeeded in seed production under control conditions and harvested sizable quantity of true seeds from different lines.

The Institute has time and again demonstrated tireless efforts and exemplary dedication of scientists and employees. I take this opportunity to place on record my deep sense of appreciation for the hard and sincere work put in by the staff of the Institute under the leadership of Director General in the service of sugar industry. I am confident that the staff of the Institute will continue their efforts to achieve excellence in various fields and render excellent services to sugar and by-product industries to maximize production with lower inputs. I sincerely thank my colleagues on the Board of Trustees and also the members of the Governing Council for their unstinted support and keen interest in the Institute's activities.



**Sharad Pawar**  
President





## VICE-PRESIDENT PERCEIVES



The sugarcane cultivation is very important from farmer's point of view. Sugarcane is perennial crop requires sustainable irrigation. The farmers give first preference for sugarcane cultivation as sugarcane has direct and assured market and cultivation of sugarcane has brought about financial stability in farming community. Therefore, with an assured source of irrigation, farmers give first preference to sugarcane.

The last crushing season was entirely different because of favourable environment for sugar exports and Government of India's proactive policy of Ethanol Blending Program (EBP) and financial position of the sugar industry became sound.

Taking into consideration the import of crude in 2021, the Government of India spent 55 billion dollars for 77% of the requirement of the crude oil. The Government decided to reduce import by 10% in the current year and planed to achieve EBP 20% by 2025. This program provides a huge opportunity for sugar sector to explore a new avenue for economic security. The present system of using C-molasses will be no longer relevant for production of ethanol. Now industry has demonstrated that ethanol from B-Heavy is more profitable and a sizable quantity of sugar can be diverted for ethanol, moreover, use of syrup is an added advantage.

The present capacity of all the distilleries is 7000 million liters of which, around 80% is used for production of ethanol. In order to produce 12,000 million liters alcohol in 2025, the distillery production capacity should be around 15,000 million liters. India will have to follow Brazilian model where capacity of distilleries is much more and diversification of sugar production to ethanol production is very easy. The banks need to give sufficient credit and oil producing companies need to enter into a long term agreement to ensure stability in the production. The success of EBP

will make sure diversification of sugar to ethanol, reduce undesirable sugar stock, reduce the inventory and help ensure payment to cane growers.

Based on three pillars of sustainability, namely economic, environment, and social aspects, waste generated from sugarcane and processing, can be gainfully utilized through reuse, recycling or remanufacturing for development of products to strengthen financial stability.

In addition to ethanol, renewable energy sources like hydrogen will play important role in country's energy requirement in future. Hydrogen is one of the clean fuel options for reducing motor vehicle emissions. Hydrogen has a strategic importance in the pursuit of a low-emission, cleaner and more sustainable energy system. India consumes about six million tonnes of hydrogen every year for the production of ammonia and methanol in industrial sectors, including fertilisers and refineries. This could increase to 28 million tonnes by 2050, principally due to the rising demand from the industry, but also due to the expansion of transport and power sectors. GoI announced a "National Hydrogen Mission to make India a Global Hub for Green Hydrogen Production on August 15, 2021. Under the Paris Climate Agreement, India pledged to reduce the emission intensity by 33-35% from 2005 to 2030 to reduce import dependency on fossil fuels. As India's hydrogen demand will increase five-fold by 2050, India has set target of 80% green hydrogen production with respect to its total demand to reduce carbon emission. Sugar industry has excess of power/electricity generated after captive consumption. Excess electricity is sold to grid and day by day tariff for electricity is going down. Sugar industry is looking for economically viable alternative like hydrogen production using water electrolysis with electricity. Bagasse (carbon neutral energy source) can be also used for hydrogen production using gasification. In addition, bagasse, press mud cake and spent wash can be used for biogas (60-65 % methane) production using anaerobic digestion. I am of the view that sugar industry must explore this opportunity.

**Dilip Walse-Patil**  
Vice-President

## FROM THE DESK OF DIRECTOR GENERAL



It is my privilege to present this 46<sup>th</sup> annual report of the Institute for 2021-22. In this year, in spite of Covid-19 Pandemic, which put number of restrictions on various activities but with pride and great satisfaction, Institute succeeded in its achievements and support to the industry.

The present annual report is covering major activities towards accomplishing the goals set by the founders of the organization.

I will be failing in my duty, if I do not specifically refer to the efforts of the staff in visiting the sugar mills, attending to research projects and trials in spite of impact of the pandemic. During the entire period under report, both technical and non-technical staff worked tirelessly. The performance of the entire VSI community during this crucial period deserves appreciation. All the departments and for that matter all the activities pertaining to research, teaching, training, visitations and manufacturing of production were uninterrupted.

In its pursuit of research, development and education, the Institute continues to contribute to the growth of sugar industry. A concise summary of the major activities carried out in various departments is detailed below.

The variety VSI 12121 (VSI 08005) has been included in The Gazette of India, Part II, Section 3, Sub-section (ii), No. 2775 dated 28<sup>th</sup> July, 2021 (CG-DL-E 28072021-228539). The proposal of this variety was also submitted to the Protection of Plant Varieties and farmers' Rights Act, New Delhi for registration. Presently, due to characteristics like high yield, high sugar, and high fiber which protects crop from damage

by wild bore. This variety gives about 15-20% higher cane and sugar yield than Co 86032 and CoM 0265 and occupies nearly 80% area in the North-East zone of Maharashtra. A midlate maturing, high cane yielding, high sugared and erect growing promising genotype CoVSI 18121 was newly developed from Co 86032 and CoT 8201. The multilocation trials at selected locations indicate that it will be possible to release this genotype for commercial cultivation in near future.

Institute's Molecular Biology & Genetic Engineering laboratory was recognized as Accredited Test Laboratory (ATL) under National Certification System for Tissue Culture raised Plants (NCS-TCS) project by the Dept. of Biotechnology, New Delhi, for testing and certification of tissue cultured plants produced by commercial tissue culture units in India. It is one of the five laboratories in India.

A project on optimisation of dose of multinutrient liquid fertilizer using drone technology, effect of nanosilica on growth, yield and quality of sugarcane was undertaken. The Institute is supplying multimacronutrient, micronutrient and VSI-Humic for sustainable soil fertility and sugarcane productivity.

The Institute is playing an important role in integrated nutrient management & integrated disease & pest management through applications of VSI's liquid bio-fertilizers & liquid bio-control agents to increase the yield of sugarcane, controlling different diseases & pests and maintaining the soil health and plant health. The technology for Entomopathogenic Nematodes for control of white grubs is transferred to the farmers field. The different trade names and organic certification for all liquid bio-fertilizers & bio-control agents were received.

The single row tractor drawn sugarcane planter developed by VSI in collaboration with M/s Rohit Krishi Industries, Pune was commercialized. The planter is useful for sugarcane planting at a distance of 5' and saves 50% cost on sugarcane planting as compared to manual planting.

The newly created sprinkler pipe testing facility of the laboratory has been accredited by NABL along with existing drip material testing facility.



The project was initiated to develop indigenous sugarbeet seeds by VSI in collaboration with USDA-ARS with aim to reduce the dependency on European countries for seed material. Ten sugarbeet lines received from USDA-ARS grown under controlled condition as per the standard protocol and guidance provided from USDA-ARS scientist. The Institute succeeded in seed production under control conditions and harvested sizable quantity of true seeds from different lines.

Study on effect of spraying of various agro chemical combinations on their physical compatibility and crop performance were taken up with vasant urja and results revealed that, the chemicals taken under study were physically compatible with each other without any coagulation, phytotoxicity and its effect on crop performance more or less equal. Foliar application of multi macro and micronutrient along with vasant urja indicated rise in cane yield by 11% than the control.

VSI's Vasant Urja also gained popularity among the farmers for its application in different crops for sustainable productivity. Directorate of Floriculture signed MOU with VSI for extending and recommending the Vasant Urja applications in floriculture crops for enhancing quality and yield. VSI also signed MoU with National Remote Sensing Centre (NRSC), ISRO, Department of Space, Govt. of India, Hyderabad for establishment of field equipment for validation of soil moisture products.

The Institute produced 9.67 lakh virus free plantlets of different sugarcane varieties and of which, 7.63 lakh plantlets were distributed to 38 sugar mills for further production of foundation seed on 290 ha. Single eye budded settling planting technique is getting popular among farmers. In addition, single eye budded seedlings were supplied for foundation seed on 256 ha to nine sugar mills.

Under ICAR seed project training, different sugarcane cultivation technologies varietal museum, use of tissue culture in seed production chain, drip irrigation system for sugarcane farming, planting methods, inter cropping, integrated nutrient management and ratoon management were demonstrated.

In addition, sugarcane quality seed, micronutrients, bio-fertilizers were supplied to tribal farmers of Nasik district. Due to adoption of new techniques and supply of VSI inputs, their average yield was increased by 10-20 MT/ha.

The laboratories namely Sugar Technology laboratory, Drip & Sprinkler Material Testing laboratory, Environment Science laboratory and Alcohol Technology & Biofuels laboratory were having individual NABL accreditation as per IS/ISO/IEC 17025. The amalgamation of four laboratories was made and accreditation was received as Vasantdada Sugar Institute's testing laboratories (VSITL). This has benefited unification of quality management system, reduction in expenses while fulfilling key requirements of NABL system.

Most probably, 20% blending will be achieved in coming few years which will also provide opportunity for sugar industry to improve its financial status. However, it is also necessary to start thinking of what can be beyond ethanol, sugar and co-generation for the sugar sector. The use of 20% ethanol blended petrol will save sizable foreign exchange and will divert 60,000 million tonnes of sugar.

India is the fourth biggest consumer of potash after China, Brazil and USA and is a net importer. Potash recovery from incineration boiler ash will save foreign exchange.

VSI has completed a vWa project with Indian and UK partners with aim to develop different value added products through biomass/wastes valorization from sugar industry.

Hydrogen is one of the clean fuel options for reducing motor vehicle emissions. It has very special properties as a transportation fuel, including a rapid burning speed, a high effective octane number, and no toxicity or ozone-forming potential. In sugar mill, hydrogen can be produced from methane (biogas/bioCBG) and water splitting using electricity produced in Cogen unit.

The Central Pollution Control Board (CPCB) has entrusted responsibility to VSI for inspection of Grossly Polluting Industries (GPI) in Ganga and

Yamuna basin. VSI inspected 372 industries as Third Party Agency. In addition, CPCB has also assigned preparation of Adequacy Assessment Reports of distillery ETPs.

The process validation for diversion of sugarcane juice/syrup and B-heavy molasses for ethanol production as per Department of Food and Public Distribution (DFPD), Ministry of Consumer Affairs, GoI, guidelines was carried out and FRP certificates were issued to sugar mills accordingly.

Government of Madhya Pradesh assigned a project entitled “Traditional verses scientific technologies for Mahua spirit and heritage alcoholic beverages production-optimization, evaluation and training” and received funding from Government of Madhya Pradesh.

I sincerely acknowledge the unstinted support and guidance of the President Hon'ble Mr. Sharad Pawar. I place on record the support rendered by Vice-President, trustees and members of the Governing Council in carrying out the work of this Institute. I am really grateful to scientists, engineers and entire staff of VSI for their contribution and proactive role in research, education and extension activities. Without their support and trust, nothing could have been accomplished in pursuit of well-being of the farming community. I am also thankful for the support of Central Government Departments, State Government Departments, Research Organizations and Agricultural Universities to VSI.



**Shivajirao Deshmukh**  
Director General



**Mr. Md. Lutfor Rahman, Deputy High Commissioner, Bangladesh accompanied by Mr. Shaheen Chowdhury, Administrative Officer visited VSI**



## ABOUT VSI

Vasantdada Sugar Institute (VSI) formerly known as Deccan Sugar Institute, is an autonomous body which is a Registered Society registered under the Societies Registration Act, 1860 and under the Bombay Public Trusts Act, 1950. It has been set up to serve the Sugar Industry in India in general and Maharashtra in particular. Established by cane grower members of the co-operative sugar factories in Maharashtra with an active and generous support of Government of Maharashtra, it is the only organization of its kind in the world.

### Genesis

When it comes to the real crunch, what sets any scientific organization apart are cutting edge R&D, the ability to deliver to make a difference and the skill to mould opinions and to act as a catalyst of the industry. These are the qualities that are inherent in VSI.

From empowering cane growers to explore new frontiers of Science and Technology, from moulding public opinion to being a platform for all sections of the sugar industry, no organization other than VSI has done so much for the industry.

The cane growers of Maharashtra who were woefully short on education but tall on imagination and impulse established this Institute. Their vision led to the development of an organization that was to symbolise a unique partnership between sugar industry, the scientific community and the cane growers. During the span of 1950-1970, there was a rapid expansion of the Sugar Industry on the Deccan Plateau. In order to meet its ever-increasing scientific and technical needs, the co-operative sugar industry in Maharashtra took the initiative and under the able and visionary leadership of the Late Dr. Vasantdada Patil, cane grower members of co-operative sugar factories forged an alliance and through a historic decision established this organization in 1975. The Institute adopted "*Sanshodhanen Samvrudhi*" meaning prosperity through research as its motto and began work in areas relevant to sugar industry through three channels namely, R&D, Extension services and HRD.

As a natural consequence, the Institute stays ahead and keeps abreast of the latest developments in the field of Science and Technology, remains relevant to the evolving needs of the sugar industry and also stays focused to the needs of sugarcane growers.

### Objective

The objective of VSI is to achieve an all-encompassing progress of the Indian Sugar Industry through HRD, Extension services and R&D.

### Location

VSI is located at Manjari village on the eastern outskirts of Pune city on the bank of river Mula Mutha. It is 12 km and 17 km away from Pune railway station and Pune airport respectively. Pune itself is located about 1500 km southwest of Delhi and 160 km southeast of Mumbai.

### Organization

Membership of VSI is given to sugar mills and their ancillary units from Maharashtra and other States. At the end of the reporting year the Institute's membership stood at 158.

The Institute is managed by a Board of Trustees comprising 11 members headed by its President. To supervise and monitor the functioning of the Institute, a Governing Council (GC) comprising 45 members has been formed. Three smaller groups or committees of the GC members assist the GC in its overall functioning.

The Director General is the executive head of the organisation implementing the decisions of the management and assisted by various divisional heads. The Institute performs multifarious functions through inter-disciplinary groups within a divisional structure. The divisions are:

1. Agricultural Sciences and Technology
2. Sugar Technology
3. Sugar Engineering
4. Alcohol Technology & Biofuels
5. Environmental Sciences
6. Electronics and Computer
7. Instrumentation
8. Education

These are supported by administration, finance, accounts, civil engineering, statistics, art & photography and library.

A sound infrastructure set-up can alone deliver excellence in the quality of work and therefore no stone has been left unturned in ensuring that the expression world class in the best sense of the term is particularly apt to the infrastructure of VSI.

VSI has created an impressive infrastructure which includes

- An administrative building housing a well-equipped auditorium with a seating capacity of a 250 contemporary seminar hall with a seating capacity of 100, a well equipped boardroom and an amphi theatre.
- Two R&D blocks (92,000 sq.ft.) housing state-of-the-art laboratories of agriculture, sugar technology, alcohol technology, environmental sciences, electronics & computer and instrumentation.
- Laboratories of molecular biology and genetic engineering (10,000 sq.ft.) with a greenhouse (2,000 sq.ft.).
- Contemporary sugarcane tissue culture laboratory- the biggest of its kind in the country with greenhouses (16,000 sq.ft.).
- A bio-fertiliser plant (8,750 sq.ft.) with a capacity of 500 t/annum and vermi-sheds (5,800 sq.ft.).
- Pilot winery and Nano-brewery (5,400 sq.ft.) for hands on training to students and contract research.
- An engineering workshop (15,000 sq.ft.).
- Students' laboratories (69,000 sq.ft.).
- A well equipped library housing over 20,000 books and other reference materials.
- A well equipped computer centre with a LAN of 250 nodes that caters to the needs of users.
- Students' hostel and guest-house (55,000 sq.ft.) and a new hostel (37,000 sq.ft.) with excellent facilities.
- Residential accommodation (41,000 sq.ft.).
- Naigaon farm: Office (6,470 sq.ft.), quarters (5,791 sq.ft.), bio-fertilizer lab. (1,038 sq.ft.), multinutrient shed (1,438 sq.ft.), shed nets (10,330 sq.ft.).
- Vasantdada farm: office (380 sq.ft.), godown (348 sq.ft.).
- Lonarwadi farm: Office, godown, implement shed, VIP suits (4,769 sq.ft.), labour quarters (2,808 sq.ft.), threshing yard (6,366 sq.ft.), old farm pond (30,294 sq.ft.), green house (6,198 sq.ft.), farm pond (1,35,009 sq.ft.), pump house (264 sq.ft.), panel & pump room, filter room for drip system (965 sq.ft.).
- Amboli farm: Office and residence (2,474 sq.ft.), building, guest house and cantten (10,544 sq.ft.), hybridization chamber (2,329 sq.ft.), electrical panel room (344 sq.ft.), watchman quarter (240 sq.ft.), toilet block (148 sq.ft.), entrance gate (272 sq.ft.), store sheds (705 sq.ft.).
- Patharwala farm: Farm pond (1,30,000 sq.ft.)
- An all weather helipad.

VSI is the only organization in Asia and probably in the world to have such a formidable infrastructure exclusively for sugarcane and sugar research in the co-operative sector.

### Key Core Competencies

#### A. Research and Development

VSI's R&D programme aims at assessing and meeting the current as well as future needs of the sugar industry in context of prevailing socio-economic conditions of the country. In ultimate analysis, it provides qualitative and quantitative data for more efficient use in the sugar industry of men, machines and materials all of which cost money. VSI's current interests include, inter alia, development of promising sugarcane varieties through biotechnology, water-conserving irrigation systems, eco-friendly methods of crop production and crop protection, reduction in sugar losses in mills, co-generation, energy audit, pollution abatement, application of modern and sophisticated techniques in farms and in mills, appropriate software for sugar mill and by-product units, development of by-products, development of bio-fertilisers and vermi-compost for improving soil fertility and productivity.

#### B. Technical Services

- Technical consultancy in the fields of crop improvement, crop production and crop protection.
- Technical consultancy and project reports for erection of new plants, modernization, expansion of the existing units of sugar, co-generation & distilleries, up-gradation of effluent treatment plants (ETPs).
- Technical audit & performance evaluation of mills.
- Technical consultancy for increase in capacity utilization, reduction of total sugar losses, improvement of sugar quality and overall technical efficiency, conservation of steam, power & water, zero liquid discharge, optimization of process chemical dosage, logic for automation.
- Environmental clearance, compliance of clearances & consents and environmental audits.
- Analysis of sugar samples, sugarhouse products, molasses, alcohol & liquors, denaturants, process chemicals, soil, water, air, effluents, noise, wine, beer, microbial analysis of soil, liquid biofertilizers, bio-control samples, compost and vermicompost. Testing of drip irrigation materials.
- Provision for pure yeast cultures to distilleries and micro-breweries.



- Production of quality seed material, tissue culture plantlets, liquid bio-fertilizers, vermi-compost, micronutrient fertilizer and microbial cultures.
- Multiplication of bio-control agents.
- Development of VSISugarERP, a quality software solution for sugar and allied industry.
- Calibration of process & laboratory instruments and consultancy for implementation of appropriate instrumentation & automation systems in sugar, co-generation & distillery units.
- Sugar Development Fund (SDF) appraisal and monitoring

### C. Human Resource Development

VSI offers a multitude of academic programmes both short-term and long-term designed to upgrade and enhance the skills of the sugar industry personnel. These include post-graduate diploma and certificate courses in sugar technology, alcohol and fermentation technology, sugar engineering, environmental sciences and instrumentation. Several short-term training programmes are offered during off-season, which aim at improving the competence of managers, technologists, workers and farmers. Special need-based programmes are conducted at the request of clients. Over 6800 professionals from India and abroad have so far been bestowed with VSI diplomas and certificates.

VSI is recognized as Scientific and Industrial Research Organization (SIRO) by the Ministry of Science and Technology, Government of India. In addition, VSI is also recognized as a research centre for PhD studies by reputed Universities from the State viz. Savitribai Phule Pune University, Pune and Shivaji University, Kolhapur. The Institute also conducts two masters degree courses affiliated to the Savitribai Phule Pune University viz. MSc (Environmental Sciences) and MSc (Wine, Brewing & Alcohol Technology).

### Achievements

With 46 years of presence in the field, VSI has come out with a large number of research papers, completed several projects, developed diagnostic and control systems, brought about process optimisation and obtained patents. Notable among its innovations are automatic drip irrigation system for cane, vermi-compost from municipal and farm waste, biofertilisers, biological control of pests and diseases, elite cane varieties through tissue culture, microprocessor-based pH control, online estimation of brix using nucleonic

density meter, automatic estimation of moisture in bagasse, juice flow stabilization, development of Sugar ERP Software, a complete and quality software solution for sugar and allied industries and other software, alcometer, chemical fastest kits, reduction in sugar losses, improvement in the quality of sugar during processing, improvement in capacity utilisation and optimisation of energy consumption in factories and development of by-products e.g. oxalic acid and sucrose ester.

### Realities

- VSI is the largest R&D organization in India concentrating exclusively on sugarcane agriculture and sugar industry.
- Government of India recognizes VSI as a centre of excellence in sugar research.
- VSI is recognized as a centre for undertaking research leading to PhD degrees of various universities.
- Accreditation of four VSI laboratories by the National Accreditation Board for Testing and Calibrating Laboratories (NABL) as also their recognition by the Bureau of Indian Standards has bestowed upon the Institute a statutory acknowledgement of its technical competence. Biotech Consortium India Limited & Department of Biotechnology, Govt. of India has recognized VSI as Accredited Test Laboratory (ATL) under National Certification System for Tissue Culture raised Plants (NCS-TCP) for virus indexing and genetic fidelity testing.
- Maharashtra Energy Development Agency (MEDA) recognizes VSI as Energy Auditing Centre for co-generation projects.
- Many sugar mills, distilleries and government bodies actively seek personnel from VSI.
- VSI is also being noticed worldwide with many high profile visits by scientists, technologists and other eminent people from all over the world.

An existence after 1975, VSI stands tall today. It has moved from strength to strength over the years and has emerged stronger tackling many challenges. In this way, the Institute has withstood the test of time and continues to operate on principles on which it was established. VSI has, thus, carved a niche for itself in the world when it comes to sugarcane research. VSI is now poised to be an ever-important player in the Indian Sugar Industry in years to come.

## BOARD OF TRUSTEES

1)	<b>Mr. Sharad G. Pawar</b> Former Minister for Agriculture and Food Processing Industries, Govt. of India	<b>Chairman</b>
2)	<b>Mr. Dilip Walse-Patil</b> Minister for Home Affairs, Govt. of Maharashtra	<b>Member</b>
3)	<b>Mr. Shankarrao G. Kolhe</b> (Upto 16/03/2022) Founder Chairman, Sahakar Maharshi Shankarrao Kolhe SSK Ltd.	<b>Member</b>
4)	<b>Mr. Ajit A. Pawar</b> Deputy Chief Minister, Govt. of Maharashtra	<b>Member</b>
5)	<b>Mr. Vijaysinh S. Mohite-Patil</b> Former Deputy Chief Minister, Govt. of Maharashtra	<b>Member</b>
6)	<b>Mr. Jayant R. Patil</b> Minister for Water Resources & Command Area Development, Govt. of Maharashtra	<b>Member</b>
7)	<b>Mr. Balasaheb B. Thorat</b> Minister for Revenue, Govt. of Maharashtra	<b>Member</b>
8)	<b>Dr. Indrajit Y. Mohite</b> Former Chairman, Yashwantrao Mohite Krishna SSK Ltd.	<b>Member</b>
9)	<b>Mr. Jaiprakash Dandegaonkar</b> Former Minister for Co-operation, Marketing & Textiles, Govt. of Maharashtra	<b>Member</b>
10)	<b>Mr. Vishal P. Patil</b> Chairman, Vasantdada Shetkari SSK Ltd.	<b>Member</b>
11)	<b>Mr. B. B. Thombare</b> Chairman & MD, Natural Sugar and Allied Industries Ltd.	<b>Member</b>



Governing Council meeting presided over by Mr. Sharad Pawar, Hon. President, VSI





## GOVERNING COUNCIL

1)	<b>Mr. Sharad G. Pawar</b> Former Minister for Agriculture and Food Processing Industries, Govt. of India	<b>President</b>
2)	<b>Mr. Dilip Walse-Patil</b> Minister for Home Affairs, Govt. of Maharashtra	<b>Vice-President</b>
3)	<b>Mr. Shankarrao G. Kolhe</b> (Upto 16/03/2022) Founder Chairman, Sahakar Maharshi Shankarrao Kolhe SSK Ltd.	<b>Member</b>
4)	<b>Mr. Ajit A. Pawar</b> Deputy Chief Minister, Govt. of Maharashtra	<b>Member</b>
5)	<b>Mr. Vijaysinh S. Mohite-Patil</b> Former Deputy Chief Minister, Govt. of Maharashtra	<b>Member</b>
6)	<b>Mr. Jayant R. Patil</b> Minister for Water Resources & Command Area Development, Govt. of Maharashtra	<b>Member</b>
7)	<b>Mr. Balasaheb B. Thorat</b> Minister for Revenue, Govt. of Maharashtra	<b>Member</b>
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10)	<b>Mr. Vishal P. Patil</b> Chairman, Vasantdada Shetkari SSK Ltd.	<b>Member</b>
11)	<b>Mr. B. B. Thombare</b> Chairman & MD, Natural Sugar and Allied Industries Ltd.	<b>Member</b>
12)	<b>Mr. Rajesh A. Tope</b> Minister for Public Health and Family Welfare, Govt. of Maharashtra	<b>Member</b>
13)	<b>Mr. Satej D. Patil</b> Minister of State for Home, Govt. of Maharashtra	<b>Member</b>
14)	<b>Mr. Babanrao V. Shinde</b> Chairman, Vitthalrao Shinde SSK Ltd.	<b>Member</b>
15)	<b>Mr. Ashutosh A. Kale</b> Chairman, Karmaveer Shankarrao Kale SSK Ltd.	<b>Member</b>
16)	<b>Mr. Shirishkumar S. Naik</b> Chairman, Adiwasi SSK Ltd.	<b>Member</b>
17)	<b>Mr. Rohit Pawar</b> President, Indian Sugar Mills Association, CEO, Baramati Agro Ltd., Unit-1	<b>Member</b>



संशोधनेन संवृद्धिः

## GOVERNING COUNCIL (Contd.)

18)	<b>Mr. Arun Lad</b> Chairman, Krantagrani Dr. GD Bapu Lad SSK Ltd.	<b>Member</b>
19)	<b>Mr. Harshwardhan S. Patil</b> Former Minister for Co-operation & Parliamentary Affairs, Govt. of Maharashtra	<b>Member</b>
20)	<b>Mr. Diliprao D. Deshmukh</b> Former Minister for Rehabilitation Relief Work, Sports, Youth Welfare & Protocol, Govt. of Maharashtra	<b>Member</b>
21)	<b>Mr. Kallappa B. Awade</b> Former Minister of State for Industries and Urban Development, Govt. of Maharashtra	<b>Member</b>
22)	<b>Mr. Yashwantrao K. Gadakh-Patil</b> Chairman, Mula SSK Ltd.	<b>Member</b>
23)	<b>Mr. Arvindrao J. Gore</b> Chairman, Dr. Babasaheb Ambedkar SSK Ltd.	<b>Member</b>
24)	<b>Mr. Ganpatrao S. Tidke</b> Chairman, Bhaurao Chavan SSK Ltd.	<b>Member</b>
25)	<b>Mr. Madan P. Bhosale</b> Chairman, Kisanveer Satara SSK Ltd.	<b>Member</b>
26)	<b>Mr. Narendra Murkumbi</b> Director, Ravindra Energy Ltd.	<b>Member</b>
27)	<b>Minister for Co-operation</b> , Govt. of Maharashtra	<b>Member</b>
28)	<b>President</b> , National Federation of Co-operative Sugar Factories Ltd.	<b>Member</b>
29)	<b>President</b> , Maharashtra Rajya SSK Sangh Ltd., Mumbai	<b>Member</b>
30)	<b>President</b> , National Heavy Engineering Co-operative Ltd.	<b>Member</b>
31)	<b>President</b> , Deccan Sugar Technologists' Association	<b>Member</b>
32)	<b>Vice-Chancellor</b> , Savitribai Phule Pune University, Pune	<b>Member</b>
33)	<b>Vice-President</b> , Maharashtra Council of Agriculture Education and Research	<b>Member</b>
34)	<b>Joint Secretary (Sugar)</b> Ministry of Food and Civil Supplies, Govt. of India	<b>Member</b>
35)	<b>Director</b> , National Chemical Laboratory, Pune	<b>Member</b>
36)	<b>Commissioner of Sugar</b> , Maharashtra State	<b>Member</b>
37)	<b>Commissioner of Agriculture</b> , Maharashtra State	<b>Member</b>
38)	<b>Director</b> , National Sugar Institute, Kanpur	<b>Member</b>
39)	<b>Director</b> , Technical Education, Maharashtra State	<b>Member</b>
40)	<b>Managing Director</b> , Maharashtra Rajya SSK Sangh Ltd., Mumbai	<b>Member</b>
41)	<b>Director General</b> , Vasantdada Sugar Institute	<b>Member</b>



## GOVERNING COUNCIL (Contd.)

INVITEE MEMBER	
1)	<b>Mr. Jaysinh Mohite-Patil</b> Chairman, Sahakar Maharshi Shankarrao Mohite-Patil SSK Ltd.
2)	<b>Mr. Narendra Ghule-Patil</b> Director, Lok. Marutrao Ghule Patil Dnyaneshwar SSK Ltd.
3)	<b>Adv. Ashok Pawar</b> Chairman, Raosahebada Pawar Ghodganga SSK Ltd.
4)	<b>The Managing Director</b> National Federation of Co-operative Sugar Factories Ltd.



**Mr. Sharad Pawar, Hon. President of VSI releases Annual Publication during AGM**

**Felicitation of Mr. Venkata Ravi, Assistant Cane Commissioner Bodhan, by DG, VSI**



**Mr. Sharad Pawar, Hon. President of VSI released a book on 'साखर अभियांत्रिकी यंत्र आणि तंत्र' in AGM**



संशोधनेन संवृद्धिः

## COMMITTEES

SELECTION COMMITTEE	
Mr. Dilip Walse-Patil	Chairman
Mr. Shankarrao G. Kolhe (Upto 16/03/2022)	Member
Mr. Jayant R. Patil	Member
Mr. Balasaheb B. Thorat	Member
Mr. Satej D. Patil	Member
Mr. Babanrao V. Shinde	Member
Mr. Harshwardhan S. Patil	Member
Mr. Narendra Murkumbi	Member
Director General, VSI	Member
INVESTMENT COMMITTEE	
Mr. Dilip Walse-Patil	Chairman
Dr. Indrajit Y. Mohite	Member
Director General, VSI	Member
Chief Accountant, VSI	Member
TECHNICAL COMMITTEE	
Mr. Narendra Murkumbi	Chairman
Mr. Dilip Walse-Patil	Member
Mr. Shankarrao G. Kolhe (Upto 16/03/2022)	Member
Mr. Vijaysinh S. Mohite-Patil	Member
Mr. Jayant R. Patil	Member
Mr. Balasaheb B. Thorat	Member
Dr. Indrajit Y. Mohite	Member
Mr. Vishal P. Patil	Member
Mr. Rohit Pawar	Member
Mr. Diliprao D. Deshmukh	Member
Mr. Arvindrao J. Gore	Member
Mr. Ganpatrao S. Tidke	Member
Mr. Madan P. Bhosale	Member
Director General, VSI	Member
BUILDING & PURCHASE COMMITTEE	
Mr. Dilip Walse-Patil	Chairman
Mr. Ajit A. Pawar	Member
Mr. Vijaysinh S. Mohite-Patil	Member
Mr. Jaiprakash Dandegaonkar	Member
Mr. Vishal P. Patil	Member
Mr. Rajesh A. Tope	Member
Mr. Ashutosh A. Kale	Member
Mr. Shirishkumar S. Naik	Member
Mr. Kallappa B. Awade	Member
Mr. Yashwantrao K. Gadakh-Patil	Member
Mr. Arvindrao J. Gore	Member
Director General, VSI	Member



## TECHNICAL PERFORMANCE OF SUGAR MILLS IN MAHARASHTRA: SEASON 2021-22 (October 2021 to September 2022)

### Sugar production scenario

The global sugar (raw value) output in 2021-22 season was 184.04 million tonnes as compared to previous season's production of 180.20 million tonnes. The sugar production increased by 3.84 million tonnes over previous season. The stock to consumption ratio of sugar remained at 37.45%. During season, average raw sugar prices decreased from US\$ 432.54 per tonne (October 2021) to US\$ 414.46 (August 2022). Price of white sugar increased from US\$ 510.33 per tonne (October 2021) to US\$ 530.65 (August 2022).

Present indications are that global sugar production in forthcoming 2022-23 season will be 189.08 million tonnes with rise of 2.04 million tonnes over 2021-22 season. This is entirely due to expected increase of sugar in Brazil, China & Thailand and strong increase in India.

The Indian sugar industry is having a huge opening stock of sugar of 8.39 million tonnes for the season 2021-22 and the production was 35.96 million tonnes (white value) which was 15.43% more than the last season (31.10 million tonnes) mainly because of increase in sugar production in major states viz. Karnataka (34.38%), Maharashtra (28.00%), Tamil Nadu & Madhya Pradesh (23.60% each), Punjab (18.45%) and Gujarat (14.29%). It is expected that sugar production will decline by 3.50 million tonnes due to more diversion of B-heavy molasses and sugarcane juice for ethanol production. The country will move with carry forward sugar stocks of around 6.14 million tonnes.

Maharashtra produced 13.72 million tonnes (white value) of sugar during 2021-22 which was more by 28.95% as compared to the previous season (10.64 million tonnes). During the current season, 106 sugar mills in the state diverted BH molasses/cane/syrup for ethanol production by sacrificing 1.19 million tonnes of sugar. In the forthcoming season 2022-23, it is expected that state will likely produce 13.00 million tonnes of sugar by crushing of around 132.00 million tonnes of sugarcane. There will be bumper sugarcane crop due to fairly good monsoon in last two years, sugarcane area is expected to increase from 1.36 million ha to 1.47 million ha (8.08%).

### Trends of sugarcane and sugar production in major sugar producing states of India

The production of sugarcane and sugar in the country has always shown wide fluctuations. These fluctuations are due to variations in the area under sugarcane, climatic conditions, water availability during the crop growth period and most importantly, remunerative and timely payment of cane price to sugarcane growers. In addition, it depends upon number of factors such as quality seed material, incidence of diseases and pests, irrigation facilities, availability of fertilizers, ratoon management and Government's policy on sugarcane pricing. The trend of sugarcane and sugar production in major states of the country for last five seasons is given in fig. 1 and fig.2

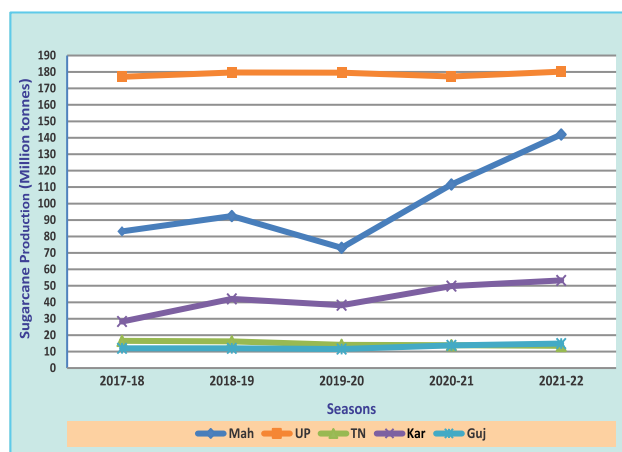


Fig.1: Trend of sugarcane production

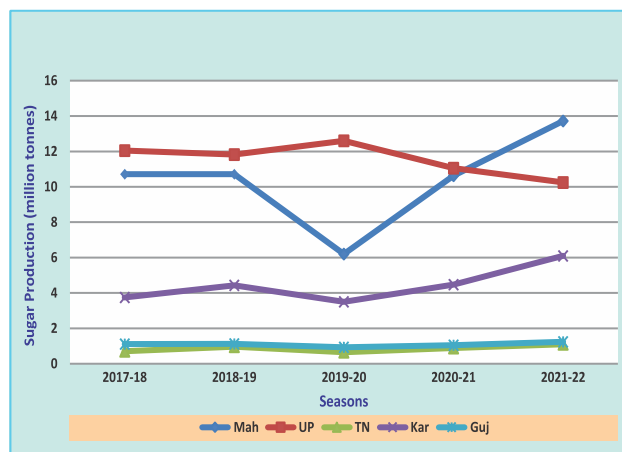


Fig.2: Trend of sugar production

### Government policies on sugar industry

- The Central Government has allocated mill-wise Maximum Admissible Export Quantity (MAEQ) of sugar for export to improve the liquidity position of sugar mills and to clear cane price dues of cane growers. The sugar mills in the country exported around 10.00 million tonnes till the end of August 2022 and exports are likely to touch 11.20 million tonnes. The Centre announced that sugar (raw, refined and white sugar) exports from June 1, 2022 would be allowed only through permits and fixed a maximum quantity of 10 million tonnes for this season (October-September). The quantitative restriction of 10 million tonnes on sugar exports has been recently relaxed by the government and allowed shipments of an additional 1.20 million tonnes in the current marketing year ending September. This has helped in improving liquidity of sugar mills by Rs 36,600 crore. This will enable mills to clear cane price dues of farmers which stood at around Rs 9,700 crore as on August 4, 2022.
- The Central Government has fixed target of 10% blending of fuel ethanol with petrol by 2021-22 and 20% by 2025-26. The country's ethanol production capacities are required to be enhanced about 1016 crore litres to achieve 20% blending by 2025. Whereas, total ethanol production capacity is at 849 crore litres. To meet this demand, the ethanol production capacity will have to be increased to 1,500 crore litres in 2025-26. There is a need to augment production capacity with sugar mills as well as necessary infrastructure and storage with Oil Marketing Companies (OMC).
- To support ethanol blending program, the Central Government had kept provision of Rs 160 crore in budget estimate for 2021-22 and Rs 300 crore for 2022-23 for extending financial assistance to sugar mills for augmentation of ethanol production capacity. This will boost setting up of more ethanol distilleries in the country. The price of ethanol from C heavy molasses route was increased from Rs. 45.69 to Rs. 46.66 per litre; B-heavy molasses from Rs. 57.61 to Rs. 59.08 per litre and sugarcane juice/sugar/sugar syrup from Rs. 62.65 to Rs. 63.45 per litre, There will be decline in production of sugar by 3.4 million tonnes because of diversion of sugarcane for ethanol.

- The Central Government has fixed the Fair and Remunerative Price (FRP) of sugarcane payable by sugar mills for sugar season 2022-23 (October-September) as under:
  - i) FRP of sugarcane at Rs 305/- per quintal for basic sugar recovery rate of 10.25%.
  - ii) A premium of Rs 3.05 per quintal for every 0.1% increase above 10.25% recovery.
  - iii) Reduction in FRP proportionately by Rs 3.05 per quintal for every 0.1% point decrease in recovery, in respect of those sugar mills whose recovery is below 10.25% but above 9.5%. However, for sugar mills having recovery 9.5% or below, FRP is fixed at Rs 282.125 per quintal.

Indian Sugar Mills Association (ISMA) urged the government to increase the minimum support price (MSP) of sugar from the current level of Rs 31 per kg to at least Rs 36-37 per kg in line with fair and remunerative price (FRP) of cane. MSP of sugar was last announced in February 2019. Since 85% of sugar mill's revenue comes from sales of sugar, it is an important component to pay the cane price to cane growers.

### Technical performance of sugar mills in Maharashtra

The technical performance of sugar mills in the state for last five seasons is given in table 1.

The contribution of the state in country's sugar production is 38.32% during 2021-22. There are 246 sugar mills in the state having installed sugarcane crushing capacity of 0.87 million tonnes per day. Of these, 134 sugar mills were in co-operative sector and 112 sugar mills in private sector. Cane crushing capacities of these sugar mills vary from 500 to 16000 TCD. During 2021-22 season, 200 sugar mills were in operation and remaining 46 could not start their crushing operation. The zone-wise technical performance of sugar mills for 2020-21 and 2021-22 seasons is given in Table 2.





### Salient features of the state for crushing season 2021-22

- The sugar production was 13.72 million tonnes by crushing 132.23 million tonnes of cane which was increased by 28.95% than that of previous season.
- The average sugar recovery was 10.38% (actual sugar bagging recovery) which is reduced as compared to previous season because of more diversion of BH molasses/cane juice/syrup for ethanol production by 106 sugar mills. The average sugar recovery sacrificed due to diversion of different feed stocks is 0.91%. Hence by adding sugar sacrificed recovery in actual bagging recovery, the average final FRP sugar recovery is 11.29% which is considered for cane payment.
- Dudhganga Vedganga SSK Ltd. and Dt. R. Kumbhar SSK Ltd. from Dist. Kolhapur recorded the highest actual sugar bagging recovery in the state (12.99% & 12.90% respectively).
- Dalmiya (Datta Asurle) Pvt, Dist. Kolhapur and Dr. Patanagrao Kadam Sonhira SSK Ltd., Dist. Sangli recorded the highest final FRP sugar recovery in the state (13.40% & 13.20% respectively).
- Total 102 sugar mills achieved sugar recovery % cane of 11 and above.
- The average pol% cane was 13.22 as slightly more than that of the previous season (13.12). Total 35 sugar mills reported pol% cane of 14 and above.
- The average crushing capacity utilization was 91.75% (with decrease of 3.57 units as compared to the previous season).
- The average RME (Mittal) was 95.21% and average RBHR (G'rao) was 84.32% and decreased by 2.02 units as compared to previous season due to diversion of different feed stocks by 106 sugar mills for ethanol production.
- Vitthalrao Shinde SSK (unit-1) and Jarandeshwar Sugar Pvt. recorded highest cane crushing (2.48 and 2.04 million tonnes) and the highest sugar production (0.235 and 0.232 million tonnes) respectively.

**Table 1: Technical performance of sugar mills in Maharashtra (2017-18 to 2021-22)**

Particulars	Season				
	2017-18	2018-19	2019-20	2020-21	2021-22
No. of installed sugar mills	241	243	244	246	246
Installed capacity ('000 TCD)	770.30	796.50	802.35	826.70	870.65
No. of sugar mills not in operation	53	48	96	55	46
No. of sugar mills in operation	188	195	147	191	200
No. of sugar mills diverted sugar for ethanol production			23	88	106
Gross days	145	130	110	142	174
Sugarcane crushed (million tonnes)	95.37	95.21	54.88	101.46	132.23
Sugar production (million tonnes)	10.72	10.72	6.20	10.64	13.72
Sugar diverted for ethanol production (million tonnes)			0.11	0.69	1.19
Capacity utilization %	95.54	99.52	89.66	95.32	91.75
Sugar recovery % cane (actual sugar bagging)	11.26	11.27	11.28	10.48	10.38
Final FRP sugar recovery% cane			11.47	11.16	11.29
Lost hrs. % to available hrs.	9.82	8.50	9.84	9.86	11.07
Pol % cane	13.21	13.35	13.42	13.12	13.22
Share of State in country's sugar production (%)	33.16	32.48	22.68	34.46	38.32

**Table 2: Zone-wise technical performance of sugar mills in Maharashtra**

Characteristics	2020-21				2021-22			
	South	Central	N- East	State	South	Central	N- East	State
No. of installed sugar mills	57	90	99	246	57	90	99	246
Installed capacity ('000 TCD)	237.50	350.05	238.30	825.85	251.000	368.10	251.5530	870.65
No. of sugar mills not in peration	5	16	34	55	7	13	26	46
No. of sugar mills in operation	52	74	65	191	50	77	73	200
No. of sugar mills diverted sugar for ethanol production	22	38	28	88	24	45	37	106
Gross days	138	144	144	142	157	179	181	176
Sugarcane crushed (million onnes)	33.07	43.77	24.62	101.46	37.08	58.57	36.58	132.236
Sugar production (million tonnes)	3.89	4.36	2.39	10.64	4.26	5.82	3.64	13.72
Sugar diverted for ethanol production (million tonnes)	0.20	0.34	0.15	0.69	0.28	0.61	0.30	1.19
Capacity utilization %	99.07	95.35	91.59	95.32	94.33	92.67	91.01	91.75
Sugar recovery % cane (actual sugar bagging)	11.75	9.96	9.71	10.48	11.50	9.94	9.94	10.38
Final FRP sugar recovery% cane	12.37	10.73	10.31	11.17	12.30	10.98	10.77	11.29
Lost hrs. % to available hrs.	6.21	9.45	13.15	9.86	6.73	9.94	14.74	11.03
Pol % cane	14.25	12.66	12.43	13.12	14.11	12.90	12.84	13.22
Fibre % cane	13.12	12.81	13.04	12.97	13.17	12.92	13.40	13.15
Sugar lost % cane	2.51	2.71	2.72	2.65	2.63	2.98	2.91	2.86
R.M.E. (Mittal)	95.64	95.07	94.85	95.15	95.65	95.19	94.92	95.21
Added water % fibre	211.67	200.30	200.92	203.63	214.94	201.12	204.13	205.63
R.B.H.R. (Gundu Rao)	87.44	85.27	86.64	86.34	85.82	83.27	84.43	84.32
R. O.E. (Mittal- Gundu Rao)	83.57	81.12	82.23	82.17	82.08	79.27	80.14	80.28
Molasses % cane	4.41	4.90	5.36	4.85	4.41	5.07	5.41	4.98



**Felicitation of Mr. Anup Kumar, Principal Secretary, Co-operation & Marketing, GoM by OSD, VSI**



**Felicitation of Mr. Shekhar Gaikwad, Commissioner of Sugar, MS by OSD, VSI**



# Services



## HUMAN RESOURCE DEVELOPMENT

To achieve the dynamic result, there is an absolute need for stable abundant human energy which could be strengthened with high competent and high technical expertise man power, which is one of the mandatory factors for sustainable growth of industry.

Highly resourceful experts from VSI are consistently striving to discover innovative scientific and technological development for upgrading modern skills, talent and potential of human resource through dynamic training modules to cater to the educational and training requirements of sugar and allied industries for their growth.

The Institute is having an outstanding infrastructure for educational learning such as each class rooms are equipped with master board and all the laboratories are equipped with highly sophisticated instruments. The Institute drafted high professional courses focusing keenly on the professional career of the students and to strengthen the industries for effective qualitative functions.

The courses conducted by the Institute are:

- Regular courses (PG Diploma, Masters Degree, Certificate Courses)
- Short term training programmes (For Sugar & Allied Industry employees)
- Summer training programmes
- Customized courses for foreign students
- Training to farmers (*Dnyanyag* and *Dnyanlaxmi*)

It is a matter of a great pride to state that the post graduate diploma courses of VSI are recognized by the Ministry of Food, Govt. of India. The genuine effectiveness and practical utility of these courses have been widely accepted and adopted by the industries. The training courses basically guide and assist the industries in many ways. Many industries treat these training courses as an essential criterion for granting promotion to higher grade to trained employees.

The Institute conducts two master degree courses namely, Environmental Sciences and Wine Brewing & Alcohol Technology affiliated to Savitribai Phule Pune University, Pune and it is the first University among Indian Universities to offer this master degree course in Wine, Brewing & Alcohol technology.

The Institute is recognized as a centre of research leading to PhD degree by Savitribai Phule Pune University, Pune and Shivaji University, Kolhapur. In

addition, the Institute is also recognized as a Scientific and Industrial Research Organization (SIRO), by the Department of Scientific and Industrial Research (DSIR), New Delhi. The recognition demonstrates the deep involvement of VSI in research field to guide sugar and allied industries.

### Regular Courses

The regular courses comprised of Post Graduate Diploma/ Certificate Courses of various duration ranging from 6 months to two & half years. The University also approved PhD in the areas of Environmental Science and Biotechnology. The list of regular courses and their duration and number of students enrolled in each courses given in the table 1. The year of commencement of courses and total number of students enrolled since inspection are given in table 2.

### Short term training programme

In addition to regular courses, VSI also offers short term courses to fulfill the specific needs of sugar mill employees to enhance their working knowledge vision to adopt new technologies and also guide the industries to perform their normal function of sugar and allied industries. The genuine effectiveness and practical utility of these courses have been widely accepted and adopted by the industries. The training courses largely guide and assist the industries in many ways. Many industries treat this training course as essential criteria for granting promotion to higher grade to trained employees.

The following STTPs are conducted every year by the Institute but due to pandemic situation, the courses except farmers' training were not conducted during the year. (Table 3)

- Boiler Attendant
- ETP Operation
- Fermentation & Distillation Techniques in distillery
- Juice Clarification & Evaporation
- Mill Foreman
- Pan Boiling & Centrifugals
- Pollution Control and Environment Management in Sugar Mill
- Repairs & Maintenance of Sugar Mill Instruments
- Special Analysis in Laboratory
- Techniques in Analytical Instrumentation
- Wet and Instrumentation Analysis in Distillery



**Table 1: Courses offered and the students enrolled**

Course Title	Duration (Years)	Number of students		
		Maharashtra	Other States	Total
<b>(I) POST GRADUATE DIPLOMA (AVSI)</b>				
Sugar Technology	2 ½	27	13	40
Industrial Fermentation & Alcohol Technology	1 ½	96	30	126
Sugar Engineering Diploma	1 ½	16	11	27
Sugar Instrumentation Technology	1 ½	01	-	01
<b>(II) MASTERS DEGREE (affiliated to Savitribai Phule Pune University, Pune)</b>				
MSc (Environmental Sciences )	2	24	--	24
MSc (Wine, Brewing and Alcohol Technology)	2	24	--	24
<b>(II) CERTIFICATE COURSES (AVSI)</b>				
Sugar Engineering	1 off season	16	05	21
Sugar Manufacturing	1 off season	59	04	63
Sugar Boiling	½	15	28	43
<b>Total</b>		<b>278</b>	<b>91</b>	<b>369</b>

**Table 2: Courses and number of students enrolled**

Programme	Year of commencement	No. of Students
Sugar Technology	1981	1659
Sugar Engineering Certificate	1981	543
Sugarcane Development	1982	132
Sugar Instrumentation Technology	1984	358
Sugar Engineering Diploma	1984	445
Industrial Fermentation & Alcohol Technology	1985	2412
Microprocessor & Computer Controlled System for sugar & allied industry	1986	52
Environmental Sciences	1992	591
Pulp and Paper Technology	1992	82
Sugar Boiling Certificate	1992	1474
Sugar Industrial Management	1992	12
Industrial Safety	1992	04
Juice Supervision Certificate	2000	155
Sugar Manufacturing Certificate	2005	631
Wine, Brewing & Alcohol Technology	2011	241
ETP Operation & Maintenance	2013	14
<b>Total</b>		<b>8803</b>

**Table 3: Short term training programmes (Farmer's training)**

Duration	Topic	No. of Participants	Details of Participants
Jul. 05 - 08, 2021	<i>Oos Sheti Dnyanyag</i>	58	Men farmers from regional areas of sugar mills in Maharashtra
Jul. 13 - 16, 2021		63	
Jul. 20 - 23, 2021		50	
Jul. 27 - 30, 2021		51	
Aug. 03 - 06, 2021	<i>Oos Sheti Dnyanlaxmi</i>	34	Women farmers from regional areas of sugar mills in Maharashtra
Aug. 10 - 13, 2021	<i>Oos Sheti Dnyanyag</i>	40	Men farmers from regional areas of sugar mills in Maharashtra
Dec. 21 - 24, 2021		101	
Dec. 28 - 31, 2021		120	
Jan. 04 - 07, 2022		119	
Feb. 22 - 25, 2022		79	
Mar. 02 - 05, 2022		86	
Mar. 08 - 11, 2022		53	
<b>Total</b>		<b>854</b>	

**Table 4: Sponsored training programmes**

Date / Period	Sponsor	No. of Participants	Details of participants
Sep. 07-08, 2021	National Food Security Mission (NFSM), Aurangabad and Latur Division	37	Officials of Agril. Department, GOM : Aurangabad and Latur Division
Sep. 13-15, 2021	Ramdeo Sugar Bankhedi, Houshangabad	44	Sugar mill officer and staff
Sep. 21-24, 2021	Chhatrapati Rajaram SSK, Kolhapur	51	Men sugarcane growers from operational area and agril. staff
Sep. 28-30, 2021	ATMA, Kolhapur	50	Progressive farmers
Dec.31, 2021 to Jan. 02, 2022	ATMA, Parbhani	50	Progressive farmers from Parbhani District
Mar. 03-05, 2022	ATMA, Beed	51	Progressive farmers from Beed District
Mar. 23-25, 2022		36	
<b>Total</b>		<b>319</b>	

### Summer training programmes

The Institute is having well equipped state of art laboratories which attract students from various reputed Institutes and colleges to join the summer training or project work. In the academic year, total 36 students were trained at the Institute for varying duration of two to six months (Table 5).

### Customized courses for foreign students

The Institute continues efforts to render service, guidance and assistance to the sugar industries of Abroad. Special attention is given to organize special courses of different durations to meet their needs, to enable higher production and to achieve desired target.

The number of foreign students passed out from the Institute since inception is given in table 6.

### Placement

The placement cell of the Institute plays an important role to extend job avenue to the students. The Institute shares the responsibility in securing job opportunities. The cell constantly develops cordial association with prominent, reputed sugar and allied industries for the placement. Representatives from esteem industries visit the Institute, organize personal interaction with students, observe their performance and select them according to their requirements. Name of the industries are given in table 7.



**Table 5: University-wise breakup of students**

Name of the University	Students
Savitribai Phule Pune University, Pune	13
Punyashlok Ahilyadevi Holkar University, Solapur	03
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli	06
Marathwada Vidyapeeth, Hingoli	03
Swami Ramanand Teerth Marathwada University, Nanded	01
IIT, Dhanbad	01
Mahatma Phule Krishi Vidyapeeth, Rahuri	08
Amity University	01
<b>Total</b>	<b>36</b>

**Table 6: Number of foreign students passed out**

Country	Students
Sudan	69
Kenya	38
Sri Lanka	20
Fiji	16
Uganda	09
Nepal	08
Ethiopia	07
Tanzania	03
Bhutan	02
<b>Total</b>	<b>172</b>

**Table 7: Organizations for the placements**

Name of organizations	
Maharashtra State	Other States
AdllersPvt Ltd.	Snj Breweries India Ltd., Andhra Pradesh
Allied Blenders and Distillers	Goa Brewing Company, Goa
Bombay Breweries Ltd .	Ganesh Khand Udyog, Gujrat
Bombay Duck Brewing Company	Copper Sugar, Gujrat
Brentaag	Gurgaon, Haryana
Brentaag, Masters Brewing Company,	Bangalore Brew Works, Karnataka
BrewcraftsMicrobrewing Pvt. Ltd.	Big Pither Brewery, Karnataka
Catalyst India Pvt Ltd.	Novozynes, Karnataka
Cerveza brewery and restaurant IIP	John Distilleries, Karnataka
Event Horizon Beverages P. Ltd.	Chamundeshari Sugar, Karnataka
Fratelli Wines P. Ltd.	Ugar Sugars, (Unit -2), Karnataka
Kimaya Brewing Company	Renuka Sugars, Karnataka
Mavana Sugars Pvt Ltd.	Gems Sugar , Karnataka
Moet Hennessy India	The Biere Club Brewpub, Karnataka
Poineer Distilleries	United Spirits Ltd., Karnataka
Radico NV Distilleries	Vijaynagar Sugar, Karnataka
Ravalgaon Sugars	Som Group of companies, Madhya Pradesh
Seagram Distilleries Ltd.	Globus Spirits, New Delhi
Smokie (Deccan Brewing Company)	Bajaj Hindustan Ltd., Uttar Pradesh
South Seas Distilleries	DSCL Sugar, Uttar Pradesh
Tilaknagar Industires Ltd.	Uttam Spirits, Uttar Pradesh
TJ Brewworks, Amnora Park	Sabmiller Breweries Pvt. Ltd., (All over India)
United Breweries Pvt. Ltd.	Carlsberg India P. Ltd., (All over India)
Wave Industries Pvt. Ltd	
Yavasura Brews IIP	

## LIBRARY

The Institute's library is knowledge resource for sugar and allied industry. It aims to fulfill the information need of users and support to achieving organizational goals. It contributes to the VSI's success as a leader in R & D by bringing together, information, knowledge, tools and systems for informed decision making for research and management.

### Services

Membership to the library is open to all VSI students, faculties, as well as researchers of various colleges, universities and sugar industry specialist from all over the India. In Covid 19 pandemic, library has enhanced the use of e-resources and fulfill the information need from online resources like open access digital library portals, E-PG Pathshala, Research Gate, STAI Database, ISSCT proceedings etc.

### Collection development

The library has made notable progress in developing library collection related to sugar and allied industries, Environmental Science, Wine Technology. Apart from these Management, Law, Economics, Statistics, Biographies, Directories, proceedings were added to the collection.

Total 31 new books and 83 journals were added to the collection and now goes massive collection of 19,271 including national and international publications. In addition, 43 periodicals are subscribed/renewed along with 320 open access e-journals collection to fulfill the current information needs of the users.

### Digitization of library resources

The library has completed the scanning and digitization work of library collection and important documents of the Institute. In the second phase, library has scanned research reports, important circulars, committees' reports, license files and rear collection of the library. In total 33,344 pages and 667 titles were added during the year in digital library database and access is given through LAN.

### Circulation Section

During the year, 334 new members were enrolled as library users. This year sample physical stock verification of books and bound volumes was done with the help of barcode system.

### Organization membership

The membership of National and International associations related to sugar and allied industries has

been renewed. This includes:

#### International

- Australian society of sugarcane Technologists (ASSCT), Australia
- International Consortium for Sugarcane Biotechnology (ICSB), Thibodaux, USA
- International Society of Sugarcane Technologists (ISSCT), Mauritius
- Sugar Industry Technologists Inc. (SIT), New York
- World Association of Beet and Cane Growers (WABCG), France

#### National

- Biotech Consortium India Ltd. (BCIL), New Delhi
- Indian Association of Special Libraries & Information centers (IASLIC) Kolkata
- Maratha Chamber of Commerce Industries and Agriculture (MCCIA), Pune
- Maharashtra Economic Development Corporation (MEDC), Mumbai
- The Sugar Technologists Association of India (STAI), New Delhi
- Society for Sugarcane Research and Development (SSRD), Coimbatore

The information received from these organizations in the form of directory, yearbooks, newsletter, journals, proceedings and souvenirs were circulated among the technical persons and scientists for reference and study. New additions to the library were communicated to the users through VSI Bulletin or a web journal of the institute. The scientists and technocrats from industry and organizations are the main beneficiaries of this activity.

#### VSI Publications

Important publications of VSI viz. *OOs Sheti Dnyanyag* (Marathi and Hindi), Technical and Financial performance of sugar mills in Maharashtra, Technical performance of member distilleries in Maharashtra, Surplus powerco-generation in sugar industry, Maintenance book of sugar engineers and new addition of "*Sakhar Abhiyantriki: Yantraani Tantra*" book are made available to the users at a discounted price. All publications were assigned International Standard Book Number (ISBN) from Raja Rammohun Roy Library Foundation (RRRLF), New Delhi.

# Agricultural Sciences and Technology



## AGRICULTURAL SCIENCES AND TECHNOLOGY

The Agricultural Sciences and Technology department is a group of divisions put together are: Crop Improvement, Crop production and Crop protection. R&D activities relevant to the organizations goals, technology transfer through various extension activities and human resources development of the persons working in sugarcane agriculture under sugar mills are some of the salient features of this department.

Development of improved sugarcane varieties suitable to different agro-climatic regions in the state through hybridization, selection of desired mutant clones and advanced tools of molecular biology & genetic engineering is the focus of the division. A promising high sugared, high yielding, drought tolerant with higher fiber sugarcane variety VSI 12121 (VSI 08005) has been released for commercial cultivation in Peninsular zone of India.

Developing best agronomical practices for enhancing sugarcane productivity and enhancing the soil fertility is taken care by Crop production division. Vasant Urja, a bio-stimulator that can be mixed with other water soluble fertilizers, insecticide and bio-fertilizers will help to reduce the operational cost and enhance the crop production. Programme on seed production of sugarbeet genotypes for tropical region in collaboration with USDA-ARS, USA is undertaken. Agronomic evaluation of different legume crops developed by BARC, Mumbai under sugarcane based cropping system was undertaken for their mass multiplication. GPS and GIS techniques have been developed for preparing the soil fertility maps and to suggest soil fertility and nutrient management practices. Application of VSI's liquid bio-fertilizers & liquid bio-control agents to increase sugarcane yield, controlling different diseases & pests and maintaining soil health and plant health in integrated nutrient, disease & pest management. Application of VSI's liquid bio-pesticide for controlling white grub as a bio-control measure is getting popular. Developed sugarcane loader to minimize the human drudgery in cane loading operation and another two models of tractor drawn sugar beet planter i.e. for sole sugar beet

crop sowing and sowing of sugar beet as inter crop. The sugarcane planter developed by VSI has been granted the patent by Controller General of patent for 20 years.

The crop protection division looks after the R&D activities related to pests and disease incidence and plant protection measures.

### RESEARCH AND DEVELOPMENT

#### CROP IMPROVEMENT

The division comprises of three sections viz., Sugarcane Breeding, Tissue Culture and Molecular Biology & Genetic Engineering.

#### SUGARCANE BREEDING

The sugarcane varieties are normally developed to suit sugar production of high cane yielding capacity with higher sugar content possessing resistance to major diseases and pests so as to help both farmers and sugar mills. High sugared varieties with higher fiber content and multi-ratooning ability will have to be produced for meeting the projected sugar and energy requirements. In Maharashtra State, the emerging varieties will play very important role which must have resistance to biotic and abiotic stresses. Hence, breeding of new sugarcane varieties possessing high cane yield and high sucrose content, adapted to the different agro climatic conditions of the state are primary objectives of the breeding programme. To fulfill these objectives, following long term research programmes are being undertaken.

- Breeding of new sugarcane varieties combining high yield and sucrose content, having resistance to biotic and abiotic factors adapted to the different agro climatic regions of the state of Maharashtra.
- All India Coordinated Research Project on Sugarcane [AICRP(S)] to develop and identify location specific varieties for peninsular zone.
- Collection of sugarcane germplasm, expansion, evaluation, characterization and their utilization in breeding program.
- Screening of genotypes for drought, flood and salinity tolerance.





## Breeding of new sugarcane varieties

### Release of varieties

#### VSI 12121 (VSI 08005)

The proposal of VSI 12121 (VSI 08005) has been accepted by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties, New Delhi and released variety for nine states viz., Maharashtra, Karnataka, Telangana, Andhra Pradesh, Tamil Nadu, Kerala, Chhattisgarh, Gujarat and Madhya Pradesh from Peninsular Zone. The name of variety VSI 08005 has been included in The Gazette of India, Part II, Section 3, Sub-section (ii), No. 2775 dated July 28, 2021 (CG-DL-E 28072021-228539). The proposal of variety VSI 08005 submitted to the Protection of Plant Varieties and Farmers' Rights Act, New Delhi for registration.

#### Elite selections from Final Varietal Trial (FVT)

Total sixteen elite clones from 2018, 2017, 2016 and 2015 batches were evaluated in FVT- I plant crop during the report year and data at 12<sup>th</sup> month of crop age is given in table 1. Out of sixteen clones, five clones viz., VSI 125-2 (TC 2513 x Co 2000-08), VSI 56-2 (Co 98006 x Co 775), VSI 65-3 (Co 0310 x Co 99002), CoVSI 7-2 (Co 99006 x Co 94008) and CoVSI 18121 (Co 86032 x CoT 8201) were found significantly superior in cane and sugar yield over the standards Co 86032 and CoC 671. However, none of the clone was found significantly superior over standards CoM 0265 and VSI 08005.

One clone tested in FVT at TK Warana SSK in two plants and one ratoon crop VSI 71-1 (Co 86002 x Co 775) (cane yield-134.68 and CCS-18.38 t/ha) from 2017 batch has shown numerically higher cane and sugar yield than the standard Co 86032 (cane yield-125.83 and CCS-17.63 t/ha). The clone VSI 71-1 showed flowering also, hence, it will be included in the germplasm at SBC, Amboli for further utilization in crossing programme.

Out of four clones which were tested in FVT- I plant (2017 batch) at SMS Kolhe SSK, none of the clone was found superior for cane and sugar yield over the standard Co 86032 (Cane yield: 148.04 t/ha; CCS: 20.35 t/ha) but two clones CoVSI 18-1 (MS 6847 x Co 92008) (cane yield-158.34 and CCS-20.10 t/ha) and VSI 72-1 (Co 97008 x Co 2000-08) (cane yield-154.08 and CCS-19.76 t/ha) has shown numerically higher cane and sugar yield over the standard.



Visit of OSD, VSI to the plot of promising genotype CoVSI 18121 at Chhatrapati Shahu SSK

**Table 1: Performance of sugarcane clones in Final Varietal Trial- I plant (2018, 2017, 2016, 2015 Batch)**

Clone	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
VSI 125-2	22.65	156.94	20.30	14.61
VSI 56-2	20.82	154.27	18.73	13.45
VSI 65-3	22.65	151.87	20.76	14.92
CoVSI 7-2	23.36	151.45	21.16	15.41
CoVSI 18121	21.92	145.81	20.83	15.02
Co 86032 (Std.)	18.04	126.85	19.77	14.23
CoM 0265 (Std.)	21.76	162.09	18.68	13.42
VSI 08005 (Std.)	23.99	154.38	21.60	15.56
VSI 434 (Std.)	19.23	119.38	22.83	16.14
MS 10001 (Std.)	19.62	130.42	20.74	15.06
CD at 5%	2.87	17.17	0.90	0.68
CV %	6.78	5.97	2.10	2.21

The two clones tested in FVT- I Plant at KA Tope Samarth SSK showed that one clone, CoVSI 2-1 (Co 86002 x Co 99006) from 2015 batch has shown numerically higher cane and sugar yield (cane yield-148.71 and CCS-21.42 t/ha) over the standard Co 86032 (cane yield-135.18 and CCS-19.17 t/ha).

#### State Level Multi-location Trial (SAU's)

State level multi-location trials were conducted at VSI, Pune; CSRS, Padegaon; RS & JRS, Kolhapur and SRS, Pravaranagar in collaboration with MPKV, Rahuri during the year. Total six trials viz., MLT-II Plant- *Adsali*, MLT-I Plant-Ratoon-*Adsali*, MLT-II Plant-Pre-season, MLT-I Plant-Ratoon-Pre-season, MLT-II Plant-*Suru* and MLT-I Plant-Ratoon-*Suru* were conducted at VSI. Total nine genotypes viz., PDN 17007, PDN 17008, PDN 17009, PDN 17010, PDN 17015, CoPDN 17013, CoPDN 16002, CoVSI 18121 and CoVSI 17121 were evaluated along with standard checks viz., Co 86032, CoM 0265, VSI 08005, CoC 671, MS 10001 and Co 09004. The results are as under-

In MLT-*Adsali*: The pooled data showed that three genotypes PDN 17009, CoVSI 18121 and PDN 17010 were found significantly superior for cane and sugar yield over the standards Co 86032, MS 10001 and Co 09004 at the age of 16<sup>th</sup> month while the genotype CoVSI 18121 found superior over the standard VSI 08005. None of the genotype was found superior over the standard CoM 0265 for cane and sugar yield (table 2a).

In MLT- Pre-season: The pooled data showed that three genotypes PDN 17009, CoVSI 18121 and PDN 17010 were found significantly superior for cane and sugar yield over standards Co 86032, CoC 671, MS 10001 and Co 09004 at the age of 14<sup>th</sup> month. None of the genotype was found superior over standards VSI 08005 and CoM 0265 for cane and sugar yield (table 2b).

In MLT- *Suru*: The pooled data showed that three genotypes PDN 17009, CoVSI 18121 and PDN 17010 were found to be significantly superior for cane and sugar yield over standards Co 86032, CoC 671, MS 10001 and Co 09004 at the age of 12<sup>th</sup> month. None of the genotype was found superior over standards VSI 08005 and CoM 0265 for cane and sugar yield (table 2c).

#### Multi-location Trials (MLTs)

The MLTs were conducted in different agro-climatic zones of Maharashtra at selected sugar mills to test the newly developed clones by VSI; CSRS, Padegaon and

promising genotypes identified under AICRP(S). A set of nine genotypes viz., CoVSI 18121, CoVSI 19121, VSI 15002, CoVSI 16002, CoVSI 17001, Co 11015, Co 12009, Co 13008, PDN 15012 along with five standards VSI 434, MS 10001, Co 86032, CoM 0265 and VSI 08005 were tested in first plant crop. The trials at fourteen locations viz. VSI, Pune; SBC, Amboli; Lonarwadi farm; Chhatrapati Shahu SSK; Jawahar Shetkari SSK; TK Warana SSK; Kisanveer SSK; SMSM Patil SSK; LMGP Dnyaneshwar SSK; Ashok SSK; SMS Kolhe SSK; KA Tope Samarth SSK; Vriddheshwar SSK and KS Kale SSK were completed.

Evaluation of clones at above locations showed that CoVSI 18121, PDN 15012, Co 12009 and Co 13008 were found promising as compared to the standards Co 86032, MS 10001 and VSI 434 in the first year trials completed. The final decision will be taken after completion of two plants and one ratoon crops.

#### Hybridization

Total 1290 clones under different groups are maintained at SBC, Amboli and evaluated for yield and quality parameters. Of these, 80.93% genotypes were flowered. The favorable climate with heavy rainfall (10520 mm) has helped the flowering during the year. Total 79 pistils and 54 pollen parents were used as parental lines in crossing program. The sugarcane germplasm included as mentioned below:

<i>Saccharum</i> species	
<i>S. officinarum</i>	52
<i>S. barberi</i>	07
<i>S.spontaneum</i>	25
<i>S.robustum</i>	05
Related genera to <i>Saccharum</i>	
<i>Erianthus</i> species	07
<i>Narenga prophyrocoma</i>	01
Interspecific Hybrids (ISH)	131
Indian Hybrids	732
Foreign Hybrids	35
Genetic stocks developed at VSI	289
Inter Generic Hybrids (IGH)	06
<b>Total</b>	<b>1290</b>

Total 903.00 gm of fluff was received from SBI, Coimbatore and 16406.96 gm of fluff was collected from SBC, Amboli during 2021-22. Details of fluff received are mentioned in table 3. The fluff will be sown in the month of June, 2022 to raise the Ground Nursery I (2022 batch).



**Table 2: Performance of sugarcane genotypes in Multi-location trials (SAU's) at VSI (Pooled over two plants and one ratoon crop)**

Genotypes	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
<b>a) MLT- <i>Adsali</i> (Crop age: 16<sup>th</sup> month)</b>				
PDN 17009	22.11	168.35	18.21	13.11
CoVSI 18121	24.62	161.82	20.96	15.16
PDN 17010	23.13	153.89	20.93	15.02
Co 86032 (Std.)	19.28	132.37	20.17	14.54
CoM 0265 (Std.)	23.95	169.45	19.52	14.11
VSI 08005 (Std.)	22.15	146.33	20.98	15.14
MS 10001 (Std.)	20.98	136.42	21.37	15.38
Co 09004 (Std.)	20.27	128.45	21.74	15.75
CD at 5 %	1.72	11.55	0.80	0.62
CV %	5.07	4.93	2.39	2.57
<b>b) MLT - Preseason (Crop age: 14<sup>th</sup> month)</b>				
PDN 17009	21.33	155.28	19.11	13.74
CoVSI 18121	22.29	149.40	20.69	14.91
PDN 17010	21.77	145.98	20.89	14.89
Co 86032 (Std.)	18.04	125.84	19.97	14.39
CoM 0265 (Std.)	22.20	160.31	19.28	13.83
VSI 08005 (Std.)	22.08	142.48	21.56	15.50
MS 10001 (Std.)	20.24	130.37	21.55	15.52
Co 09004 (Std.)	17.69	112.59	21.68	15.70
CoC 671 (Std.)	17.41	106.61	22.24	16.27
CD at 5 %	2.46	14.27	0.95	0.72
CV %	7.68	6.53	2.78	2.93
<b>c) MLT - I Plant- <i>Suru</i> (Crop age: 12<sup>th</sup> month)</b>				
PDN 17009	18.47	149.56	18.75	13.54
CoVSI 18121	20.13	146.70	20.55	14.57
PDN 17015	18.59	140.63	20.36	14.69
PDN 17010	19.07	139.73	20.73	14.95
Co 86032 (Std.)	16.24	118.94	19.58	14.23
CoM 0265 (Std.)	18.19	151.82	18.71	13.41
VSI 08005 (Std.)	18.91	135.72	20.52	14.63
MS 10001 (Std.)	17.40	124.38	20.36	14.74
Co 09004 (Std.)	17.33	109.84	21.17	15.29
CoC 671 (Std.)	16.11	111.96	21.68	15.68
CD at 5%	2.46	16.85	1.09	0.81
CV %	8.98	7.95	3.34	3.44



**Table 3: Details of fluff received**

Particulars	Number crosses / PC / GC	Quantity of fluff received (gm)
<b>A. SBI, Coimbatore</b>		
Station crosses	15	288
General collections (GC's)	21	280
<b>Total (A)</b>	<b>40</b>	<b>568</b>
<b>B. DHG, Agali</b>		
Agali crosses	05	335
<b>Total (B)</b>	<b>05</b>	<b>335</b>
<b>C. SBC, Amboli</b>		
Commercial crosses & Germplasm enhancement	647	16406.96
<b>Total (C)</b>	<b>647</b>	<b>16406.96</b>
<b>Total (A+B+C)</b>	<b>688</b>	<b>17309.93</b>

From the last year fluff received, total 10560 seedlings were transplanted in field as GN-II (2021 Batch) at VSI and Patharwala farm locations (table 4).

#### Ground Nursery (GN)-II (2020 batch)

From the GN-II (2020 batch) conducted at VSI, total 154 clones out of 9,100 clones were selected and advanced to Clonal Trial-I (2020 batch) on the basis of number of canes/clump, HR brix %, cane diameter, millable height, non-flowering, leaf clasping and natural incidence of diseases and pests, flowering behavior etc. for commercial purpose.

From the GN-II (2019 Batch) ratoon crop at VSI, total 16 clones out of 2050 seedlings were selected and advanced to Clonal Trial-I (2019 Batch). The seedlings were selected on the basis of number of millable canes

**Table 4: Details of seedlings in GN-I (2021 batch)**

Particulars	Number of crosses/ PC/GC	Total seedlings transplanted
<b>A. SBI, Coimbatore</b>		
a. Station crosses	20	528
b. Poly crosses (PC's)	05	113
c. General collections (GC's)	15	1150
<b>Total (A)</b>	<b>40</b>	<b>1791</b>
<b>B. DHG, Agali crosses</b>	05	--
<b>Total (B)</b>	<b>05</b>	<b>--</b>
<b>C. SBC, Amboli</b>		
Commercial crosses & Germplasm enhancement	653	8769
<b>Total (C)</b>	<b>653</b>	<b>8769</b>
<b>Total (A+B+C)</b>	<b>698</b>	<b>10560</b>

per clump, cane diameter (cm), non-flowering and HR brix % and ratoonability.

#### First clonal trial (2018 batch)

The Clonal Trial-I (2019 batch) was conducted. Of 52 clones, three clones CoVSI 64-4 (Co 11004 GC), VSI 101-3 (Co 8371 x Co 775) and VSI 179-65 (Co 93017 GC) were selected and forwarded to PFVT. The Clonal Trial (2018 batch) conducted at SMS Kolhe SSK, out of 11 clones, three clones CoVSI 37-12 (Co 775 x Co 62198), VSI 66-16 (Co 0310 x CoT 8201) and VSI 40-22 (Co 8371 x Co 8353) were selected and forwarded to PFVT. The clones selected on the basis of number of millable canes, sucrose %, cane diameter, millable height, flowering behavior, leaf clasping, erect growth habit and natural incidence of diseases and pests.

#### Pre-final Varietal Trial (PFVT)

Out of fourteen clones planted in PFVT (2018 batch) at Natural Sugar & Allied Industries Ltd., six clones were found significantly superior over the standards Co 86032, CoC 671 and MS 10001 for cane and sugar yield. The two clones VSI 106-2 and VSI 106-6 (97 A 44 x Co 86249) shown at par for cane and sugar yield with the standard Co 86032. All eight clones were forwarded to FVT. The data of clones at 12<sup>th</sup> month of crop age is given in the table 5.

**Table 5: Performance of clones in PFVT at Natural Sugar & Allied Industries**

Name of clone	CCS (t/ha)	Cane yield (t/ha)	Sucrose %	CCS %
CoVSI 5 -8	24.12	168.81	19.95	14.27
CoVSI 18 -5	25.23	172.09	19.98	14.64
VSI 53 -7	25.38	168.76	20.94	15.04
VSI 66 -1	26.04	169.92	21.44	15.33
VSI 81 -4	25.13	174.46	20.21	14.40
VSI 106 -2	18.56	149.68	17.31	12.39
VSI 106 -6	20.99	153.95	19.24	13.53
VSI 109 -8	23.97	166.27	20.36	14.43
<b>Standards</b>				
Co 86032	20.37	146.34	19.55	13.92
MS 10001	20.61	144.35	19.92	14.31
CoC 671	18.85	123.57	21.20	15.42
VSI 08005	22.98	157.69	20.52	14.57
CD at 5 %	3.18	19.69	1.16	0.94
CV %	6.99	6.14	2.78	3.17



PFVT (2017 batch) conducted at Bhaurao Chavan SSK showed that two clones VSI 66-29 (Co 0310 x CoT 8201) (Cane yield-179.45 t/ha; CCS-25.25 t/ha) and VSI 78-56 (CoC 90063 x Co 775) (Cane yield-164.43 t/ha; CCS-23.45 t/ha) tested were found superior for cane and sugar yield (Cane yield: 142.39 t/ha; CCS: 20.51 t/ha) over the standard Co 86032 (Cane yield-149.56 t/ha; CCS-19.74 t/ha).

### Propagation of nucleus seed of released varieties and promising genotypes

The morphologically pure seed selected for production of nucleus seed of sugarcane varieties and after MHAT treatment (MHAT at 54 oC for 2.5 hours at 95-99 % RH) was planted as the nucleus seed plots on an area of 4.911 hectare as per month-wise planting schedule provided by farm section and grown at Manjari, Vasantdada, Lonarwadi and Patharwala farms of the Institute during planting season 2020-21 is given in table 6.

The seed inspection committee of the Institute comprised of the scientists from plant breeding, entomology and pathology visited breeders' seed plots grown at Manjari, Vasantdada, Naigaon and Lonarwadi farms of the Institute and recorded the observations as per schedule. On the basis of the observations, the breeders' seed plots of varieties viz., CoC 671 (0.69 ha), Co 86032 (7.01 ha), CoM 0265 (3.76 ha), Co 92005 (0.12 ha), VSI 434 (0.10 ha), CoVSI 03102 (1.23 ha), VSI 08005 (3.83 ha), MS 10001 (0.30 ha) and CoVSI 18121 (5.45 ha) grown on an area of 22.49 ha were certified before the distribution of seed to sugar mills.

### All India Coordinated Research Project on Sugarcane [AICRP(S)]

As per the approved technical programme of AICRP(S) plant breeding under crop improvement, following four zonal varietal trials (ZVT) were conducted

- Initial varietal trial,
- Advanced varietal trial plant I,
- Advanced varietal trial plant II,
- Advanced varietal trial plant I Ratoon,

The performance of promising genotypes under AICRP (S) different trials is given in table 7.



Visit of AICRP(S) monitoring team to seedlings developed from fluff in Ground Nursery-I (2021 batch) in net shed



**Table 6: Variety-wise nucleus seed plots on the area of Institute farms**

Variety	Nucleus seed area at Institute farms (ha)					
	Manjari	Vasantdada	Naigaon	Lonarwadi	Patharwala	Total area
CoC 671	0.003	0.005	0.04	0.011	0.017	0.076
Co 86032	0.003	0.020	0.60	0.39	0.067	1.08
CoM 0265	0.042	0.034	0.30	0.29	0.037	0.703
VSI 434	0.003	0.007	0.08	0.006	0.03	0.126
CoVSI 03102	0.003	0.007	0.08	0.011	0.023	0.124
MS 10001	0.042	0.005	0.17	0.290	0.053	0.56
VSI 08005	0.032	0.027	0.255	0.140	0.04	0.526
CoVSI 18121	0.032	0.095	0.486	1.002	0.133	1.716
<b>Total</b>	<b>0.16</b>	<b>0.20</b>	<b>2.011</b>	<b>2.14</b>	<b>0.40</b>	<b>4.911</b>

**Table 7: Performance of sugarcane genotypes in AICRP(S) trials at VSI**

Clone	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
<b>Initial Varietal Trial (Crop age: 12<sup>th</sup> month)</b>				
CoVc 18061	20.11	165.05	17.99	12.83
Co 18012	20.43	148.85	19.40	13.95
Co 18009	19.53	146.51	20.63	14.93
CoVSI 18121	20.38	145.28	19.53	14.04
Co 18001	18.42	142.70	18.13	12.91
Co 18003	20.74	138.87	20.63	14.93
Co 86032 (Std.)	16.84	123.58	18.99	13.63
CoC 671 (Std.)	15.47	98.93	21.69	15.63
Co 09004 (Std.)	14.60	95.50	21.18	15.27
CD at 5 %	2.10	13.69	0.54	0.40
CV %	7.44	6.62	1.69	1.77
<b>Advanced Varietal Trial - I Plant (Crop age: 12<sup>th</sup> month)</b>				
Co 16018	19.14	134.64	19.65	14.21
Co 16006	18.44	124.79	20.41	14.21
Co 86032 (Std.)	16.79	117.82	19.82	14.29
CoC 671 (Std.)	15.31	98.65	21.55	15.52
Co 09004 (Std.)	18.52	120.14	21.27	15.40
CD at 5 %	1.78	11.55	0.96	0.72
CV %	5.92	5.72	2.66	2.75
<b>Advanced Varietal Trial - II Plant (Crop age: 12<sup>th</sup> month)</b>				
Co 15010	16.15	154.43	19.49	13.87
CoN 15071	18.22	152.61	18.04	12.94
Co 15021	16.68	143.25	18.14	12.90
Co 14005	18.05	142.72	19.41	13.92
Co 15009	15.46	140.75	19.13	13.65
Co 86032 (Std.)	16.76	131.19	19.67	14.13
CoC 671 (Std.)	16.28	119.65	21.20	15.25
Co 09004 (Std.)	18.26	139.78	21.34	15.44
CD at 5 %	1.96	13.26	0.95	0.72
CV %	6.96	5.91	2.86	3.02
<b>Advanced Varietal Trial – Ratoon - I Plant (Crop age: 11<sup>th</sup> month)</b>				
Co 15010	19.92	141.18	19.22	14.11
Co 15021	20.48	138.27	20.61	14.80
Co 14005	20.26	134.73	20.83	15.03
Co 15009	17.81	129.55	19.22	13.74
Co 86032 (Std.)	16.42	118.21	19.43	13.89
CoC 671 (Std.)	15.01	97.04	21.38	15.45
Co 09004 (Std.)	18.58	122.88	20.96	15.12
CD at 5 %	2.33	13.15	0.89	0.70
CV %	8.01	6.65	2.58	2.83



## **Sugarcane genetic resources, collection, evaluation, characterization and utilization**

### **Germplasm Evaluation**

The sugarcane database was created by recording data in the flowering sugarcane germplasm clones on flowering behavior, pollen fertility. The other observations like HR Brix %, number of millable canes, stalk diameter, stalk height, single cane weight and number of internodes in all the available sugarcane germplasm at SBC, Amboli.

### **Germplasm Utilization**

Marcotting technique for the controlled crossing was utilized and total 2979 canes were marcotted. During the year, 80.93% of the clones have flowered. Total 647 bi-parental crosses were done at SBC, Amboli.

### **Utilization of inter-specific hybrids (ISH) and involving different species of *Saccharum* and related genera i.e *Erianthus***

Total sixteen clones selected from crosses involving ISH and *Erianthus* hybrids were tested. Two clones VSI 191-3 (Co 419 x ISH 57) and VSI 150-61 (ES 17 x Co 775/ F 134) have recorded higher sucrose % (20.86 and 20.29) and fiber % (14.81 and 15.76) as compared to standard Co 86032 (19.37 and 14.25) respectively. The final conclusion will be drawn after testing the ratoonability of these clones. These clones will be included in the germplasm at SBC, Amboli for making back crosses.

### **Screening of genotypes for drought tolerance**

The first plant crop was conducted under AICRP(S) programme for 'Evaluation and Identification of climate resilient ISH and IGH genetic stocks. Total of 18 entries along with six VSI's promising clones were tested along with three standards in normal and under stress condition.

Out of total eighteen promising entries tested for moisture stress tolerance, none of the genotype was found significantly superior to the standard VSI 12121 (Cane yield- 95.74 t/ha; CCS 13.31 t/ha) and CoM 0265 (Cane yield- 90.59 t/ha; CCS 11.39 t/ha) under moisture stress (Table 9) for cane and sugar yield. But four entries, i.e., IGH 833 (Cane yield- 92.83 t/ha), IGH 829 (Cane yield- 87.45 t/ha), IGH 823 (Cane yield- 84.05 t/ha) and ISH 590 (Cane yield- 83.74 t/ha) were found significantly superior over standard CoM 88121 (Cane yield- 64.36 t/ha) only for cane yield trait.

## **TISSUE CULTURE**

Tissue culture section works on various objectives such as quality seed production through sugarcane micropropagation, production and R & D of Vasant Urja as a biostimulator, extension, research and training for cane development of sugar mills. The main activities include,

- i) Virus free plantlet produced as breeder's seed through sugarcane micropropagation technique and distribution to sugar industry in Maharashtra and neighboring states for raising the seed plots through three tier seed production.
- ii) Collaboration with BARC on use of irradiated and non-irradiated biopolymer for improvement in cane yield and sugar recovery of sugarcane.
- iii) Staff was involved in extension work to various sugar mills for cane development and visits to various organizations for R & D activities. In addition, the staff participated in Dnyanyag, Dnyanlaxmi and other various training programs with offline and online training modes.

The brief work done on various aspects of sugarcane and development of biostimulator for improvement of sugar and sugarcane productivity is given below.

### **Sugarcane micropropagation**

Efforts were made to improve the quality of tissue culture plantlets by improving the media protocol and inducing abiotic and biotic stress tolerance during their production by using the Vasant Urja and fertilizer incorporated bio-sludge from sugar mills. The section developed suitable micropropagation protocol for CoM 09057, Co 15023 and CoVSI 18121 sugarcane variety and produced seedlings of these varieties as per demand of the sugar mills from Kolhapur district and Uttar Pradesh. Section continued the work on optimization of in media composition to improve micropropagation protocol for Co 86032, Co 92005, CoVSI 03102, MS 10001, CoM 0265. During the year, section has produced 9.67 lakh virus free plantlets of different sugarcane varieties and of which 7.63 lakh plantlets were distributed to the sugar industry and sugarcane growers of Maharashtra as well as adjoining states as breeders' seed for production of foundation seed and subsequently production of quality certified planting material. Due to the problem of COVID-19 pandemic, the work of sugarcane micropropagation was hampered from April 2021 to June 2021 and maximum stock cultures of all stages (meristem, shoots and rooting cultures) got damaged. After June 2021, production

activity slowly restarted and it was normalized from September 2021 onwards. The production and supply of micro-propagated plantlets are given under inputs and analytical services in table 11 and 12.

### **Production of Vasant Urja (Non-irradiated bio-stimulator)**

The production and supply of Vasant Urja was continued during the year 2021-22 on a large scale. The section produced 1,23,322 liters of Vasant Urja as bio-stimulator and supplied 1,26,984 liters including previous year carry over balance to sugar mills and farmers within the state and outside even under pandemic situation of corona. Vasant Urja proved its utility in agriculture and showed the improvement in quality and productivity of sugarcane and other crops. Considering the importance of the irradiated and non-irradiated bio-stimulator, MOU was signed with Directorate of Floriculture Research, Pune for integrating and recommending the chitosan derivatives in their mandate crops and studying feasibility of floriculture crops as intercrops in sugarcane for sustainable crop productivity.

Presently, the technology is under consideration of the Central Government's Bio-stimulator Approval Committee-FCO. Necessary bio-efficacy trials and toxicity data generation is undergoing and necessary G1 and G2 forms have been routed through state Govt. to Controller of Fertilizers, New Delhi. The bio-efficacy trials on green gram and sugarcane have been undertaken at agriculture research stations of Universities of UAS, Dharwad, DBSKKV, Dapoli and IGKV, Raipur.

Trials for recommending the irradiated chitosan for sustainable improvement in ground nut, drought tolerance in Okra, Fertilizer briquettes for applications in rice are going on at DBSKKV, Dapoli. The trials on studies on phenomics of irradiated chitosan, silixol and non-irradiated chitosan on TC plantlets and single eye bud seedlings are going on at NIASM, Malegoan whereas, trials on sustainable onion yield improvement are going on at DOGR, Rajgurunagar. The irradiated chitosan phenomics data has shown superiority over Silixol.

Different trials on irradiated chitosan and its Nano conjugate for its integration with liquid fertilizers, bio-fertilizers, bi-control agents, weedicides and improvement of production efficacy of microbial bio-fertilizers, management of drought tolerance in sugarcane, management of sugar industry waste water

are going on association with different departments/ sections of VSI with promising results at initial evaluation. Under collaborative project with BARC, Mumbai the irradiated chitosan has been provided to CSKHPKV, Palampur for studying its effects on improving the fodder quality in Tall Fescue grass. The first year trial of effect of irradiated chitosan with salicylic acid, silicic acid and MOP on drought tolerance management and non-irradiated chitosan as a bio-stimulator for sugarcane was completed and has shown promising results. Thiourea- irradiated chitosan conjugate has also showed promising results as biostimulator. Thus, the product developed is playing very versatile role not only in improving sustainability of the sugar industry but the entire agriculture at large.

For improving quality of Vasant Urja, grafting of nanoparticles of salicylic acid, silicic acid, thiourea, and copper nano-conjugates were synthesized and evaluated in laboratory and in green house conditions. The  $\beta$ -glucannano particles were synthesized from yeast as well as *Sclerotium rolfsii* the sugarbeet bulb rot pathogen. The chitosan- $\beta$ -glucannano conjugates were synthesized and evaluated for its efficacy on *Sclerotium* rot control in sugarbeet. The molecular level confirmation of sugarbeet pathogen *Sclerotium Rolfsii* was carried out. The nanoconjugate synthesized showed very promising results in its antimicrobial efficacy rather than the chitosan or chitosan nanoparticles alone. Chitosan nanoparticles inhibit *S. rolfsii* growth at 600 ppm. Structural abnormalities observed under microscopes Yeast  $\beta$ -glucannano particles have higher antifungal activity at higher pH 7.5.

### **Development of low molecular weight bio-stimulator by gamma irradiating the bio-polymers**

The collaboration with BARC, Mumbai has been in place on the use of irradiated and non-irradiated bio-polymer for yield improvement in sugarcane. The methodology for large scale production of irradiated chitosan is under progress. The methodology has been evaluated for preparation of paste and use of HDPE containers for irradiation. The special type vented lid HDPE carboys are being developed for regular utilization for the irradiation work.

### **MoU between VSI and BARC**

Initially VSI signed MoU with BARC, Mumbai which was valid for two years i.e. 2019-20 to 2020-21 for different activities of cane development works. Later, in 2021, it was extended till Dec 2022. Irradiated chitosan was supplied to fourteen sugar mills for use in





ratoon crop and two sugar mills for plant cane for spraying at different schedules. The data collection work of field trial was in progress.

### **Vasant Urja Research and Development**

A research and development activity was carried out on use of different chitosan derivatives and its nano-conjugates with Thiourea on tissue culture plantlets for acclimatization. It has been observed that chitosan irradiated at 100 Kgy with gamma rays showed significantly superior results in terms of shoot height, leaf length, leaf width, root length, dry biomass accumulation and relative water content of shoot and root biomass.

### **Copper, Thiourea and Salicylic acid Nano-conjugates**

It has been observed that sugarcane tissue culture plantlets of Co 86032 showed better survival percentage, and root growth @ 50 ppm irradiated chitosan+ 250 ppm Thiourea combination. Whereas, single eye bud settlings treated with irradiated chitosan (100 ppm) + Thiourea (500 ppm) given higher rate of germination.

### **Multilocation field trials**

Multilocation trials were conducted at VSI, ARS-Napane & DBSKKV, Dapoli for evaluation of the effect of non-irradiated chitosan (Vasant Urja) for cane & sugar yield improvement. Results at VSI indicates non-irradiated chitosan @100 PPM & irradiated chitosan @ 50 PPM were found superior for germination %, tillers count and height, no of internodes, girth & weight of cane, cane yield (t/ha), CCS (t/ha).

Another field trial was conducted to evaluate the use of nanoparticle based elicitors for water stress management in sugarcane. Irradiated chitosan & thiourea were tested at different concentrations & in combinations. Thiourea @ 500 PPM were found superior for NMC/ha, cane yield (t/ha), CCS (t/ha) and other yield contributing characters i.e. height, no of internodes, girth and weight of cane.

Experiment was conducted under greenhouse conditions to study the effect of irradiated chitosan (nanoparticles), normal chitosan and new chitosan composite on priming of micropropagated sugarcane plantlets of Co 92005. Individually, the derivative @ 60 PPM & with composite @ 40 PPM showed promising results as compared to the control. The new composite derived resulted in enhancing growth performance of TC plantlets and also reduced the hardening period by 10-12 days.

## **MOLECULAR BIOLOGY AND GENETIC ENGINEERING**

The section is working on major objectives viz. DNA marker technology & Molecular breeding, sugarcane improvement through transgenic approach and as an Accredited Test Laboratory (ATL) for Virus Indexing & Genetic Fidelity tests of tissue culture raised plants under NCS-TCP Project.

### **Sugarcane improvement through transgenic approach for drought and salinity tolerance**

- **Ectopic expression of Glycine betaine accumulating genes for enhanced water deficit stress tolerance in sugarcane**

Development of drought tolerant sugarcane varieties by genetic transformation using Glycine betaine accumulating genes like bet A and bet B was continued. In total four experiments were done with bet A + bet B genes together (co-transformation) under reporting period. About 15 putatively transformed shoots from these batch are on rooting medium were transferred in to polybags and maintained in transgenic green house. Around 29 plants were regenerated from earlier batches were multiplied by sowing ten sets of each plant and germinated 259 plants in total. Genomic DNA was isolated from these plants and pooled samples were analyzed by PCR using gene specific primers. In total 10 DNA samples out of 84 pooled DNA samples has shown positive results for bet B gene specific PCR.

- **Developing salt and drought tolerance in sugarcane is continued using *SoMYB18* transformed plants**

About 10 eye buds from each of seven transgenic plants and two non-transgenic plants were taken for germination. Total 73 plantlets were germinated under controlled conditions in green house. After 50 days of planting in the trays, 37 plants were subjected to drought stress with PEG (20% PEG-4000) and another 36 plants were subjected to salt stress (150 mM NaCl) and leaf samples were collected after 0, 10 and 20 days of interval with respective control. All plants were analyzed for physical parameter like height and relative water content also biochemical parameters like chlorophyll, proline and enzymes SOD and POD. Plant Agro-86-2 showed tolerance to drought stress and plants Bio-86-2-4 and Bio-86-7 showed tolerance to salt stress. Whereas, plant Bio-86-2-8 exhibited tolerance to drought as well as salt stress.

Real-Time PCR analysis of these plants were carried out. Genomic DNA was isolated from 18 pooled plant leaf samples from 7 transgenic plants. Negative control DNA samples were isolated from respective non transgenic control. Around 50 ng of genomic DNA were used as template and simple presence/absence RT-PCR assay was performed. Gene specific primers were used with Syber green florescence dye. Total 5 from 18 pooled DNA samples have shown positive results with end RFU values higher than negative plant control. These results indicate that the plant samples with higher end RFU values could have extra copies of SoMYB18 gene (Transformed) along with endogenous MYB18 genes. Further analysis of exact transgene copy number using plasmid DNA standard curve method is in progress.

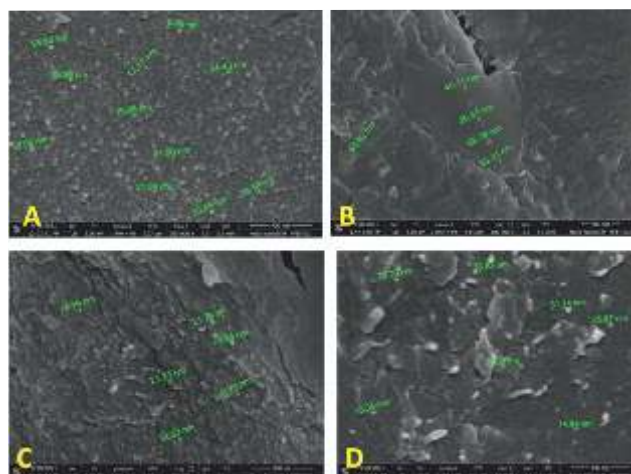
### Chitosan nanoparticle as protein delivery carriers

The Bt liquid culture was grown and the suspension culture was sonicated at 100 W for 10 min to dispel clumping, then centrifuged at 6000 rpm for 10 min. The obtained pellet was re-suspended in a saline solution, the organic solvent was added again and the same procedure was repeated three to four times. Finally, the pellet was washed twice with cold distilled water. Spores were trapped by the hexane on the top layer; cell debris remained in the aqueous phase while the crystals accumulated to form the pellet.

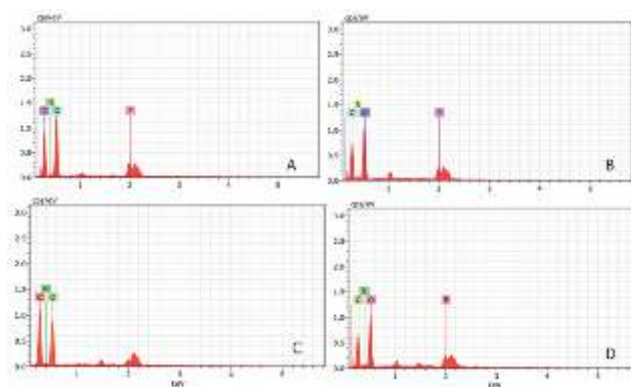
Scanning Electron Microscope and EDS analysis of Bt loaded Chitosan Nano-particles was carried out at Savitribai Phule University, Pune. Relatively more amount of detectable nanoparticles was formed by using acetic acid soluble chitosan than water soluble chitosan. Size for both type of nanoparticles ranges from 14 to 32 nm were observed. Size of Bt protein loaded nanoparticles were observed about 25-68 nm for acetic acid soluble chitosan with larger coagulation and flakes like structures and less detectable nanoparticles. Whereas, size of Bt protein loaded nanoparticles using water soluble chitosan is about 14-33 nm. EDS results have shown only phosphorus as impurity and carbon, oxygen and nitrogen as basic elements in given samples. (Fig. 1 & 2)

### Evaluation and molecular characterization of *in vitro* mutagenesis and salt selection sugarcane clones

Sugarcane is an important cash crop and is affected by soil salinity. CoM 0265, a moderately salt-tolerant variety grown in the Maharashtra (India), has low sugar



**Fig 1:** Scanning electron microscope Image of Chitosan and Bt loaded chitosan nanoparticles



**Fig 2:** EDS analysis of Chitosan and Bt loaded chitosan nanoparticles;

- A: Acetic acid soluble chitosan nanoparticles,
- B: Acetic acid soluble chitosan nanoparticles with Bt protein
- C: Water soluble chitosan nanoparticles,
- D: Water soluble chitosan nanoparticles with Bt protein

content. The present study was aimed to employ gamma ray induced *in vitro* mutagenesis with repeated and step-wise selection in sugarcane for the isolation and physio-biochemical profiling of the selected salt-tolerant mutants for improved agronomic performance and sugar content.

Embryogenic callus culture of CoM 0265 variety was subjected to different doses of gamma radiation (10, 20, 30, 40, 50, and 60 Gy) followed by selection on NaCl containing media (50, 100, 150, 200, and 250 mM NaCl). The regenerated plantlets were hardened and selected based on ground nursery field trial on normal and saline soil field trial, augmented block design were adopted for the selected mutant clones. Different physio-biochemical changes and activity of antioxidant enzymes were analyzed in the salt selected *in vitro* cultures and field-grown mutant clones.



Dose optimization showed 40 Gy as the  $Ld_{50}$  for gamma radiation and 150 mM NaCl as the dose for *in vitro* selection experiments. The selected mutant clones showed higher tissue water content (TWC), chlorophyll, and lower sodium content indicative of tolerance to salt stress. Catalase and peroxidase enzyme activities in the top visible dewlap (TVD) of the putative mutant clones were significantly higher than the control. The average yield and sucrose percent of the selected mutant clones were significantly higher than control checks in the saline field trial. Mutant clones M8457 and M8721 exhibited improved yield and commercial cane sugar over the parent control check varieties under saline field condition. Catalase activity was strongly associated with TWC ( $r = 0.34$ ) and chlorophyll content ( $r = 0.41$ ) while it was negatively correlated with sodium ion content ( $r = -0.38$ ). Peroxidase activity in TVD also showed a significant positive correlation with chlorophyll content ( $r = 0.42$ ) and a negative correlation with sodium ion content ( $r = -0.39$ ). The improvement in (t/ha) was strongly associated with the lower sodium ion content of the mutant clones ( $r = -0.54$  and  $-0.53$ , respectively).

Gamma ray induced mutants were isolated for improved sucrose and high yield in sugarcane var. CoM 0265. The results suggest that gamma radiation induced mutations result in physiological and metabolic alterations for better growth and adaptation under *in vitro* and field stress conditions in sugarcane. The improved mutants can be further useful for commercial cultivation in saline areas.

#### **Virus indexing (VI) and genetic fidelity (GF) tests of tissue culture raised plants under NCS-TCP Project**

National Certification Systems for Tissue Culture Raised Plants (NCS-TCP) management cell of Biotechnology Consortium India Limited (BCIL) as the Certification Agency under this VSI is one of the Accreditation Test Laboratory (ATL) among four in India. Under this we have started our ATL from the year April 2015 to September 2021 (6.6 Years) with the objectives of certifying the production and distribution of disease free and quality tissue culture plants.

At present our ATL is continued from October 1, 2021 to September 30, 2026 (Five Years). Under the project entitled 'National Certification Systems for Tissue Culture Raised Plants (NCS-TCP)' management cell of National Institute of Plant Genome Research (NIPGR), New Delhi as the Certification Agency funded by Department of Biotechnology. VSI is one of

the ATL work under the NCS-TCP guidelines for certification of virus indexing (VI) and genetic fidelity (GF) testing of tissue culture raised plants produced by commercial tissue culture production facility (TCPFs) registered with DBT/NIPGR.

Present activity pertains to virus indexing of Banana: Cauliflower Mosaic Virus (CMV) and Banana Bract Mosaic Virus (BBrMV) by using enzyme-linked immunosorbent assay (ELISA) and Banana Streak Virus (BSV) and Banana Bunchy Top Virus (BBTV) by polymerase chain reaction (PCR) technique. Genetic fidelity was tested by PCR using inter simple sequence repeat (ISSR) markers.

Gerbera samples were tested for CMV using ELISA methods. However, date palm tested for phytoplasma using nested PCR and genetic fidelity using PCR based ISSR markers. Leaf samples were received from different TCPFs especially from states of Maharashtra, Gujarat, Chhattisgarh and Madhya Pradesh.

In Banana, 43521 leaf samples were assessed for GF & VI, in Gerbera, 8781 leaf samples analyzed for virus indexing (CMV) and 208 leaf samples were tested for phytoplasma and genetic fidelity using PCR based ISSR markers in Date palm. Total 20 TCPFs approached for VI & GE testing and 552 batches were certified and certificates approved for the year up to September 30, 2021.

After the new sanction of the project from October 1, 2021 to March 31, 2022, 10769 Banana leaf samples have been analyzed for GF & VI, in Gerbera, 1078 leaf samples analyzed for virus indexing (CMV) and 69 leaf samples were tested for phytoplasma and genetic fidelity using PCR based ISSR markers in Date palm. Total 16 TCPFs approached for VI & GE testing and 68 batches were certified and certificates approved for the year up to March 31, 2022.

## **CROPPRODUCTION**

### **AGRONOMY**

The section carried out research on agronomic evaluation of new elite sugarcane and sugarbeet genotypes, effect of different sugarcane varieties on staggered harvesting, evaluation of existing sugarcane varieties for drought resistance, evaluation of different crops in sugarcane based intercropping system. Technical guidance and consultancy to various sugar mills is provided for improving sugarcane productivity through advanced crop management practices of plant and ratoon sugarcane crops. Scientists are also involved in large scale cultivation of sugarbeet at farmers' fields

under several projects. Development of indigenous sugarbeet seed was also tried with the technical guidance from USDA scientist.

### **Effect of harvesting periods of advanced genotype/ varieties on yield and quality of sugarcane (IIIrd plant crop)**

The field trial was initiated to evaluate the promising sugarcane genotypes/ varieties with different harvesting periods and its effect on growth, yield and quality of sugarcane. Crop was harvested at 10, 12 and 14 months of age. The results revealed that, variety CoM 0265 recorded maximum cane yield of 144.09, 154.82 & 169.77 t/ha at 10, 12 and 14 months after planting respectively. The similar yield trend was observed in VSI 08005 and MS 10001. Whereas, CCS yield in MS 10001 was at higher side. The quality parameters like brix % and sucrose % were observed maximum in CoC 671, VSI 434, MS 10001 & Co 9004.

### **Evaluation of product compatibility and its effect on growth, yield and quality of sugarcane (Ist plant crop)**

At present, farmers tend to give more emphasis on nutrient spraying on crop for improvement in productivity which leads to adding extra cost to cultivation. Considering this issue, a field experiment was laid out to study the effect of spraying of various chemical combinations on the mutual compatibility and also on crop performance. The results revealed that, the chemicals under study were physically compatible with each other without any coagulation, phytotoxicity and their effect on crop performance was more or less equal. Foliar application of multi macro and micronutrient along with Vasant Urja showed maximum cane (138.14 t/ha) and CCS (18.88 t/ha) yield.

### **Agronomic evaluation of promising sugarcane mutant (Ist plant crop)**

Trial was laid out to evaluate the sugarcane mutants (developed by tissue culture technique) for their agronomic performance. The outcome of 1st plant crop indicated significantly higher cane yield (124.62 t/ha) was recorded by mutant 8711 (derived from CoM 0265) whereas, maximum brix and CCS yield (19.45%, 16.41 t/ha respectively) by mutant 8733 (derived from Co 86032) and in case of sucrose and CCS % was higher (18.53% and 13.52% resp.) in mutant 3990 (derived from Co 86032).

### **Agronomic performance of elite sugarcane genotypes**

Performance of various elite sugarcane genotypes received from Advanced Varietal Trial were studied with different fertilizer levels. Results of the plant crop showed that, fertilizing the crop with 125% of RDF showed maximum cane yield (130.58 t/ha), whereas, with respect to genotypic performance, all the genotypes were found significant with each other. CoN 15071 showed numerically higher cane yield (141.46 t/ha), Co 11015 showed maximum brix (23.75%), with respect to sucrose content which was higher in Co 15007 (21.75%) and Co 15017 in CCS% (15.82%).

### **Evaluation of sugarcane varieties for drought tolerance (IIIrd plant crop)**

The field experiment was conducted to evaluate existing/ promising sugarcane varieties for drought tolerance at two irrigation levels i.e 0.3 and 1.0 IW/CPE ratio. The result showed that, irrigating the crop at 1.0 IW/CPE ratio recorded higher NMC (0.80 lakh/ha), improved growth and physiological attributes, cane yield (148.15 t/ha) and CCS yield (22.90 t/ha). With respect to cane variety, CoM 0265 secured maximum cane yield (157.87 t/ha), CCS yield (24.05 t/ha), but not significantly different from var. VSI 08005, Co 86032 and CoVSI 18121. In case of brix (23.95%), sucrose (22.81%) and CCS (16.54) it was observed maximum in variety VSI 434.

### **Varietal performance of groundnut, green gram and black gram under sugarcane based cropping system (BARC) (IIInd plant crop)**

A field experiment was conducted on varietal performance of groundnut, green gram and black gram under sugarcane based cropping system to study the intercrop compatibility with sugarcane crop and the outcome of 2nd plant crop showed that, intercropping of sugarcane with groundnut gives maximum cane yield (124.90 t/ha), cane equivalent yield (238.58 t/ha) with 14.90 t/ha of CCS.

### **Evaluation of new tropical sugar beet genotypes under peninsular zones of Maharashtra (SeSVender Have)**

Nine sugar beet genotypes/varieties were selected for study on yield, quality and pest incidence under peninsular zone of Maharashtra. The results showed that, genotype SZ 35 (104.67 t/ha) and SV 4 (102.10 t/ha) recorded maximum root yield, whereas superior juice quality was found in SV 2495 & SV-SCLE-1. With



respect to incidence of *sclerotium rolfsii*, genotype SV 1697 found more susceptible and least incidence was observed in SV-SCLE-2. Incidence of *Spodoptera* Spp. was observed on genotype SV-4 & SZ 35 at 120 DAS, but it was below economic threshold level.

#### **Sugarbeet seed production program in collaboration with USDA-ARS**

VSI is trying to promote sugarbeet as supplementary crop to sugarcane in tropical region. Seed is an important input, for which presently, we have to depend on European seed producing companies. In this direction, discussion was held with Dr Imad Eujayl, a scientist from USDA-ARS in USA regarding possibility of development of indigenous sugarbeet seed and learnt that, sugarbeet seed can be produced in tropical region. With this objective, a project was initiated with the help from USDA-ARS. Breeding Material Transfer Agreement was signed between VSI and USDA-ARS Accordingly, seeds of ten sugarbeet breeding lines received and sowing in portraits under greenhouse condition was done on 22nd September 2020 at VSI and kept for 12 weeks to grow, then transferred to cold room for 12 weeks for vernalization & initiation of bolting and again transferred to greenhouse at 25 °C temperature and 70% of humidity for flowering and seed setting. After 14 months of crop age, harvested the sizable amount of raw sugar beet seeds from these breeding lines. The project was successful and the sugarbeet seed production technique in tropical region has been developed for future requirements.

#### **Climate resilient sugarbeet based cropping system model under rainfed condition- United Nations-FAO-NRAA**

It is now proved that growing of sugarbeet is more profitable than sugarcane for production of sugar and ethanol. Considering less water requirement & crop period, the Food and Agriculture Organization of United Nations sanctioned a project to VSI for developing sugarbeet based cropping system in rainfed area in western Maharashtra in association with National Rainfed Area Authority, New Delhi. Sugarbeet sowing on 71 acres was done at the farmers' fields in the operational area of Baramati Agro Ltd Dist. Pune. All the technical guidance was given by the VSI. Seeds of SeSVanderHave, Belgium was used. Two seed drills for sowing of sole sugarbeet and intercropping in sugarcane were developed by VSI and used for sowing. Crop was harvested during April- May 2021 and processed in 100 TBD pilot plant for production of ethanol. During this project, farmer got average 10

t/acre of beet yield in intercrop system and 20-22 t/acre in sole crop system and proved to be economical to the farmers of rainfed area as compared to other crops in competition. The project report and policy documents of the projects submitted to the FAO authorities.

#### **Bamboo plantation at SBC, Amboli**

Commercial cultivation of Bamboo (*Bambusa balcooa* L.) is nowadays worldwide accepted as raw material in furniture industry, co-generation plants and is a substitute to coal based electricity generation. Soil and climate of SBC Amboli are well suited for bamboo plantation. Commercial bamboo plantation on 3.25 acres with 3600 Tissue culture plantlets of var. Beema bamboo was done at 10x4 feet spacing. All the agronomic practices are followed as per the schedule. Second year of crop growth is satisfactory; first harvest will be done after three years of crop age. Another 3.0 acres area has been identified for bamboo plantation.

#### **SOILSCIENCE**

The section is engaged in the activities such as research and development, extension, training, consultancy and production of agro-inputs to provide services to the farmers, sugar mills, government, and private agencies in the field of soil and fertilizer management. The section deals with the research related to nutrient management in calcareous soil and saline sodic soil, carbon sequestration in organic sugarcane crop, and preparation of biochar using sugarcane bagasse, also engaged in the formulation of innovative fertilizer products for sugarcane crop using low-cost technology. One of the recent accomplishments of the section is the formulation of nano-silica for foliar application in sugarcane. The soil testing training services and guidance for soil testing laboratory establishment, soil fertility assessment by GPS-GIS technique, nutrient enrichment of bio-compost, and package of practices for soil fertility management are provided. In addition, the supply of inputs namely multi-macronutrient and micronutrient liquid fertilizers for foliar application, water-soluble solid micros land VSI-humic acid for soil application are supplied.

#### **Modeling relationship between soil potassium, plant potassium, yield and juice quality of sugarcane (Plantcane)**

A study was conducted to assess the relationship between soil potassium, plant potassium, yield and juice quality of sugarcane. The results indicated that, the application of 100% recommended dose of

potassium as per soil testing (25% RDK at planting + 25% RDK at earthing up + 25% RDK at 180 DAP + 25% RDK at 240 DAP) increased cane yield by 12.8 t/ha and sugar yield by 2.9 t/ha.

#### **Development of package of practices for organic sugarcane (Plantcane)**

The field experiment was conducted to develop the package of practices for organic sugarcane. The results revealed that application of vermicompost @ 5 t/ha at planting and 120 days after planting, zeolite @ 100 kg/ha, seaweed @ 12.5 kg/ha along with foliar application of fulvic acid 2 lit/ha @ 60 DAP increased cane yield by 14.5 t/ha and sugar yield by 2.3 t/ha.

#### **Effect of VSI's water soluble micronutrient in sugarcane (Two plantcane + One ratoon)**

A study was conducted to evaluate the effect of VSI's water soluble micronutrient in sugarcane. The pooled results showed that fertigation of VSI's water soluble solid micronutrient @ 25 kg/ha in four splits - at planting, 60, 120 and 180 DAP increased cane yield and sugar yield by 14.2 t/ha and 2.6 t/ha, respectively. Soil application of VSI's water soluble solid micronutrient @ 25 kg/ha in two splits - at planting and 120 DAP increased cane and sugar yield by 11.7 t/ha and 2.3 t/ha, respectively.

#### **Nutrient management in calcareous soil for sugarcane (Plant cane)**

The study was conducted on nutrient management in calcareous soil for sugarcane in pre-season. The results revealed that application of nitrogen through Urea and ammonium sulphate, phosphorus through diammonium phosphate and potassium through muriate of potash, micronutrient mixture grade -1 or ferrous sulphate @ 12.5 kg/ha and zinc sulphate @ 10 kg/ha along with bio-fertilizer (Soil health) increased cane yield by 16.3 t/ha and sugar yield by 3.1 t/ha.

#### **Integrated reclamation technology for saline sodic soil (Plant cane)**

The field experiment was conducted on integrated reclamation technology for saline sodic soil. Application of various combinations of organic inputs with different packages of chemical fertilizer did not show statistically significant results.

#### **Precision nutrient management through rescheduling time of application for widely spaced sugarcane plant - ratoon system (Plantcane)**

The field experiment was conducted on precision nutrient management through rescheduling time of

application for widely spaced sugarcane plant-ratoon system. Application of nitrogen and potassium by band placement in seven splits (Basal 10% and remaining at 45, 75, 90, 120, 150 and 180 DAP in equal splits) increased cane yield by 10.5 t/ha and sugar yield by 1.84 t/ha.

#### **Evaluation of Polysulphate efficiency in sugarcane productivity & sugar recovery (Two Plant crop + one ratoon) (Sponsored by International Potash Institute)**

A study was conducted to assess the fertilizer use efficiency in sugarcane as influenced by polysulphate and levels of muriate of potash. The pooled data showed that soil application of polysulphate and muriate of potash in 50:50 proportionate increased cane yield by 13.7 t/ha and sugar yield by 2.3 t/ha.

#### **Response of STL's package (Soil + WSF Grades) on growth, yield & quality of sugarcane (Ratoon) (Sponsored by Smart Chem. Tech. Ltd.)**

The field experiment was conducted on response of STL's package (Soil + water soluble fertilizer grades) on growth, yield and quality of sugarcane. The results indicated that the application of recommended dose of fertilizer through STL's practice (soil application + fertigation) increased cane yield significantly by 14.74 t/ha and sugar yield by 2.75 t/ha over farmers practice (soil application).

#### **Response of Smartek 10:26:26 on sugarcane crop (Plantcane) (Sponsored by Smart Chem. Tech. Ltd)**

A study was conducted to evaluate the response of Smartek 10:26:26 on growth, yield and quality of sugarcane in pre-season. The result concluded that, the application of recommended dose of fertilizer through Smartek 10:26:26 along with sulphur increased cane yield by 13.21 t/ha and sugar yield by 2.80 t/ha.

#### **Multi-micronutrient and Multi-macronutrient Liquid Fertilizer production**

Soil Science section produced and supplied the state govt. notified grade multi-micronutrient (grade-2), multi-macronutrient (NPK 8:8:8), multi-macronutrient water soluble (NPK 15:15:15), microsols (grade-1 solid soluble micronutrient mixture) and VSI-Humic to sugar mills and individual farmers in Maharashtra state. The details of supply of products is given in Table xx under inputs and analytical services.



## AGRICULTURAL MICROBIOLOGY

The section is now widely recognized as a centre of research in Agricultural Microbiology with respect to basic, applied & strategic research extensively for the development of different agricultural beneficial liquid biofertilizers, decomposing culture for agri-waste recycling, bio-pesticides & bio-fungicides. Over the year, about ten lakh lit. of different microbial biofertilizers and also bio-control agents have reached to the farmer's field from the laboratory. The efficient microbial strains developed in the laboratory undergo for field evaluation and after recommendation from Joint Agresco, the mass production is undertaken.

The section also deals with rearing of earthworms and production of vermicompost, provides consultancy for establishment of mass production of liquid biofertilizers unit, composting of agro industrial waste & its enrichment and supply of vermicompost to the sugar mills in Maharashtra and adjoining states. Apart from development of microbial products, section has also well equipped in-house Quality Control & Microbial Analysis Laboratory, where quality control, analysis of bio-fertilizers, vermicompost, compost, sugar and enriched compost samples from outside is carried out. The section is recognized as advanced research centre and continues to be centre for mass production & supply of different liquid biofertilizers and biocontrol agents of high quality standards as per Fertilizer Control Order (FCO) & Central Insecticide Board (CIB), Faridabad. The liquid biofertilizers & biocontrol agents are registered with different trade names and have received organic certification from Ecocert. Technical advice to the farmers on liquid bio-fertilizers, bio-control agents & vermicompost is transferred through popular articles in newspapers, magazine and by delivering talk on Radio and Television. The section has a strong liaison with sugar industry and individual farmers.

### Laboratory research

#### Use of isotopic techniques ( $^{15}\text{N}$ isotope studies) for assessment of nitrogen fixation in sugarcane ratoon by consortium of endophytic bacteria

Foliar application of consortium of nitrogen fixing endophytic bacteria @ 3 lit/ha after 60 DAP without application of nitrogenous fertilizer gave significantly higher cane yield (13.83 Kg/pot) as compared to RDF [100% of N through labelled Urea] + 100% P & K (10.81 Kg/pot). The  $\text{dN}_{15}\%$  in leaf analysis was 22.82% in treatment where foliar application of consortium of nitrogen fixing endophytic bacteria @ 3

lit/ha after 60 DAP without application of nitrogenous fertilizer as compared to treatment where RDF [100% of N through labelled Urea] + 100% P & K was used (9165.06%).

#### Isolation, identification and screening of Exo-Polysaccharide (EPS) producing microorganisms & its effect on sugarcane

The developed consortium of EPS was evaluated for growth and yield of sugarcane varieties CoM 0265, VSI 08005, Co 86032 under water stress condition at pot scale. The initial moisture percentage of soil was 27.80%. The total bacterial count ( $3.0 \times 10^{10}$ ), fungal count ( $12.0 \times 10^6$ ) and total actinomycetes count ( $12.0 \times 10^6$ ) was recorded from initial soil sample. The further studies on growth parameters, yield & quality of three sugarcane varieties under water stress conditions are in progress.

#### Collection, isolation, characterization and identification of entomopathogenic fungi on sugarcane white fly, (*Aleurolobus barodensis* Maskell) and development of consortia as bio-control agent for its control in sugarcane eco-system

The laboratory evaluation of individual and consortium of isolate of entomopathogenic fungi for control of white fly, (*A. barodensis*) revealed that spraying of individual entomopathogenic fungi T1-spraying of *Beauveria bassiana*, T11-spraying of BVM and consortia of WF1 WF2, WF3, WF4, and WF 5 and T4 BVM product @ 1:1 dilution resulted in 62.72%, 58.07% and 52.01%, reduction in white fly population respectively after eight days of spraying. Spraying of consortium of T4- BVM product, T1- spraying of *Beauveria bassiana* and T11- spraying of BVM and consortia of WF1, WF2, WF3, WF4, WF5 @ 1:1 dilution showed maximum reduction (72.13%, 68.27% and 66.44%, respectively) in white fly population after ten days. Among the all fungal isolates, microbial and spore count of *M. anisopliae* recorded maximum i.e  $3 \times 10^{10}$  cfu/ml and 313 spores/ml respectively, followed by *B. bassiana*  $4 \times 10^{10}$  cfu/ml and 272 spores/ml. All five fungal cultures were compatible to each other and can be used for control of white fly (*A. barodensis*) at laboratory level studies.

#### Isolation, identification, characterization and development of special decomposing culture for decomposition of sugar ETP

In continuous sugar ETP feeding experiment, 4000 mg/lit COD, 1617  $\text{MgO}_2$ /lit BOD, 85.78  $\text{MgSO}_4$ /lit sulphate, 62.48  $\text{MgCl}_2$ /lit chlorides, 353 mg/lit TSS and

200 mg/lit TDS was found in initial sugar effluent. After treatment with Subac culture (Market product usually used by the most of mills), it was 1200 mg/lit COD, 500 MgO<sub>2</sub>/lit BOD, 77.98 MgSO<sub>4</sub>/lit sulphate, 69.98 MgCl<sub>2</sub>/lit chlorides, 2326 mg/lit TSS, and 2920 mg/lit TDS and in developed consortia, it was 400 mg/lit, 180 MgO<sub>2</sub>/lit, 72.94 MgSO<sub>4</sub>/lit, 134.96 MgCl<sub>2</sub>/lit, 2738 mg/lit & 2940 mg/lit, respectively recorded after 5 days of incubation. The batch wise feeding with sugar ETP at 2, 4, 6, 8, 12, 24 hrs up to 5 days recorded 6000 mg/lit COD, 2632 MgO<sub>2</sub>/lit BOD, 100 MgSO<sub>4</sub>/lit sulphate, 65.00 MgCl<sub>2</sub>/lit chlorides, 250 mg/lit TSS, and 2000 mg/lit TDS in initial sugar effluent. In this experiment after treatment with Subac culture, 5600 mg/lit COD, 2253 MgO<sub>2</sub>/lit BOD, 250 MgSO<sub>4</sub>/lit sulphate, 69.98 MgCl<sub>2</sub>/lit chlorides, 278 mg/lit TSS, and 6884 mg/lit TDS and in developed consortia, it was 4000 mg/lit, 1620 MgO<sub>2</sub>/lit, 257.53 MgSO<sub>4</sub>/lit, 64.98 MgCl<sub>2</sub>/lit, 264 mg/lit & 1938 mg/lit, respectively after 3 days of incubation. It was confirmed that the fast decomposition of sugar effluent was carried out by consortium of decomposing culture than Subac culture which is used by most of the mills.

#### **Studies on compatibility of beneficial microorganisms with oligo-chitosan (Biostimulator) and its effect on sugarcane**

In compatibility studies of all beneficial microorganisms, Phosphate solubilizing bacteria showed compatibility with chitosan A, with 15, 20, 75, 100 ppm concentrations whereas chitosan B with 5, 15 and 75 ppm concentrations. Silicate Solubilizing bacteria showed compatibility with chitosan A at 5, 20, 75 ppm and at 5, 10, 15, 25, 50 and 100 ppm of chitosan B concentrations. Nitrogen fixing bacteria showed compatibility with chitosan A at 5, 15, 20, 25 ppm and at 5 and 150 ppm with chitosan B concentrations.

Potash mobilizing bacteria showed compatibility at 5, 10, 15, 25, 50, 75, 100 ppm chitosan A and chitosan B at 5-150 ppm. Sulphur Oxidizing microorganism showed compatibility at 5, 20, 75, 100, 150 ppm chitosan A and at 10, 15, 50, 75, 100, 150 ppm chitosan B concentrations. Iron and zinc solubilizing microorganisms showed compatibility with 5, 25, 75, 100 ppm chitosan A and at 10, 15, 75, 100 ppm chitosan B concentrations. Protein concentration of 4th and 7th day old PSB culture showed higher protein concentration 0.458 µg/ml and 0.476 µg/ml respectively. Protein concentration increased to 0.8799 µg/ml of 4th day old PSB culture after saturation. PSB showed less acid and alkaline phosphatase activity. Standardization of protocol is under process.

Organic acids estimation protocol standardization by HPLC system with standard organic acids was performed. Further process of evaluation of chitosan effect on organic acids production by microorganisms is under study. Qualitative and Quantitative estimation of phosphate solubilization by PSB and other soil beneficial isolates protocol standardization and their effect on chitosan A and chitosan B on beneficial activity of microorganisms is under study.

#### **Isolation, identification and screening of plant growth promoting rhizobacteria for enhancing cane and sugar yield of sugarcane crop**

Out of twenty-five bacterial isolates, fifteen were studied for plant hormone i.e. Indole Acetic acid (IAA) and Gibberelic acid (GA). The IAA production was recorded highest 1359 µg/ml and 988.4 µg/ml respectively by isolate no. 4 & 14 in broth with tryptophan (3 mg/ml). The higher GA production in broth 7.27 µg/ml & 9.25 µg/ml by isolates 11 & 17 respectively.

Out of ten screened isolates, higher IAA (1007.0 µg/ml) production was shown by PGPR 3 followed by 205.4 µg/ml IAA by isolate no PGPR 5. These isolates were further used for pot scale studies. The pot scale trial on var. Co 86032 for growth of sugarcane showed higher tillering ratio (1:6.33 & 1:5.67) at 5 mg/ml concentration and higher leaf lamina (3.00 cm & 2.83 cm) by isolate no. PGPR 5 at 1 mg/ml & 5 mg/ml concentration respectively. There is no effect on number of leaves. Further evaluation of PGPR isolate on sugarcane yield and quality is in progress.

#### **Field research**

##### **Effect of application of consortium of agricultural beneficial microorganism as soil health and endophytic Nitrogen fixing bacterial liquid bio-inoculant (Plant health) on yield and quality of sugarcane ratoon in nutrient exhausted soil**

The field trial was carried out in nutrient exhausted soil to evaluate the effect of soil health containing eco-friendly beneficial microorganisms viz. nitrogen fixers, phosphate solubilizers, potash mobilizing bacteria, sulphur oxidizing bacteria, silicon solubilizing bacteria, iron and zinc solubilizing bacteria and plant health containing endophytic nitrogen fixing bacteria. The study revealed that significantly highest cane yield (102.68 t/ha) and CCS yield (14.67 t/ha) was recorded in drenching of soil health @ 10 lit./ha at planting, 30, 75, and 120 DAP and foliar application of plant health @ 3.0 lit./ha at 60 DAP with 0% N & 50 % PK over





control (100% NPK), where cane yield (93.65 t/ha) and CCS yield (12.57 t/ha) was found.

#### **Effect of application of microbial slurry containing natural agricultural beneficial microorganisms on yield and quality of sugarcane**

The field trial was conducted to evaluate the effect of microbial slurry containing natural eco-friendly beneficial microorganisms viz. nitrogen fixers, phosphate solubilizers, potash mobilizing bacteria, sulphur oxidizing bacteria, silicon solubilizing bacteria, iron and zinc solubilizing bacteria. The study revealed that the highest cane yield (151.07 t/ha) and CCS yield (21.40 t/ha) was found in 100% RDF along with application of microbial slurry as a sett treatment and its drenching at planting, 30, 60, 90 and 120 DAP over the treatment where RDF & microbial slurry was not used i.e. cane yield (80.43 t/ha) and CCS yield (10.98 t/ha) found.

#### **Studies on use of bio-toxins as bio-weedicide for control of weeds (pre-emergence & post emergence) in sugarcane (Pot culture/ Field studies)**

The field study was carried out to test the effect of bio-weedicide on pre & post emerged weeds. It showed weed control within 48 hrs. but vegetative growing weeds like grass, shippi & lavalas were regenerated when irrigation was given seven days after bio-weedicide application. From the field trial, it was confirmed that bio-weedicide can control seed borne weeds. No phytotoxicity in sugarcane crop was observed. Significantly highest cane yield (86.55 t/ha) and CCS yield (12.22 t/ha) was observed in pre + post emergence application of bio-weedicide at 5<sup>th</sup> and 9<sup>th</sup> DAP followed by application of bio-weedicide at 7<sup>th</sup> and 9<sup>th</sup> DAP showed (80.70 t/ha) cane yield and (11.10 t/ha) CCS yield.

#### **Effect of application of different entomopathogenic fungi (EPF) and entomopathogenic nematode (EPN) for control of white grub in sugarcane crop (IInd plant cane) - Naigaon farm**

The field study on efficacy of EPF & EPN against white grub in sugarcane (CoM 0265) revealed that the highest germination percentage at 45 DAP was observed 69.72% in T2 (Fipronil 5 SC). The tillering ratio at 120 DAP was observed 1:4.29 in T5- drenching with *Beauveria bassiana* @ 7.5 lit/ha (1 x 10<sup>10</sup> conidia per ml).

#### **Effect of application of entomopathogenic nematode on sugarcane crop for control of white grub pest (IInd Plant cane)- Naigaon farm**

The field study on efficacy of EPN against white grub in sugarcane crop (CoM 0265) revealed that, the highest germination percentage at 45 DAP was observed 70.20% in drenching of EPN @ 4000 IJ/ml. The tillering ratio at 120 DAP was observed highest 1:4.77 in T1-drenching of EPN @ 1000 IJ/ml.

#### **Evaluation of some newer insecticides and newer bio-control agents like entomopathogenic fungi (EPF) against white fly, (*Aleurolobus barodensis* Maskell) in sugarcane (Two plant + Ratoon) at SMS Kolhe SSK**

##### **(Pooled results)**

Application of consortium of *Metarhizium anisopliae* + *Lecanicillium lecanii* + *Aspergillus flavus* + *Cladosporium tenuissimum* + *Fusarium chlamydosporium* @ 5 ml/lit of water (1×10<sup>8</sup> CFU) showed maximum reduction (74.13%) in white fly population followed by *Cladosporium tenuissimum* @ 5 ml/lit of water (1×10<sup>8</sup> CFU) i.e. 73.49% and Thiamethoxam 30% FS @ 0.5 ml/lit of water i.e. 72.48%. Spraying of consortium of *Metarhizium anisopliae* + *Lecanicillium lecanii* + *Aspergillus flavus* + *Cladosporium tenuissimum* + *Fusarium chlamydosporium* @ 5 ml/lit of water (1×10<sup>8</sup> CFU) found equally effective as spraying of individual formulation of *Cladosporium tenuissimum* @ 5 ml/lit of water (1×10<sup>8</sup> CFU) and Thiamethoxam 30% FS @ 0.5 ml/lit of water.

#### **Revalidation of “effect of foliar application of consortium of endophytic nitrogen fixing bacterial liquid bio-inoculant on sugarcane” trial (Revalidation and Demonstrative trial)**

##### **Research trial**

The field trial was conducted in nutrient exhausted soil by growing hybrid maize (African tall) for three months at Manjari farm. The study revealed that significantly highest cane yield (127.89 t/ha) and CCS yield (17.74 t/ha) was observed in 0% N & foliar application of consortium of endophytic bacteria @ 3 lit/ha. followed by 25% N & foliar application of consortium of endophytic N fixing bacteria (120.97 t/ha cane yield & 16.26 t/ha CCS yield) as compared to 100% RDF (104.56 t/ha cane yield and 14.36 t/ha CCS yield).

### Demonstrative trial

The demonstrative trial was conducted at Manjari farm in nutrients exhausted soil by growing maize (African tall) for 3 months. The study revealed that highest cane yield (93.88 t/ha) and CCS yield (14.35 t/ha) was observed in 0% N & foliar application of consortium of endophytic bacteria @ 3 lit/ha as compared to 100% RDF (93.87 t/ha cane yield and 13.80 t/ha CCS yield). The application of 25% N & foliar spray of endophytic bacteria @ 3 lit/ha resulted 91.58 t/ha of cane yield and 14.18 t/ha of CCS yield.

### Demonstrative trial at sugar mills

The demonstrative trial was conducted at Pandurang SSK, Vishwasrao Naik SSK, Nira Bhima SSK and Shri Nath Mhaskoba, where soils are nitrogen deficient. The study revealed that highest cane yield (163.39 t/ha) and CCS yield (16.52 t/ha) was found in 25% N & foliar application of consortium of endophytic bacteria. @ 3 lit/ha as compared to 100% RDF (147.61 t/ha cane yield and 15.69 t/ha CCS yield). The treatment 0% N & foliar application of consortium of endophytic bacteria @ 3 lit/ha showed 146.31 t/ha cane yield and 16.02 t/ha CCS yield.

### Effect of consortium of halotolerant & halophilic microorganisms on biological remediation of saline sodic soil

Trial was planted on January 31, 2022. Initial chemical and microbial analysis of soil sample was completed. Recording of observations as per schedule is in progress.

### Effect of application of liquid bio-fungicide and Vasant Urja on sugarcane crop for control of rust & brown spot diseases

The field trial was conducted at Daund sugars, for control of rust disease revealed that, foliar application of Vasant Urja @ 2.5 lit/ha + Probineb (Antracol) @ 3 gm/lit treatment recorded minimum incidence of disease i.e. 11.91%. However, foliar application of Probineb (Antracol) @ 3 gm/lit was also effective for management of rust in sugarcane (12.78%).

The field trial was conducted at Vishwasrao Naik SSK and results revealed that minimum incidence (20%) of brown spot was observed in foliar application of Blitex 50% wp (Copper oxychloride @ 2 g/lit). Whereas, maximum incidence (39.50%) in control.

### AGRICULTURAL ENGINEERING

Activities of the section are focused on irrigation water management and sugarcane mechanization. The advanced technologies of water and fertilizer management through micro irrigation systems are developed by the section. The farm equipments for mechanized sugarcane farming are also developed by this section. These technologies and equipments developed by the section are recommended through Joint Agresco of Agricultural Universities in Maharashtra State. The fertigation technology developed by the section has wider adaptability in sugarcane crop. The single row sugarcane planter is developed by the section in collaboration with M/s Rohit Krishi Industries, Pune has been commercialized and has a wide adaptability in cane cultivation. The newly created facility of sprinkler pipe testing has been accredited by NABL along with existing facility of drip material testing.

### Performance evaluation of inverted sprinkler system in sugarcane crop

The results of plant cane and two ratoon crops revealed that among different systems of irrigation viz. inverted sprinkler, drip, raingun sprinkler, inverted sprinkler along with drip and surface irrigation, inverted sprinkler along with drip recorded the highest cane yield of 146.68 t/ha and 0.95 t/ha-cm water use efficiency. The inverted sprinkler system alone recorded cane yield of 124.91 t/ha and 0.63 t/ha-cm water use efficiency. Both the treatments were at par with drip and raingun sprinkler systems.

### Response of bio stimulator (Vasant Urja) for water stress management in sugarcane under drip irrigation

The results of plant cane revealed that among irrigation levels of 1.0 and 0.3 ETc, 1 ETc level recorded cane yield of 149.58 t/ha and was significantly superior over 0.3 ETc level. No significant difference in cane yield was recorded in any combination of bio stimulator Vasant Urja with salicylic acid, ortho silicic acid, MOP spraying and control treatments. The highest cane yield of 150.64 t/ha was recorded in 20 ppm ortho silicic acid sett dipping and foliar sprays at 30, 60, 90 and 120 DAP. The interaction of irrigation level and bio-stimulator, salicylic and ortho silicic acid. Muriate of potash (MOP) spraying also does not show any significant difference in cane yield over control. The highest cane yield of 159.40 t/ha was recorded in 100 ppm chitosan and 20 ppm ortho-silicic acid, sett



dipping and foliar spray at 30, 60, 90 and 120 DAP under 1.0 ETc irrigation level. The further trials are in progress.

### Development of Cane Loader

The cane loader is developed in collaboration with Mr. Mathew Zacharias, Mumbai. The design, drawings and development of prototype is completed. The modifications are done in loader after testing in the field. The ease of cane loading operation is possible with the equipment with minimum involvement of man power. The extensive field trials of cane loader are in progress before its commercialization.

### Development of single row sugarcane sett planter

The tractor operated single row sugarcane sett planter is developed in collaboration with M/s Rohit Krishi Industries, Pune. The sugarcane planter carries out the operation viz. cuts the whole cane into setts, apply insecticide and fungicides to the setts, place the setts in the furrows, apply fertilizers in the furrow, cover the setts and fertilizers with soil. The planter is useful for sugarcane planting at a distance of 5'. The planter saves 50% cost on sugarcane planting as compared to manual planting. The planter is commercialized and is under wider adoption by the farmers.

## AGRICULTURAL ECONOMICS

This section collects, compiles and analyzes the data on cost of cultivation, impact of adoption of innovative techniques of sugarcane cultivation, season-wise and variety-wise area under sugarcane in the area of different sugar mills. Estimates percent seed area change in the operational area of sugar factories. In addition to these findings and information to the government officials for future planning is provided. The section is also engaged in conducting lectures on agricultural economics to farmers, different organization and academic courses, and also conduct statistics lecture to students of academic courses and gives statistical guidance to scientists of the institute.

### Trends in variety-wise area and their impact on productivity and sugar recovery in Maharashtra

The majority of sugarcane area in the state was covered by VSI 08005, Co 86032, CoM 0265 and MS 10001 during last five years (2017-18 to 2021-22). Other varieties in the state were in the range of 5.99% (2021-22) to 12.90% (2017-18). The varieties Co 86032 and CoM 0265 have consistently covered

74-80% area in the state. With the decrease of 8.16% i.e. from 82.48% (2019-20) to 74.32% (2020-21) and increased to 76.63% (2021-22). The variety Co 86032 covered in the range of 46-54% and the variety CoM 0265 in the range of 28-33% in the state. The variety VSI 08005 covered about 10% area and MS 10001 covered about 6% area during last two years 2020-21 to 2021-22. These two varieties have shown rising trend i.e. VSI 08005 [0.41% (2017-18) to 11.10% (2021-22)] and variety MS 10001 [1.2% (2017-18) to 6.28% (2021-22)]. (Fig 1).

The overall average cane yield of the state (92 t/ha) was recorded maximum in 2017-18, while, it was minimum (79 t/ha) in 2019-20. Maximum sugar recovery was attained in 2019-20 (11.29%) (Fig 2). In 2021-22, average sugarcane yield is expected to increase by 1.5\* t/ha and decrease in sugar recovery by 0.02 units as compared to 2020-21 due to long duration of crushing season. (\* - Estimated figure)

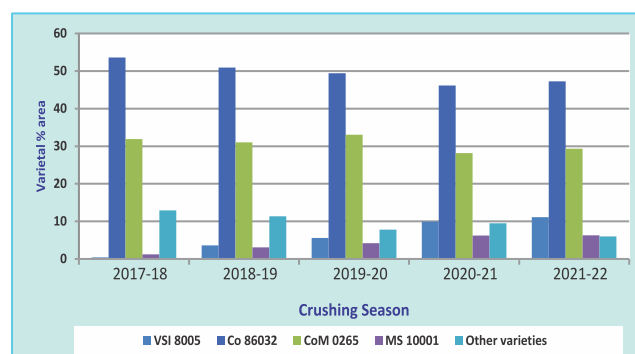


Fig 1: Trends in variety-wise area

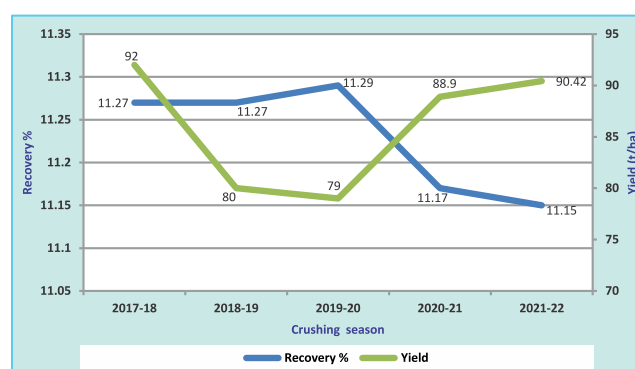


Fig 2: Trends in average yield and sugar recovery



## Trends in season wise planting area in Maharashtra

It is expected that proportion for sugarcane plantation in *adsali*, preseason, *suru* and ratoon crop is 10:30:20:40 percent respectively, while actual trend during last 5 years (2017-18 to 2021-22) showed variation. The variation in planting season depends on climatic factors, rainfall distribution and price of sugarcane. *Adsali* area was in the range of (25% (2017-18) to 18% (2018-19)), preseason [30% (2017-18) to 12% (2019-20), *suru* (23% (2020-21) to 7% (2019-20))] and ratoon crop [54% (2019-20) to (27% (2017-18)]. In planting season area was maximum 72.82% (2017-18) and minimum 45.54% (2019-20) while, ratoon crop area was maximum (54.46%) in 2019-20 and minimum (27.18%) in 2017-18. This means more planting was done in 2017-18 and less in 2019-20, means farmer kept more ratoon crop in 2019-20 and less in 2017-18. In year 2021-22, *adsali* area was decreased by 0.64%, preseason increased by 0.76%, *suru* decreased by 7.83% and ratoon crop increased by 7.71% as compared to last year. In view of the economics of cost of cultivation, it was observed that the ratoon crop area remained at around 40-45%.

## Estimate of percent seed area change in the operational area of sugar mills

In cane development programme of sugar mills, one third area of total plantation required to be changed every year, so the percent seed area change can be obtained from certified seed plantation. Under this study, the data was received from 74 sugar mills in Maharashtra. Out of that, nursery programme was not operated in 28 sugar mills during 2020-21. In 2020-21, out of 46 sugar mills who implemented seed program, 21 have changed seed up to 25%, thirteen classified under 25 to 50%, four classified under 51 to 75%, and 76 to 100% each. Only four sugar mills have changed the seed more than 100%.

From the above study, it was observed that the efforts towards change of seed are very poor. More efforts required from sugar mill for taking seed nursery under cane development program to bridge this gap so that good quality of seed from three tier system will be provided to the farmers and there by yield in operational area of sugar mill could be enhanced.



## CROP PROTECTION

### ENTOMOLOGY

The section undertakes screening of varieties in AICRP'S trials and promising genotypes developed under Institute's breeding programme against major insect pests. The section conducts survey of insect pests and trial on Integrated Pest Management (IPM) of major sugarcane insect pests, mass multiplication of potential bio-agent and its supply to sugar mills & sugarcane growers, bio-efficacy of new insecticide against white grub, integrated approach to manage it and bio-efficacy of insecticides against *Spodoptera* spp. on sugarbeet for effective and timely management of pests.

### Evaluation of zonal varieties/genotypes for their reaction against major insect pests

#### Advance varietal trial (I Plant)

Out of eight varieties/ genotypes screened were noticed tolerant to early shoot borer and internode borer. Only CoC 671 (std.) was found highly susceptible to early shoot borer and Co 16006 was moderately susceptible to internode borer.

#### Advance varietal trial (II plant)

Out of sixteen varieties/ genotypes screened, thirteen were tolerant to early shoot borer and fifteen for internode borer. Out of which, fourteen varieties/ genotypes were tolerant and Co 14005 & Co 15006 were found moderately susceptible to mealy bug. Out of screened varieties/ genotypes, fifteen were free from scale insect infestation.

#### Advance varietal trial (Ratoon)

All the varieties/ genotypes screened were tolerant to internode borer and scale insect. Thirteen genotypes were tolerant to early shoot borer out of fifteen, while CoC 671 (Std.) and Co 09004 (Std.) were moderately susceptible to early shoot borer and Co 15005, CoSnk 15102 & PI 15131 were free from mealy bug infestation.

### Survey and surveillance of sugarcane insect pests

In the area of Pandurang SSK, the percent incidence of early shoot borer was maximum (6.84%) on ratoon crop (October 2021) of Co 86032. Internode borer was in the range of 0 to 20% and the mealy bug was found only on Co 86032 (40%) planted in July 2021. In the area of Dwarkadhish Sakhar Karkhana Ltd., the percent incidence of early shoot borer was maximum (2.51%) on ratoon crop (January 2022) of VSI 08005, internode borer was found (10%) on Co 86032 planted in August



2021. In the area of Adiwasi SSK, the percent incidence of early shoot borer was maximum (1.73%) on VSI 08005 planted in January 2022 and internode borer was found (20%) on VSI 08005 planted in August 2021.

### **Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem**

The incidence of early shoot borers was in the range of 0.00 to 26.67% and it was maximum 26.67% in 22nd standard meteorological week (31.05.2021). Internode borer was found in the range 0 to 11% and it was recorded maximum 11% in the 4th standard meteorological week (28.01.2022). Mealy bug incidence was found in the range 0 to 26% and it was recorded maximum 26% in the 48th standard meteorological week (02.12.2021). Scale insect was in the range of 0 to 7% and it was recorded maximum 7% in the 50th standard meteorological week (13.12.2021).

### **Standardization of simple, cost effective techniques for mass multiplication of sugarcane bio-agents**

Produced 2017.90 cc *Corcyra* eggs, 1318 *Trichogramma chilonis* cards and 226 *T. Pretiosum* cards. Supplied 569 *Trichogramma chilonis* cards and 30 *Trichogramma pretiosum* cards for management of borer insect pest. 188 cc *Corcyra* eggs, 15 *Trichogramma chilonis* cards and 29 *Trichogramma pretiosum* cards were supplied to bio-control lab as nucleus culture.

### **Integrated approach to manage white grubs in sugarcane**

Organic module was free from white grub infestation from July to Sept. 2021. In treated module, no. of grubs per clump were 0.4, 0.8 and 0.0 in Jul., Aug. and Sep. 2021, respectively, while in untreated block, no. of grub per clump were highest 2.0, 1.4 and 0.2 in July 2021, Aug 2021 and Sept 2021, respectively.

### **Assessment of yield losses caused by borer pests of sugarcane under changing climate scenario**

The cumulative percent incidence of early shoot borer was 3.15% in treated block, while 9.27% in untreated block. Plant population per ha was numerically higher 62,381 in treated block and it was 59,524 in untreated block. Sugarcane yield per ha was statistically higher 154.50 t/ha in treated block, while it was 114.50 t/ha in untreated block.

### **Evaluation of zonal varieties /genotypes for their reaction against major insect pests in IVT**

Out of sixteen varieties/genotypes screened, fifteen were found tolerant against early shoot borer. All

varieties/genotypes were tolerant to internode borer and mealy bug. Fourteen were tolerant and two were moderately susceptible to scale insect.

### **Evaluation of varieties/genotypes for their reaction against major insect pests in breeding trials at VSI**

#### **Field screening of sugarcane varieties/ genotypes in MLT (IInd Plant Adsal)**

Out of twenty-one varieties/genotypes screened, fourteen were tolerant and seven were moderately susceptible to internode borer. For mealy bug, three varieties/genotypes were tolerant and eighteen were moderately susceptible. Twenty varieties/ genotypes were tolerant to scale insect.

#### **Field screening of sugarcane varieties/ genotypes in MLT (IInd Plant Preseason)**

Twenty varieties/genotypes screened were found tolerant against early shoot borer and internode borer and free from mealy bug and scale insect infestation.

#### **Field screening of sugarcane varieties/ genotypes in MLT (II Plant Suru)**

Out of fifteen varieties/genotypes screened twelve and three were tolerant and moderately susceptible to early shoot borer, respectively. All varieties/genotypes were found tolerant against internode borer and mealy bug and also free from scale insect infestation.

#### **Field screening of sugarcane varieties/ genotypes in FVT (I Plant 2015, 16, 17, 18)**

Twenty-one varieties/genotypes were screened against early shoot borer and internode borer and found tolerant. Co VSI 12-2, VSI 82-1, VSI 125-2, CoVSI 18121 and CoM 0265(Std.) were free from early shoot borer infestation. VSI 82-1 VSI 125-2 and VSI 103-6 were free from internode borer. Mealy bug infestation was found 2% in Co VSI 12-1, VSI 103-6 VSI 62-1 and CoVSI 12121, while other varieties/genotypes were free from it. All varieties/genotypes screened were free from scale insect, except Co VSI 12-1 (12%).

#### **Field screening of sugarcane varieties/ genotypes in MLT (Ist Plant, Suru, factory)**

Out of fifteen varieties/genotypes screened, eight were tolerant and seven moderately susceptible to early shoot borer. All were tolerant to internode borer and scale insect and fourteen were tolerant to mealy bug.

#### **Field screening of sugarcane varieties/ genotypes in MLT (Ist Plant, Adsal, ratoon)**

All sixteen varieties/ genotypes screened were tolerant to early shoot borer and internode borer. Nine

and seven varieties/genotypes were tolerant and moderately susceptible to mealy bug respectively and fifteen varieties/genotypes were tolerant to scale insect.

#### **Field screening of sugarcane varieties/ genotypes in MLT (Ist Plant, Preseason, ratoon)**

All fifteen varieties/genotypes screened found tolerant to early shoot borer and internode borer. Four were tolerant and eleven were moderately susceptible to mealy bug, whereas, ten, four and one varieties/genotypes were tolerant, moderately susceptible and highly susceptible to scale insect, respectively.

#### **Field screening of sugarcane varieties/ genotypes in MLT (Ist Plant, Suru, ratoon)**

All fifteen varieties/ genotypes screened were tolerant to early shoot borer and internode borer. From screened varieties/genotypes one were tolerant and fourteen were moderately susceptible to mealy bug. CoVSI 17121 was free from mealy bug infestation. Whereas, seven were found tolerant, seven were moderately susceptible and one was highly susceptible to scale insect.

#### **Field screening of sugarcane varieties/ genotypes in PFVT (2017 Batch, Ratoon)**

Total twenty-five varieties/genotypes screened were tolerant to early shoot borer and internode borer, whereas, three, seventeen and five varieties/genotypes were tolerant, moderately susceptible and highly susceptible to mealy bug, respectively. CoVSI 17121 and 82-1 were free from mealy bug infestation. While seventeen were tolerant, six moderately susceptible and two were highly susceptible to scale insect.

### **PLANT PATHOLOGY**

The section carries out research on diseases of sugarcane caused by biotic and abiotic factors. The section is also associated in screening of newly developed sugarcane genotypes by VSI and genotypes under Zonal Varietal Trials against diseases of sugarcane under natural as well as artificial disease conditions. The basic work in Plant Pathology is also carried out in laboratory by staff of the section as well as students on 'On Hand training' deputed by various research institutions. This section is associated with other disciplines to carry out field experimentation at VSI farms and also other farms outside VSI. The staff of the section participates in providing different extension services including farmers & officers training programs, television & radio programs, popular publications, 'online' lectures and consultancy services to sugar mills, other institutes and NGO's.

#### **Evaluation of varieties/genotypes under zonal testing for resistance to smut under artificial disease condition**

Thirty-seven genotypes including 23 under ZVT's, 2 susceptible checks (Co740 and Co 7219), 3 Standard checks (Co 86032, CoC 671 and Co 94004) as well as fourteen genotypes which have shown resistance in last year were screened artificially for evaluating their resistance to smut disease. Out of 37, eighteen genotypes were found resistant, ten moderately resistant and nine were moderately susceptible to smut.

#### **Identification of yellow leaf disease resistant varieties under natural condition**

Yellow leaf disease (YLD) incited by Sugarcane Yellow Leaf Virus (ScLV) is observed on major commercially cultivated sugarcane varieties in many states of India. At VSI, as per the guidelines of AICRP(S), five genotypes were observed in 8th, 10th and 12th month's age to see the natural incidence of YLD and were classified on the basis of severity grades. Out of five genotypes tested, YLD was noticed on Co 16010 and was found moderately susceptible, while remaining four were resistant to YLD.

#### **Methodology for screening of varieties for brown rust**

Five genotypes under AVT were observed throughout the crop period for the natural occurrence of brown rust disease of sugarcane. After the initiation of the disease, six observations were recorded at weekly intervals. Out of five genotypes, Co 16006 and PI 16131 were found moderately resistant, while remaining three were found resistant to brown rust.

#### **Screening of entries under AVT for pokkah boeng**

Five genotypes under AVT were observed throughout the crop period for the natural occurrence of pokkah boeng. The observations were recorded after every fortnight till the harvest of the crop. Out of five genotypes, Co 16006 genotype was found moderately susceptible to pokkah boeng disease, while remaining four genotypes Co 16010, Co 16018, CoVSI 16121 and PI 16131 were found resistant to pokkah boeng under natural conditions.

#### **Survey of diseases of sugarcane in Maharashtra**

- The smut caused by *Sporisorium scitaminae* was observed in severe form in some parts of Marathwada and Vidarbha region of Maharashtra due to climate change, rise in temperature, negligence towards change of seed and poor management of ratoon crop. The incidence was more in ratoon crops of Co 86032 and VSI 08005.



- All the commercially cultivated varieties of sugarcane in various stages of crop growth found succumbed to grassy shoot disease. The incidence was more in ratoon crops as compared to plant crop. The incidence was found more in CoM 0265, Co 86032 and CoC 671.
- Brown rust was observed severe in western part of Maharashtra and orange rust noticed in central part of Maharashtra. However, the incidence of brown rust was severe in Western and Central Maharashtra in CoM 0265, Co 86032 and Co 92005.
- The incidence of pokkah boeng was observed in all commercially cultivated varieties in all parts of Maharashtra. All the stages of the disease including knife cut stage were observed on affected canes.
- Incidence of YLD was maximum in all the regions on Co 86032, VSI 08005 and CoC 671 up to 25%. Though, the disease initiation was commonly observed after 8th months age of the crop, last year, the incidence was also noted in early crop period in ratoon crop.

### Management of yellow leaf disease through meristem culture

Under this AICRP(S) project, properly hardened tissue culture plantlets of two varieties Co 86032 and VSI 08005 were used for the production of breeders' seed and were observed throughout the year for the natural incidence of YLD. The incidence of YLD was observed on VSI 08005 where, planting material was used from commercial nursery in the form of setts, while rest of treatments were free from YLD disease.

### Efficient delivery of the fungicides and other agro inputs to manage major fungal diseases

Under this AICRP(S) project, sett treatment with fungicide (Propiconazole) was carried out by using sett treatment device for management of smut disease. The incidence of smut was observed up to 10.33%, throughout the year in treatment where infected setts were used; while rest of treatments were free from smut.

### Screening of promising clones of sugarcane developed by VSI for resistance to smut

Nine clones developed at VSI along with two standard checks (Co 740 and Co 7219) were screened artificially for evaluating their resistance to smut disease. Out of nine clones, five were found resistant, three were moderately susceptible; while, one clone found susceptible. Co 740 and Co 7219 were found moderately susceptible and moderately resistant to smut disease, respectively.

### Natural incidence of known and unknown diseases of sugarcane on promising genotypes tested under zonal trials at VSI

Under AICRP(S), Plant Breeding section tested 30 genotypes and three standard checks under three trials for assessing the performance at VSI. The bi-monthly observations on natural incidence of diseases of sugarcane were recorded. Observations revealed that, grassy shoot was noted on eight genotypes, pokkah boeng on twenty, mosaic on eight, brown spot on one, brown rust on eight and yellow leaf disease on fourteen genotypes. However, seven genotypes were free from all diseases throughout the year.

### Occurrence of major diseases on promising genotypes of sugarcane at VSI

Sugarcane genotypes under seven trials viz., MLT-I Plant-*Suru* (ratoon); MLT-II Plant- Preseason, MLT-I Plant- Preseason (ratoon), MLT II Plant-*Adsali*, MLT II Plant *Suru*, MLT I Plant *Suru* (sugar mill) PFVT and FVT I conducted at VSI were observed for naturally occurring diseases, in the area. The observations reveal the presence of whip smut on twelve genotypes, grassy shoot disease on seventeen, brown spot on two, brown rust on eighteen, pokkah boeng on 35, mosaic on seven and YLD on eighteen genotypes. Twenty genotypes were observed free from diseases.

### Management of pokkah boeng by nonchemical means

Under this project, two botanicals Tulsi (*Ocimum tenuiflorum*) and neem (*Azadirachta indica*) and two bio-agents *Trichoderma viride* and *Pseudomonas fluorescense*, along with carbendazim were tested. The data revealed that, there was a significant difference in treated and untreated plots. The maximum disease control (58.02%) was obtained by 3 foliar sprays of Tulsi @10% at an interval of 15 days after initiation of disease. However, Neem @ 10% as well as Carbendazim 0.1% were also found promising to control the pokkah boeng. The results were synonymous with the previous year's experimentation.

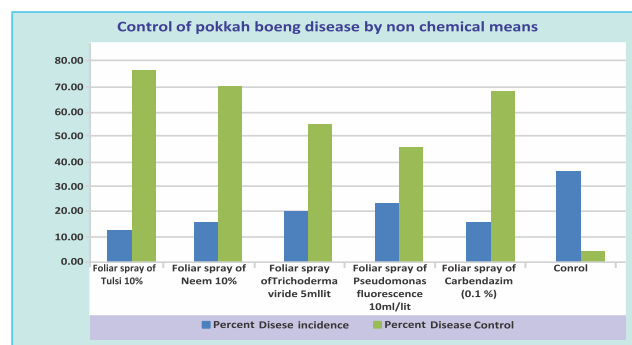


Fig 3: Management of pokkah boeng by nonchemical means

### Efficacy of irradiated chitosan (Nanoparticles) in combination with silver nanoparticles and fungicide for the management of pokkah boeng disease in sugarcane

Under this VSI funded project, sett treatment and foliar application of irradiated chitosan alone or in combination with silver nanoparticles as well as fungicide were tested. The analyzed data revealed that, there is a significant difference in treated and untreated plots. The maximum disease control (73.11%) was obtained by 3 foliar sprays of silver nanoparticles (100 ppm) + Mancozeb (0.3%) + irradiated chitosan (50 ppm) at an interval of 15 days after initiation of disease which was at par with treatment irradiated chitosan (50 ppm) + Mancozeb (0.3%). (Fig. 4)

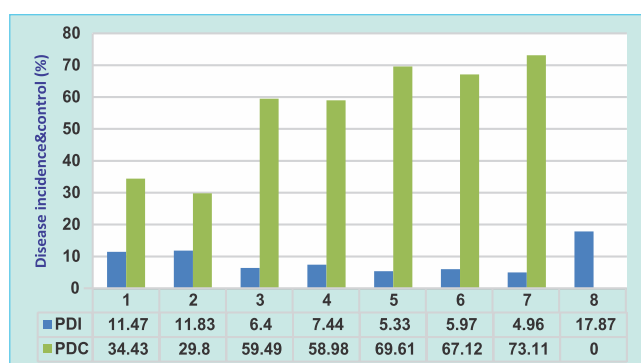


Fig 4: Efficacy of irradiated chitosan (Nano particles) for the management of pokkah boeng

### FARM DEVELOPMENT AND MANAGEMENT

The Institute is having six farms at different locations in the state. The land at Manjari farm and part of Vasantdada farm are used for field experiments and demonstration trials of Agriculture Sciences and Technology (AST) division. During the year various field experiments were taken on 29.62 ha and germplasm seed plot maintained on 0.85 ha at Institute’s farm. The lands of Naigaon and Lonarwadi farms are exclusively utilized for production of nucleus and the breeder’s seed of released, pre released varieties and promising genotype of sugarcane. In totality, 18.18 ha land was used for production of breeder’s seed at Institute’s farms for distribution to sugar mills and selected sugarcane growers for further production of foundation seed. The Amboli farm is particularly dedicated for the maintenance of sugarcane germplasm and development of new elite varieties through hybridization under plant breeding section.

The Patharwala Farm- This is a new acquisition of land of 51.33 ha

There was a demand to have a center of VSI for Marathwada, Vidarbha and Khandesh region in the suitable geographical area. Suitable and sizable land was identified at Gut No. 154 in Patharwala village, Tal. Ambad, Dist. Jalna. It was a Taluka seed farm of Department of Agriculture, Govt. of Maharashtra and remained idle, uncultivated for the last 25 years. Shrubs, herbs, thorny plants and trees with grasslands grown naturally and covered the entire farm, some area is water logged and marshy. The Institute purchased 51.33 ha (127 acre) land. The possession of the land was taken on January 2nd, 2021 after measurement, fixing boundaries by DILR office. Cleaning of grass land, shrubs, thorny plants and trees was done. Ploughing and sub soiling of land was carried out. Out of 51.33 ha, 42 ha will be available for crop planning and remaining 9.33 ha will be under canal, drainage nala, farm pond, open wells and farm building structures.

Demarcation of sizable plots, internal roads, leveling of land was carried out on priority basis. Existing three open wells were brought in operation by installing water pumps. Planting of sugarcane seed nursery was done immediately on 4.00 ha. Raised & managed scientifically and was harvested during Jan.-Mar. 2022 for distribution of breeders’ seed to the farmers and sugar mills in Marathwada, Vidarbha, Khandesh region and in Madhya Pradesh for planting on about 56 Ha.

Work of lift irrigation scheme of about 4.8 km length from Godavari river, erection of pump house, excavation of farm pond with a water storage capacity of 800 lakh liter, and barbed wire fencing on the farm boundaries have been started.

It has been decided to irrigate the sugarcane crop with drip irrigation. Initially, 14 ha was developed and brought under sugarcane cropping system during January 2022 with irrigation and fertigation through drip system. Seed nursery of 14 recommended sugarcane varieties has been raised. Second phase of drip irrigation on 40 acres will be completed by May 2022. Kharif, soyabean and pigeon pea sowing has been planned.

Considering the interruptions in electric supply for the irrigation pumps a solar system with a capacity of 14.4 KW / 22 AMP has been installed near a well. Building plans for construction of farm structures, staff quarters, administrative office, training hall etc. are being prepared by architect.

The area utilized for different purposes on these farms is given in table 8.





**Table 8: Area under sugarcane and rotational crops at different farms (ha)**

Particulars	Manjari	Vasantdada	Naigaon	Lonarwadi	Patharwala	Total
Plant cane expt.	6.70	9.23	1.47	2.38	-	19.78
Germplasm maintain	0.85	-	-	-	-	0.85
Ratoon cane expt.	2.10	4.28	0.20	3.28	-	9.86
Nucleus seed	0.16	0.20	1.71	2.14	0.4	4.25
Breeder seed	1.02	3.24	8.17	5.75	3.60	21.78
Commercial cane	-	-	3.99	5.29	-	9.28
Green manuring	5.60	8.40	18.80	8.01	-	40.81
<b>Kharif crop</b>						
1.Soybean	0.00	2.60	2.80	6.61	4.00	16.01
2.Green gram	0.00	0.00	0.00	1.09	-	1.09
<b>Rabi crops</b>						
1.Wheat	0.50	0.60	0.80	1.20	-	3.10
2. Chick pea	0.00	0.00	0.00	3.62	-	3.62
3. Onion	0.02	0.02	0.04	0.00	-	0.08
<b>Summer</b>						
1.Groundnut	2.00	0.00	0.00	0.40	-	2.40
2.Green gram	0.40	0.60	0.00	0.00	-	1.00

#### Land development

Land leveling and soil filling was done on 0.80 ha of Manjari farm and brought under cultivation. Uncultivable land at Naigaon and Lonarwadi of 5 ha and 0.4 ha respectively was brought under mango plantation.

#### Production of nucleus seed

Nucleus seed is preserved on 4.64 ha which originates from the sponsoring plant breeder or Institution recommended variety for the region. Seed cane obtained from Nucleus seed crop is subjected to heat treatment (MHAT at 54°C for 2.5 hr. at 95-99% RH). Total 0.275 million two budded setts of nucleus seed were produced and used for breeders' seed production at Institute's farm. The farm-wise nucleus seed planted during 2021-22 is given in table 9.

**Table 9: Farm-wise, variety-wise nucleus seed planted (ha)**

Variety / Farm	CoC 671	Co 86032	CoM 0265	CoVSI 03102	VSI 434	MS 10001	CoVSI 18121	VSI 08005	Total
Manjari	0.00	0.00	0.04	0.00	0.00	0.04	0.04	0.04	<b>0.16</b>
Vasantdada	0.01	0.02	0.03	0.01	0.01	0.01	0.10	0.03	<b>0.22</b>
Naigaon	0.04	0.50	0.30	0.08	0.08	0.05	0.44	0.23	<b>1.72</b>
Lonarwadi	0.01	0.39	0.29	0.01	0.01	0.29	1.00	0.14	<b>2.14</b>
Patharwala	0.00	0.10	0.00	0.00	0.00	0.10	0.10	0.10	<b>0.40</b>
Total	0.06	1.01	0.66	0.10	0.10	0.49	1.68	0.54	<b>4.64</b>

### Production of breeders' seed

Sugarcane being a vegetative propagated crop, most of the diseases are transmitted through setts, which affects the cane productivity adversely. Therefore, the production of disease free, healthy and genetically pure seeds through three tier seed program is very important. The breeders' seed is distributed to sugar mills and cane growers for production of foundation and certified seed. This seed multiplication chain is expected to increase sugarcane productivity by 15 to 20%. Breeders' seed production programme was taken on an area of 18.18 ha under NFSM, AICRP on seed project and from Institute's fund. Total 5.8 million two eye budded setts were supplied to 48 sugar mills in Maharashtra and outside states 0.29 million setts to nine mills. The section also distributed 1.46 million one eye bud settlings to fifteen mills in the State as a breeder's seed and outside states 0.18 million to eight mills. The settlings distributed are given in table 13 & 14 under Inputs and Analytical Services.

The rotational crops like sun hemp, soybean, cowpea, green gram, wheat, green gram and ground nut were taken in *kharif*, *rabbi* and summer seasons on 64.11 ha area. The onion seed production was undertaken on 0.08 ha area under Directorate of Onion and Garlic Research Centre, Rajgurunagar, Pune (ICAR) for production of quality seed of elite onion lines in isolation at Institute's farms.

### Monthly workshops

The Institute has continued the intensive programme of monthly one day workshop on important need based themes of sugarcane development. This activity has been started from July 2013 The workshop themes of conducted programme were as in table 10.

### Recommendations finalized in the working group

#### Progress of VSI's Promotional Cane Development Award Scheme (CDAS)

- All data regarding CDAS (area under various aspects like seed supply, varietal planning and harvesting programs, soil fertility inputs and drip irrigation) should be sent to the Institute for compilation.
- Maximum number of adaptive trials of newly developed midlate maturing, high sugared and erect growing genotype CoVSI 18121 in comparison with its mother parent Co 86032 should be conducted in all planting seasons. For this, maximum demand of the settlings should be booked to the Institute's Farm section for timely conduct of adaptive research trial on five acres of each or maximum 100 acres can also be booked, if you conduct the mini mill trial of eight hours each of CoVSI 18121 with Co 86032.
- Information on more participants for the award "Oos Bhushan" should be sent immediately.
- The demand for sugarcane seed and settlings of different varieties should be placed in advance at the earliest for timely supply.
- Application of drone is being popular now-a-days among the farmers for spraying in sugarcane, however, the basic research is undertaken by the Institute and MPKV, Rahuri. Hence, all the result data and experience of drone users through sugar mills should be shared/ made available with the Institute.

**Table 10: Monthly workshops**

Date	Title of the Seminar/ Workshop	No. of Participants	No. of Sugar Mills
Aug.28, 2021	Review of CDAS program	46	23
Oct.23, 2021	Management of soil fertility and characterization of salt affected soil	37	21
Nov.27, 2021	Sugarcane ratoon management	48	25
Dec.25, 2021	Review of CDAS program	44	25
Jan.22, 2022	Crop protection in sugarcane	62	30
Feb.26, 2021	Integrated water management in sugarcane	54	19
Mar.26, 2022	Sugarcane management in stress condition	42	21



### Soil fertility management and characterization of salt affected soil

- The practice of cross sub-soiling at 1m distance and two harrowing before plantation of sugarcane was beneficial pre tillage practice to increase cane and sugar yield in saline sodic soil
- It is necessary to use chemical amendments like Gypsum and sulphur for reclamation of sodic and saline sodic soil.
- Application of organic amendments like FYM, pressmud cake, green manuring, groundnut and safflower husk, wheat straw etc. is beneficial for improving the physical properties of soils.
- For higher cane yield, CCS yield and net monetary returns, the application of potassium @ 225 kg/ha  $K_2O$  through sulphate of potash was recommended along with recommended dose of N (340 kg/ha) and  $P_2O_5$  (170 kg/ha) for sodic soils of Western Maharashtra.
- Mulching by using crop residue, polythene sheet and sugarcane trash management helps in reduction in soil water loss through evaporation and capillary rise of ground water therefore, salt load remain in lower horizon. Soil moisture may be conserved by reducing the water evaporation. Thus, salts may remain in the lower horizon below root rhizosphere
- Subsurface drainage system should be adopted by the sugar mills in their area of operation for reclamation of salt affected soils.
- The application of organic matter / organic fertilizers accelerates the leaching of NaCl which decreases the percentage of exchangeable sodium, the electrical conductivity and increases water filtration, the water holding capacity and aggregate stability, consequently, the microbial biomass.
- Halophilic /halotolerant microbes are not only survives under high salt concentration but also possess ability to produce phytohormones, i.e. IAA, gibberellic acids, cytokinin & solubilize and bind nutrients like N, P, K and zinc.
- Microbial formulations of Halophilic/halotolerant microbes are ideal input for reclamation of salt-affected soils so it is necessary to use it as sett treatment, seedling dip and soil application with FYM/manure.

### Sugarcane Ratoon Management

- Multiple rationing proved cost effective; it should be encouraged in operational area of sugar mills.
- For higher ratoon productivity strictly follow agronomic practices viz. stubble shaving, trash mulching, off barring, gap filling and basal dose of fertilizer followed by irrigation within 15 days after harvesting of previous cane crop.
- The fertilizer should be applied 10-15 cm away from the root zone with the help of crow bar for increasing the fertilizer use efficiency in ratoon sugarcane.
- Application of 75% fertilizer nutrient worked out by STCR (Soil test crop response) equation through fertigation along with drenching of phosphate solubilizing bacteria @ 2.5 lit/ha at planting and foliar application of *acetobacter* @ 3.0 lit/ha at 60 DARI is recommended higher ratoon productivity.
- Grassy shoot disease (GSD) of sugarcane can be efficiently managed through the strategies like, use of healthy diseased free setts / plantlets from three tier seed nursery program, sett treatment with recommended pesticides, regular inspection of crop and roguing of affected stools and their destruction, and control of insect pests which acts as a vectors at right time may be employed.
- Vasant ujra can be sprayed/ Drenched with bio-fungicides on stubbles immediately after the harvesting of cane, also used with plant health, multi macro & micronutrient for spraying, it can be used with muriate of potash or silicic acid to manage the adverse effect of water stress.
- Following measures to be adopted under water stress condition for sustainable ratoon productivity
  - Application of additional dose of Potash @ 125 kg MOP/ha at earthing up.
  - Combined foliar application of urea and murate of potash each at 2.0% concentration (2.0 kg urea +2.0 kg potassium in 100 liters of water) during the drought period applied at 15-20 days interval.
  - Protective irrigation by means of alternate or skip furrow systems combined with trash mulching helps to sustain yields with limited water availability.

## Review of CDAS and guidelines for VSI's Cane Development Awards

- Agriculture Officer/ Cane Development Officer should confirmed with their CDAS file that the each information page was signed.
- The seed material of promising sugarcane genotype CoVSI 18121 should be uplifted at the earliest and conduct the adaptive trials in comparison with its mother parent Co 86032. The list of farmers with their area needs to be submitted immediately after completion of planting for further visit to plots for guidelines and to record the observations.
- Field demonstration of spraying using drone technology in agriculture was demonstrated by the sample drone which was provided by Rajarambapu Patil Sugar mill and Chatak Innovations Company.
- The practical and technical aspects of drone technology were discussed. Forum expected more research work on concentration of inputs, water volume, time of operation etc. from VSI scientists. The tentative technical program on standardization of dose of herbicides through drone was presented by Mr. PV Ghodke, Scientist, Agronomy. DG VSI nodded, the use of new technology of using drones for spraying and crop scouting is a need of the hour. This will help the sugarcane and other farmers in increasing the productivity with low cost of cultivation.

## Crop protection in sugarcane

- Sett and soil borne diseases of sugarcane can be effectively managed through the strategies like use of healthy diseased free seed collected from three tier seed nursery program, mass eradication of infected stools/clumps and sett treatment with recommended pesticides before planting.
- Foliar application of systemic and contact fungicides alone or in combination may be useful for management of foliar diseases. While, use of TC plantlets and management of sucking pest at right time is the best way for management of viral diseases in sugarcane.
- Management of borers in sugarcane in *suru* season and ratoon
  - Trash mulching particularly in ratoon crop should be encouraged,
  - Avoid late planting after March and light earthing up at 45 to 60 DAP.

- Soil application of Fipronil 0.3 GR @ 25 kg/ha or Chlorantraniliprole 0.4 GR @ 22.5 kg/ha at planting and 60 DAP.
- Spraying of Chlorantraniliprole 18.5% SC @ 375 ml per ha (0.4 ml / lit of water), if necessary.
- Release of Egg parasitoid *Trichogramma chilonis* in field @ 3 to 5 lakh parasitized eggs / ha in suitable installments.
- For the control of soil borne fungal diseases add 1 lit / acre (2.5 lit / ha) of liquid bio-fungicides in 500 kg FYM / compost and mix it uniformly. Apply this mixture in fields equally before planting or add 1 lit liquid bio-fungicide in 250 lit of water and drench in furrows at the time of planting.
- For the control insect pests, add 2lit. /acre (5 lit/ha) of liquid bio-pesticides in 500 kg of FYM / compost and mix it uniformly. Apply this mixture in fields equally before planting or add 2 lit. liquid bio-pesticides in 250 lit. of water and drench in furrow at the time of planting.
- For the control of white grub, mix 1000 ml Entomopathogenic Nematodes (EPN) in 200 lit water properly and apply preferably by drenching at the root zone or through drip irrigation. After application of EPN, maintain field moisture level for better result.
- Sugarcane grown in *suru* season always profitable than *adsali* season as it is long duration crop. It should be encouraged in the operational area of sugar mills in south and central Maharashtra, where *adsali* planting is more than 20%.

## Integrated water management in sugarcane

- The micro irrigation systems like drip and rain gun sprinkler irrigation should be adopted on large scale for efficient water management in sugarcane.
- Fertigation should be mandatory for micro irrigation systems in sugarcane for improving fertilizer use efficiency.
- In situ trash mulching without shredding is a useful technique to conserve soil moisture and reduce the impact of moisture stress and atmospheric draught.
- Use of drought tolerant sugarcane varieties and early planting of sugarcane in *suru* season is useful for combating the adverse effect of moisture stress on sugarcane productivity.
- Foliar application of VSI's Multi-macronutrient



and Multi-micronutrient 2 lit/acre in 200 lit. of water at 60 days after planting and 3 lit./acre in 300 lit. of water at 90 DAP along with vasant urja, a biostimulator @ 5 ml/lit. of water boosts the growth of sugarcane. The Vasant urja alone is also beneficial for management of abiotic stress in sugarcane.

- Application of bagasse ash @1.5 t/ha is beneficial for sustaining sugarcane crop in water stress condition.

#### **Sugarcane management in stress condition**

- The planting of drought tolerant varieties like CoC 671, VSI 434 and VSI 08005 should be undertaken in the drought prone area of Maharashtra.
- The early planting (Pre-season planting) should be preferred (October-November) in drought prone area.
- Distance between two rows can be reduced up to 90 cm in the drought prone area.
- Incorporation of sugarcane trash in soil instead of burning OR in situ decomposition with trash mulching favors to increase the fertility of soil, it has a major role in soil conservation, checks the weed growth, helps to minimize the impact of water stress as well as salt stress on crop.
- The application of *Acetobacter diazotrophicus* bioinoculant @ 3 lit./ha in 500 lit of water as foliar application after 60 DAP in morning hours.
- To control sugarcane mealy bug or scale insect infestation in stress condition removal of lower 2-3 dry leaves and spraying of Imidachloprid 17.8 % SL @ 300 ml/ha (0.3 ml/lit) is recommended.
- For the management of early shoot borer and internode borer in stress affected sugarcane crop, the release egg parasitoid *Trichogramma chilonis* @ 3-5 lakh parasitized eggs /ha in suitable installments in the field and soil application of granular insecticide fipronil 0.3 GR @ 25 kg/ha or chlorantraniliprole 0.4 GR @ 22.5 kg/ha or spraying of chlorantraniliprole 18.5% SC @ 375 ml per ha (0.4 ml/ lit of water) is recommended.
- Under abiotic stress condition incidence of sugarcane diseases viz, pokkah boeng, rust, red rot, wilt, pineapple and whip smut is increasing as well as abnormalities viz., leaf scorching, drying of leaves, rotting of leaves, decaying of leaves, defoliation and banded chlorosis are also observed.

To control these diseases and abnormalities the recommended prophylactic measures should be adopted for the management of sugarcane diseases and abnormalities under stress condition.

#### **EXTENSION AND ADVISORY SERVICES**

VSI is one of the monitoring agency appointed by SDF, Ministry of Food and Consumer Affairs, Government of India, New Delhi for assessing the proper utilization of SDF cane development loan and its impact. During the year, the reports were prepared and sent to SDF.

#### **SDF monitoring and impact assessment report**

- SM Kagal Taluka SSK

#### **Irrigation plan report for utilization of ETP water for irrigation.**

- SMS Kolhe SSK
- Kumbhi Kasari SSK

#### **Consultancy for**

#### **Cane development**

- Bhimashankar SSK, Pune
- Dwarkadhish Sakhar Karkhana

#### **Planting programme**

- SMSM Patil SSK
- Pandurang SSK

#### **Harvesting programme**

- Pandurang SSK
- SMS Kolhe SSK

#### **Production of Trichogramma cards**

- YM Krishna SSK Ltd. Satara

#### **Input and Analytical Services**

#### **Production and supply**

The tissue culture section produced 0.967 million micro-propagated plantlets of different sugarcane varieties. Of these, 0.763 million plantlets were supplied to sugar industry and sugarcane growers of Maharashtra and neighboring states, other agencies and VSI. The details of plantlets produced and supplied are given in table 11 & 12 respectively. The details of zone-wise distribution of breeders' seed and one eye bud seedlings are given in table 13 and 14.



संशोधनेन संवृद्धिः

**Table 11: Production of micro-propagated sugarcane plantlets**

Month	Name of variety									Total
	Co 86032	VSI 08005	Co 92005	MS 10001	CoVSI0 3102	CoM 0265	CoM 9057	Co 0238	Co 15023	
Apr. 2021	19050	6230	2670	1950	-	14870	-	-	-	44470
May	25665	7840	-	-	-	13350	-	3025	900	50780
Jun.	19205	2830	-	-	-	2660	-	2975	-	27670
Jul.	19810	2930	1150	-	-	13620	-	2800	2700	43010
Aug.	23650	-	9220	4020	-	16820	1720	1275	5530	62235
Sep.	43320	-	30595	5730	-	22260	750	700	1080	104435
Oct.	52010	-	44940	8200	-	20800	-	2250	-	128200
Nov.	51320	-	22175	550	-	14660	-	3440	-	92145
Dec.	47820	-	17170	540	-	8650	-	3175	-	77355
Jan. 2022	78635	-	12090	6670	1270	11560	-	675	-	110900
Feb.	70125	-	18350	16735	3460	14770	-	-	-	123440
Mar.	72125	-	3000	12170	1790	13115	-	-	-	102385
<b>Total</b>	<b>522920</b>	<b>19830</b>	<b>161360</b>	<b>56565</b>	<b>6520</b>	<b>167135</b>	<b>2470</b>	<b>20315</b>	<b>10210</b>	<b>967325</b>

**Table 12: Supply of micro-propagated plantlets**

Particulars	Sugarcane varieties										Total
	Co 86032	VSI 08005	Co 92005	MS 10001	CoVSI 03102	CoM 0265	CoM 9057	Co 15023	Co 0238	Co 0118	
<b>I) Maharashtra</b>											
A) Sugar mills (15)	206670	22050	24000	16325	-	56900	1200	-	-	-	327145
B) Other organization (6)	7925	-	15025	-	-	19595	-	-	-	-	42545
C) Farmers (216)	110171	4922	18417	8802	2800	41112	200	2	2	2	186430
D) VSI *	1595	110	-	540	-	1040	-	-	-	-	3285
<b>Total(I)=A+B+C+D</b>	<b>326361</b>	<b>27082</b>	<b>57442</b>	<b>25667</b>	<b>2800</b>	<b>118647</b>	<b>1400</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>559405</b>
<b>II) Other States</b>											
A) Mills(9)	56800	-	79500	1750	-	31000	650	10100	12700	1400	193900
B) Farmers (6)	4800	500	850	250	-	3440	-	-	-	-	9840
<b>Total (II)=A+B</b>	<b>61600</b>	<b>500</b>	<b>80350</b>	<b>2000</b>	<b>-</b>	<b>34440</b>	<b>650</b>	<b>10100</b>	<b>12700</b>	<b>1400</b>	<b>203740</b>
<b>Total=I+II</b>	<b>387961</b>	<b>27582</b>	<b>137792</b>	<b>27667</b>	<b>2800</b>	<b>153087</b>	<b>2050</b>	<b>10102</b>	<b>12702</b>	<b>1402</b>	<b>763145</b>

\*Indicates plantlets supplied free of cost for field experiment



**Table 13: Zone wise breeders' seeds distribution**

(in '000)

Name of zone	No. of mills	Co 86032	CoC 671	CoM 0265	CoVSI 03102	VSI 434	MS 10001	VSI 08005	CoVSI 18121	Total
<b>I) Maharashtra</b>										
a. South	10	665	0	328	0	0	28	10	258	<b>1289</b>
b. Central zone	22	1639	0	786	121	34	114	243	1295	<b>4232</b>
c. North East										
i) Marathwada	9	92	5	37	22	0	22	161	293	<b>632</b>
ii) Khandesh	4	9	0	1	10	0	16	66	79	<b>181</b>
ii) Vidharbha	3	8	0	0	0	0	0	50	76	<b>134</b>
(A)	<b>48</b>	<b>2413</b>	<b>5</b>	<b>1152</b>	<b>153</b>	<b>34</b>	<b>180</b>	<b>530</b>	<b>2001</b>	<b>6468</b>
<b>II) Other State (B)</b>	<b>11</b>	<b>9</b>	<b>5</b>	<b>0</b>	<b>2</b>	<b>4</b>	<b>0</b>	<b>101</b>	<b>318</b>	<b>439</b>
<b>Total (A+B)</b>	<b>59</b>	<b>2422</b>	<b>10</b>	<b>1152</b>	<b>155</b>	<b>38</b>	<b>180</b>	<b>631</b>	<b>2319</b>	<b>6907</b>

**Table 14: Zone-wise one eye budd seedling distributed**

(in '000)

Name of zone	No. of mills	Co 86032	CoC 671	CoM 0265	CoVSI 03102	VSI 434	MS 10001	VSI 08005	CoVSI 18121	Total
<b>I) Maharashtra</b>										
a. South	8	97	0	22	1	0	0	0	243	363
b. Central zone	3	173	11	49	1	0	10	20	314	578
c. North East										
i) Marathwada	1	53	0	0	0	0	0	2	249	304
ii) Uttar Marathwada	3	10	0	0	0	0	2	2	29	43
(A)	<b>15</b>	<b>333</b>	<b>11</b>	<b>71</b>	<b>2</b>	<b>0</b>	<b>12</b>	<b>24</b>	<b>835</b>	<b>1288</b>
<b>II) Other state (B)</b>	<b>8</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>180</b>	<b>180</b>
<b>Total (A+B)</b>	<b>23</b>	<b>333</b>	<b>11</b>	<b>71</b>	<b>2</b>	<b>0</b>	<b>12</b>	<b>24</b>	<b>1015</b>	<b>1468</b>

#### Tricho cards

Produced 2017.90 cc Corcyra eggs, 1318 Trichogramma chilonis cards and 226 Trichogramma pretiosum cards and supplied 569 TC cards and 30 TP cards for management of borer insect pest.

#### Nucleus culture

Total 188 cc Corcyra eggs were supplied to bio-control lab viz. Wardha (75), Amhednagar (25), NARP, Aurangabad (20), Bhor (6), Kolhapur (20), Agriculture college, Pune (20), YM Krishana SSK (10), Agriculture college, Dhule (5), CRS, Bhate (5), Biotech Lab, Pune (2) as nucleus culture. Total 15 TC cards were supplied to bio-control lab viz., Bio-control lab, Amhednagar

(12), CIPMC, Nashik (2) and Nature Biotech, Dhule (1). Total 29 TP cards were supplied to Bio-control lab viz., NARP, Aurangabad (25), Nature Biotech, Dhule (2) and CIPMC, Nashik (2).

#### Liquid bio-fertilizers

The section produced 1,23,201 liters of different types of liquid bio-fertilizers, bio-pesticides, bio-fungicide & 12,328 lit Vermiwash and supplied 1,24,916 liters of liquid bio-fertilizers, bio-pesticides, bio-fungicide & 6 lit Vermiwash to various sugar mills from Maharashtra state and other states and 12322 lit Vermiwash to LBF Production Unit.

### Vermicompost

The section produced 169.921 tons of vermicompost and supplied 235.204 tons, out of which 203.267 tons was supplied to various departments in the Institute for experimental purpose. Remaining 31.937 tons was supplied to sugarcane growers from Maharashtra. In addition to this, 206 Kg earthworms of Eisenia foetida and 6 lits of vermiwash was supplied to the farmers.

### Microbial culture

Total thirty eight slants were supplied to the sugar mills, Vishwasrao Naik SSK (15), SMB Thorat SSK (5), YM Krishna SSK (8) and Vignahar SSK (10) which are producing different liquid bio-fertilizers.

### Microbial analysis

Total 863 samples (In-house and outside) were analyzed for microbial analysis. In-house samples –DC - 31, liquid bio-fertilizers - 116, bio-control -85, PH and Microscopy - 276, chemicals - 26, Vermicompost - 184, Outside samples - lbf 10, Soil Samples (Agril Micro) - 97 and soil samples other section's - 38

### Agricultural tools

Total 216 VSI developed harvesting knives were supplied to the farmers and sugar mills.

### Multimicronutrient and Multimacronutrient Liquid Fertilizer production

The Institute produced and supplied the state govt. notified grade Multi-micronutrient (grade-2), multi-macronutrient (NPK 8:8:8), multi-macronutrient water soluble (NPK 15:15:15), microsols (grade-1 solid soluble micronutrient mixture) and VSI-Humic to sugar mills and individual farmers in Maharashtra state. The details supply of the products is given in table 15

**Table 15 : Supply of agro-products**

Particulars	Quantity (lit.)
Multi-micronutrient liquid fertilizer	66049
Multi-macronutrient liquid fertilizer (NPK 8:8:8)	39655
Multi-macronutrient liquid fertilizer (NPK 15:15:15)	13155
VSI-Microsol	47565
VSI-Humic	11097
<b>Total</b>	<b>177521</b>

### Analytical Services

#### Soil/Fertilizer/Chemical Testing (Soil Science)

It has been recommended that the application of fertilizers should be done on the basis of soil analysis. Total 193 soil samples and 24 compost samples received from sugar mills and individual farmers were analyzed for various parameters like pH, electrical conductivity, organic carbon, calcium carbonate, available nitrogen, phosphorous, potassium and micronutrient etc. The detailed analysis was carried out and fertilizer doses were recommended on the basis of analytical data. Total 1052 soil samples and 1260 sugarcane leaf samples of research trials were analyzed for different parameters and nutrient contents as an important part of scientific research on nutrient management. In addition, total 325 process chemical and fertilizer samples received from sugar mills and private organizations were analyzed.

#### Drip and sprinkler material testing laboratory

Newly created sprinkler pipe testing facility of the laboratory has been accredited by NABL along with existing drip material testing facility. The accreditation of drip and sprinkler material testing laboratory is continued till September 2023. During the year, total 66 samples were tested as per relevant Indian standards.



**Demonstration of drone provided by Rajarambapu Patil SSK and Chatak Innovations Company**



# Sugar Technology



## SUGAR TECHNOLOGY

The department consistently works for technical improvement of sugar mill to produce quality sugar and upgradation of technical know-how from time to time in process house through applied research, extension & advisory services, analytical services and academic activity.

Under applied research, new technologies are assessed for their suitability in the industry. Research projects are taken up on the issues related to manufacturing process and collaborated with other institutions/sugar mills, which enable to produce improved quality sugar with less cost of production.

The department guides member sugar mills for technical improvement in reduction of sugar losses in the manufacturing process, capacity utilization improvement, quality of sugar, reduction of process steam by rendering required expertise and introduction of latest technology and equipment. Conservation of water for achieving zero raw water requirement is also area of consultancy in order to achieve the pollution control norms. All these activities are extended to non-member sugar mills too as per their requirement on charge basis.

Consultancy services are given for member and non-member sugar mills for modernization, expansion and preparation of detailed project reports of boiling house, effluent treatment plant, condensate polishing unit, water balance and ETP adequacy.

Central Pollution Control Board (CPCB) has entrusted responsibility of inspection of Gross Polluting Industries (GPI) in basins of river Ganga and Yamuna and accordingly 56 sugar mills, 19 textile industries and 31 other industries were inspected during the year.

In the situation of pandemic, the department conducted online lectures for regular courses in the Institute. The accredited laboratory of the department extends analytical services to sugar mills and issues test reports for samples received.

### RESEARCH AND DEVELOPMENT

#### Clarification of intermediate molasses for better keeping quality of sugar

To conduct plant scale trial of the R & D work at KA Dr. GD Bapu Lad SSK and Dr. P Kadam Sonhira SSK,

the location of BH clarifier was fixed and accordingly material was procured, erection work was completed. The trial will be conducted in month of April-May, 2022.

Treatment of spray pond water by carbon particle from esp/wet scrubber to minimize the raw water addition in spray pond

This project was done in four sugar mills viz. Rajarambapu Patil SSK, Unit 1 (Maharashtra), Jakraya Sugars Ltd. (Maharashtra), LPSV Patel SKM (Chhattisgarh) and Cooper Co-operative Sugar Ltd. (Gujarat).

#### The findings were as under

- The physical appearance of water almost transparent
- There was a rise in pH by 0.5 units in the treated water
- TSS was tremendously reduced up to 88.87%
- COD and BOD was reduced to 40% minimum
- TDS value was increased from untreated to treated water by 16%
- Result from different sugar mills, scope for pilot plant trial/mill trial on phase 2nd
- Re-use of same treated water for make up of cooling tower/spray pond this will reduce the extraction of ground water/river water
- Lime consumption at spray pond/cooling tower water was reduced
- ETP load was reduced up to 50% as treated water is going to be recycled

#### B & C sugar melting by using clear juice in double sulphitation process during syrup and BH diversion

This pilot plant scale project was undertaken after studying BH/syrup process validation at sugar mills those who have diverted BH molasses/syrup, partial sugarcane juice for production of fuel ethanol for blending with fossil fuel as per the policy of Govt. of India. The importance of this research is to replace the use of vapour, condensate or syrup for B & C sugar melting, to reduce foaming at melter while using sulphited syrup and to balance the vapour load at evaporator condenser during BH molasses diverted for



bio-fuel (ethanol) production. Two sugar mills viz. Vighnagar SSK and Shreenath Mhaskoba were visited with the use of clear juice for low grade sugar melting. The observations and analytical data of the first phase will be compiled and analysed.

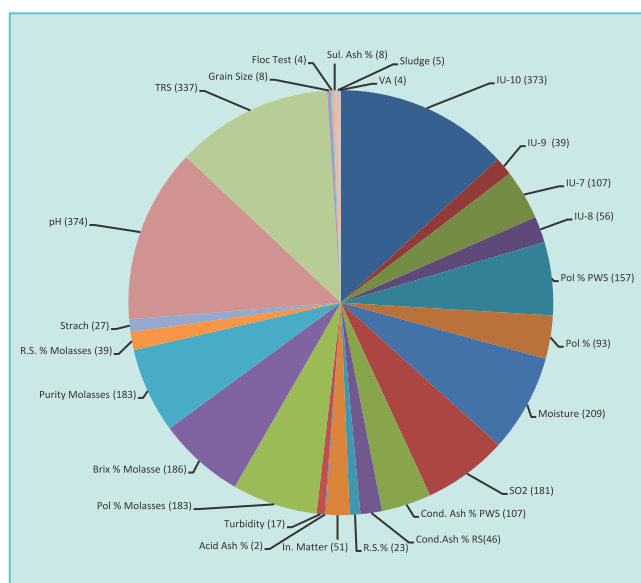
### Sugar Laboratory

In Sep, 2020, four individual laboratories of VSI are amalgamated and single application was made in the name of Vasantdada Sugar Institute's Testing Laboratories (VSITL) and received the NABL accreditation. All the laboratories have given the individual code as under:

- SL: Sugar laboratory
- DSMTL: Drip and sprinkler material testing laboratory
- ESL: Environmental Science laboratory
- AT & B: Alcohol Technology and Biofuels laboratory

### Details of analysis in sugar laboratory

There are twelve test parameters related to sugar quality which are under the scope of this laboratory. Total 836 samples of sugar and molasses were received for analysis of different parameters. Of which, around 575 sugar samples for ICUMSA colour by different methods, 153 samples for conductivity ash percent, 209 samples for moisture percent, 180 samples for SO<sub>2</sub> content, 250 samples for pol%, 23 samples of reducing sugar and 337 samples for total reducing sugar analysis of CH and BH molasses were analyzed.



Number of samples analyzed in sugar laboratory

### EXTENSION AND ADVISORY SERVICES

A total 473 visits were paid by the technologists to sugar mills for extending consultancy services on the following technical issues.

- Increase in capacity utilization.
- Reduction of sugar losses in manufacturing process.
- Improvement in sugar quality.
- Improvement in overall technical efficiency.
- Conservation of steam, power and water.
- Zero fresh water requirement and minimizing effluent generation.
- Verification of ETP adequacy and water balance of sugar mills.
- Optimization of process chemicals dosage.
- Logic for automation at different stations in boiling house.
- Selection of Technical personnel.
- ETP adequacy & water balance of sugar mills
- Detailed Project Reports (DPR) regarding modifications, additions, alterations, modernization and expansion of boiling house.

### Achievements

#### YM Krishna SSK

The mill reported no saving of bagasse even after two massecuite boiling during BH molasses diversion, as load on condenser was increased and mill had to follow water boiling in C-massecuite pan to balance the load on condenser in season 2020-21. Following changes were suggested in evaporator configuration for season 2021-22.

- RJ2 heating by 4<sup>th</sup> body vapour instead of 3<sup>rd</sup> body vapour.
- SJ1 heating by 3<sup>rd</sup> body vapour instead of 2<sup>nd</sup> body vapour.
- Clear juice heating in two stages 2<sup>nd</sup> body followed by first body by using PHE.

As a result, steam consumption was reduced from 41 to 38.50% on cane and saved bagasse of 10000 MT.

## Gurudatta Sugars

During 2020-21, the mill was crushing at the rate of 5500 TCD with steam consumption of 39 to 40% on cane. Distillery capacity was 60 KLPD with distillery boiler of 22 TPH. In the off-season, sugar mill planned to increase distillery capacity to 220 KLPD on BH molasses which needs 36 TPH steam.

The mill approached VSI for additional requirement of 14 TPH steam without addition or up-gradation of boiler. It was suggested to go for steam saving scheme to bring down steam consumption to 32% on cane. The department configured evaporation set with profuse vapour bleeding and achieved targeted steam consumption of 31-32% on cane.

### Dr. BB Tanpure SSK

The mill has reported the problem of high purity and high TRS of final molasses to VSI. Accordingly, the visit was paid and the observations were as under.

- The final molasses purity was around to 44 and TRS percent was 56.
- The sanitation condition at mill house was not to satisfaction.
- Poor working at pan boiling.
- Crystal content in low grade massecuite was on lower side.

The following remedial measures were taken

- Implemented physical mill sanitation and modified the mill sanitation (chemical) dosing application at mill house also shock dosing at filtrate receiving tank.
- MOL Brix is maintained around 10.0 and maintained the defecated juice pH to 7.3±0.1
- Increased seed slurry dosing at B M/C & C M/C boiling.
- Operated continuous centrifugal machines at rated capacity.

The results observed after 24 hours showed that the purity of final molasses is reduced to below 40 and TRS to 50

### Chhatrapati SSK, Sonajinagar

In month of Jan-2022 in season 2021-22, the mill faced mud problem and crushing rate was reduced by about 300 to 400 MT/day. The observations were as follows.

## Observations

- Mill sanitation was poor.
- Mud level at the time of visit was 16 to 18 clock.
- Sulphured juice settling was not proper due to improper temperature
- Vaccum filter operation was not proper.

Following suggestions were implemented

- Mill sanitation chemical dose was optimized
- Average mixed juice brix was maintained in the range of 15.5 to 16.0
- Mud level in the clarifier was optimized
- Temperature of sulphured juice was maintained to optimum due to which the settling was improved and mud level in the clarifier is reduced to normal.
- Vaccum filter operation was improved

## Results

Due to corrective measures taken, mud problem was solved and crushing rate was improved to normal.

## Detailed Project Reports (DPRs)

DPRs were prepared for boiling house machinery of sugar mills for modernization, expansion and appraisal are given in table 1.

## Preparation of tender technical specifications, scrutiny of design and drawing of equipments

Detailed tender specifications of boiling house equipment were prepared for six sugar mills viz. Ajinkyatara SSK, Datta Shetkari SSK, Daund Sugars, KA Dr. GD Bapu Lad SSK, Malegaon SSK and Vilas SSK, Unit 1. The technical pre-bid meeting was also attended for these sugar mills. In addition, the scrutiny of drawing & design of boiling house equipment for Ashok SSK, Malegaon SSK, Gurudatta Sugars and Someshwar SSK was done.

## Extension and advisory services to member and non-member sugar mills

The consultancy services provided to member and non-member sugar mills in the state and outside state are given in table 2 & 3 respectively.





**Table 1: Detailed Project Reports**

Name of mill	Type of DPR
Bhimashankar SSK	ETP and CPU
Daund Sugar	Expansion of sugar mill from 7000 to 17000 TCD
Datta Shetkari SSK	Expansion of sugar mill from 9000 to 12000 TCD
Daund Sugar	New ETP and CPU for 10000 TCD sugar plant
Gurudatta Sugars	Steam economy from 38% to 32 % with BH diversion
KA Dr. GD Bapu Lad SSK	Expansion of sugar mill from 5000 to 10000 TCD
KS Kale SSK	New ETP for country liquor effluent
Lok. Balasaheb Desai SSK	Expansion of sugar mill from 1250 to 2500 TCD
Siddheshwar SSK, Kumathe	ETP up-gradation suitable to 10000 TCD sugar plant
Vilas SSK, Unit 1	Modernization of boiling house machinery for 3500 TCD

**Table 2: Extension and advisory services to member sugar mills**

Name of mill	Purpose
Aadiwasi SSK, Nawapur	Boiling house machinery required to balance 2100 TCD crush rate
Agasti SSK	Assessment of sugar losses and improving boiling house performance
Ajinkyatara SSK	Finalization of boiling house machinery and pump capacities for proposed expansion, technical and commercial bid meeting and review of expansion
Ashok SSK, Ashti Sugar, Indreshwar Sugar, KS Patil SSK, Rena SSK	To improve boiling house performance
Bhaurao Chavan SSK, Unit 1 & 2	Expansion & improvement in overall technical performance
Chhatrapati SSK, Sonajinagar	Observations and suggestions for mud problem
Chhatrapati SSK, Bhavaninagar	Low recovery and overall improvement in boiling house performance
Chhatrapati Rajaram SSK, Nira-Bhima SSK	Off-season maintenance
Datta Shetkari SSK	Expansion from 9000 to 12000 TCD, pre-bid, financial bid, co-ordination meeting of machinery manufacturer & off-season maintenance
Daund Sugar	Finalization of layout for proposed expansion project, pre-bid and financial bid meeting and reduction in steam consumption
Dr. Babasaheb Ambedkar SSK	Low crush rate, improving boiling house performance & reduce steam % cane
Dr. P Kadam Sonhira SSK, Lok. S Solanke SSK, YM Krishna SSK	Reduction in steam consumption
Dwarkadhish Sakhar Karkhana	To reduce total losses and improvement in boiling house performance
Gurudatta sugars	Inspection of boiling house equipment, installation of falling film evaporators, vapor line juice heater, flashing system, performance assessment of steam saving systems and pre-bid & financial bid meeting

**Table 2: Extension and advisory services to member sugar mills (Contd.)**

Name of mill	Purpose
Halasiddhanath SSK	Preparation of DPR
Kadwa SSK	Expansion from 2500 to 3500 TCD, boiling house machinery with budgetary cost, suggestions to improve sugar colour, to improve boiling house performance and to reduce steam % cane
KA Tope Samarth SSK, Unit 1 & 2, Natural Sugar & Allied Ind.	Assessment of boiling house performance and steam reduction
KA Dr. GD Bapu Lad SSK	Expansion from 5000 to 10000 TCD, technical and pre-bid meeting
KS Kale SSK	DPR of expansion
Kumbhi Kasari SSK	Low recovery problem, improvement in boiling house performance
Lok. B. Desai SSK	Modernization-cum-expansion from 1250 to 2500 TCD
LPSV Patel SKM , Chhattisgarh	Performance of sugar plant and expansion of sugar mill
Malegaon SSK	Board meeting, off-season work and pre-bid meeting, assessment of performance of new FFE evaporator body
Narmada Sugar	Performance improvement
Pad. Dr. V V Patil SSK, Unit 1 & 2	Assessment of boiling house performance and low crush rate
Rajarambapu Patil SSK, Unit 2	Vacuum problem in pan station and improvement in boiling house performance
64 Sharad SSK	Expansion from 5000 to 10000 TCD, boiling house machinery calculation with budgetary cost and improvement in boiling house performance
SMB Thorat SSK	Expansion 7800 to 8500 TCD and improving boiling house performance
SMSN Nagawade SSK	Improvement in boiling house performance, survey of exploded final molasses storage tank and DPR of expansion
Someshwar SSK	Progress of erection and review of expansion of machineries
Vighnahr SSK	Expansion from 6000 to 7500 TCD and off-season work
Vilas SSK, Unit 1	Boiling house machinery for 3500TCD with budgetary cost, low crush rate and assessment of sugar losses in boiling house
Vitthalsai SSK	Expansion for 3500 TCD



**Training programmes on 'Laboratory Equipments & Analytical' and 'Sugar Manufacturing Process' conducted for Balrampur Chini Mills Ltd., Uttar Pradesh**



**Table 3: Extension and advisory services to non-member sugar mills**

Name of mill	Description of consultancy services
The Saswad Mali Sugar Factory	Low recovery problem, technical guidance for improvement in ETP performance and overall improvement in boiling house performance
Gayatri Sugar, Telengana	To fix the layout and location of proposed machinery
Bishnu sugar	Suggestion for BH molasses diversion
Dr. BB Tanpure SSK	Higher side TRS in final molasses
Shree Laxmi Narashina LLP and Swaraj Agro India	To improve boiling house performance
Rana Sugars, Butter	ETP adequacy report.
UP State corporation, Mohiuddinpur	To assess ETP performance
Shree Mahuva PKUML	Expansion from 4200 to 5000 TCD, Reduction in steam % cane and guidance for BH diversion
Venkateshwara Power Project and Nandi SSK , Karnataka	Project work
Khedut SKUM, Gujarat and Avadh Sugar Mill, Bihar	Guidance for BH route calculations
Sharyu Agro	Off-season work

### Suggestions for improvement in overall technical performance

Around 25 sugar mills availed services to improve their technical performance.

### Steam and energy conservation

In co-generation units, lower process steam consumption increases economic viability of plant, resulting more number of co-generation plants are interested in reducing the steam consumption in thirteen sugar mills

### Off-seasonal maintenance

Off-season maintenance work is a very important aspect for smooth operation of any sugar mill. Suitable guidelines were given on off-season maintenance work. Required modifications are suggested in the equipment for better working in the next crushing season. Visited nine sugar mills for the off-season maintenance work.

### Low crush rate

Technologists visited Vilas SSK, Dr. Babasaheb Ambedkar SSK and Pad. Dr. V V Patil SSK, Ganeshnagar to improve the crushing rate.

### Low recovery problem

Reasons for the low recovery problem are studied systematically and remedial measures were suggested for improving the recovery in three sugar mills.

### Validation of different ethanol feed stock production process in sugar mills

Lucrative policies were introduced by GoI for diversion of various feed stocks for ethanol production to fulfill the 20% blending up to 2025. In view of this, many sugar mills in the country started diversion from season 2018-19. For this, Department of Food and Public Distribution (DFPD) has given the guidelines through notifications. Sugar Commissioner of Maharashtra state has allotted validation of sugar mills in the state to VSI. Accordingly, 48 member and 38 non-member sugar mills were visited to validate the process of diversion of cane juice, syrup & BH molasses for ethanol production.



### Assessment Certificate for FRP recovery of sugar mills

The department has made certification of FRP recovery achieved by 86 sugar mills while diverting Syrup/BH-molasses for ethanol production during crushing season 2020-21. This certification was done as per advice of Director (Finance), Sugar Commissionerate, Maharashtra.

### Assessment of technical data for different technical efficiencies and individual awards

To encourage member sugar mills and inspire a sense of competitiveness, awards are declared for all important categories every year. Assignment relating to collection of data for comparison and identification of the best in the specific group completed.

### ETP and water management

Effluent treatment plays an important role in the environment protection. ETP station enable in achieving norms laid down by Pollution Control Board.

- GPI's inspection services provided to 106 sugar mills by technologist Central Pollution Control Board (CPCB) has given responsibility of inspection of Gross Polluting Industries (GPI) in basin of river Ganga and Yamuna (56 sugar mills and 50 textile and other industries).
- Visited fourteen sugar mills to carry out ETP upgradation and for waste water management and
- Visited five sugar mills for verification of water balance and preparation of ETP adequacy report.



Inauguration of the training programme on 'Agri-clinic and Agri-business Management' under National Institute of Agricultural Extension Management

The training programme on 'Agri-clinic and Agri-business Management' under National Institute of Agricultural Extension Management

- In the present scenario of water crisis, available water has to be conserved and pollution needs to be avoided. Five sugar mills were visited for advising them on water conservation and minimizing waste water generation.
- Preparation of Technical specifications to Bhima Shankar SSK for condensate polishing unit

### Selection of suitable candidate for technical posts in sugar mills

Technologists are members in the interview board for the selection of suitable candidate for senior technical posts. They visited five sugar mills for selection of candidates.

### Academic

Lectures and practicals of regular courses of the Institute were conducted by online mode due to pandemic situation.

### Short term training programme

A short term tailor made training programme was conducted at Luknow for the laboratory staff namely Quality control officer, Lab in-charge, Manufacturing chemist, Production Manager of Balrampur Chini Mills Limited (BCML). Around 64 staff participated in this training programme. The training programme was appreciated by the Management of BCML.

### Campus Interviews for the Students

During last few years, there was 100% campus placement for Sugar Technology and other courses. This year campus interviews were conducted online for six sugar mills.





# Sugar Engineering



## SUGAR ENGINEERING

Since 1975, from the very inception of VSI, sugar engineering department is a pioneer in extending multitudinous services to sugar mills along with consultancy services and need based R & D. The department is also involved in academic activities of the Institute.

The consultancy for preparation of detailed project reports (DPRs), tender technical specifications, scrutiny of design & drawing, an inspection of plant & machinery, supervision during erection & commissioning, technical audits and performance evaluation of the sugar, distillery captive power & co-generation projects is provided by the department.

The department plays a major role in the implementation of bagasse-based co-generation in 69 sugar mills having a capacity of 1268.15 MW with exportable power of 776.85 MW.

The department is involved in handling zero liquid discharge projects i.e. spent wash-fired incineration boilers with matching captive power projects. So far, 12 projects are executed and 19 are in pipeline

The department has completed 104 applied R & D projects and published 104 research papers in national and international journals. In addition, published three books on “Surplus Power Co-generation in Sugar Industry”, “Maintenance Book for Sugar Engineers” and “Sakhar Abhiyantriki Yantra Ani Tantra”.

### RESEARCH AND DEVELOPMENT

R & D is a continual ongoing activity. The department undertakes need based and cost effective R & D projects useful to the sugar industry to enhance its viability, competitiveness and sustainability. New applied R & D projects are undertaken to enhance the dissemination of the information on latest new technologies for improving the processing and energy efficiency.

Following are the need-based applied R & D projects taken-up during the year to adopt the innovative technologies for processing and energy conservation.

### Study of distillery spent wash incineration boilers with alternative supporting fuels

The project was undertaken with an objective to establish the suitability of available incineration technology in distillery to meet the stringent norms stipulated by pollution control boards.

The study was taken in eight distilleries and it revealed that, the distilleries are able to reduce the overall production cost per litre of alcohol by utilizing captive steam and power demands. Further, the ash generated during the combustion of fuel in boiler is rich in mineral potash and used as a fertilizer. It was also observed that an independent and new installation of the distillery, Atmospheric Fluidized Bed Combustion (AFBC) technology boiler is better suited option subject to the landing cost of coal and for existing sugar mill having backend distillery travelling grate boiler is preferred as the fuel is readily available.

### Study of 100 TBD sugarbeet pilot project for optimization process for production of sugar and ethanol at Baramati Agro Ltd.

The project was undertaken to establish sugarbeet cultivation as a supplementary crop for sugar and distillery industry.

During 2020-21, trials were conducted in the separate fermenter for 14th batches and presented in 2021-22. The average ethanol yield was observed only 38.82 liters per tonne of beet due to an average 6.07% TRS of (14th Batches) beet juice.

### Optimization of imbibition to improve mill performance

The observations indicated that hot water at a temperature of 85-90°C is quite advisable for compound imbibition to extract more sugar from bagasse besides improving the mill sanitization condition.

Use of higher imbibition % cane was definitely beneficial for reducing sugar loss in bagasse and for increasing the sugar recovery.

Higher imbibition % fiber from 200 to 300% will increase the revenue to the tune of Rs.17-20 per tonne



of cane. However, appropriate planning is required at clarification, evaporator and pan stations to handle increased quantity of mixed juice and diluted (low brix) clear juice. The increase in steam consumption envisages the modernization of boiling house with steam-saving systems.

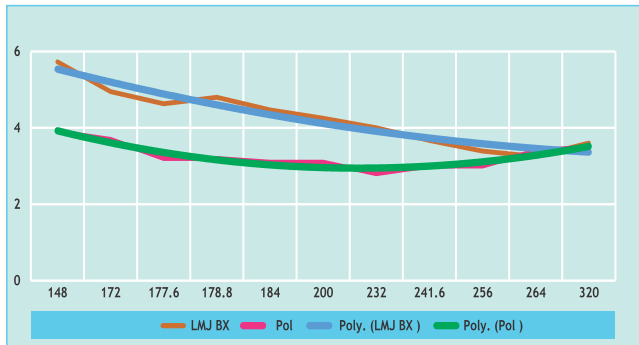


Fig. 1 : Imbibition% fiber Vs LMJ Brix Vs Pol % bagasse

### Remote monitoring and advisory system

The department has carried out the study on “Remote Monitoring & Advisory System” to monitor the operating data of sugar mill and co-generation remotely and to alert the concerned about any deviation in the process parameters and to take corrective action reducing losses and down time.

The advisory system compares real-time data of mill, boiler, turbine, electrical and boiling house with design data for corrective action if any at the site. The adviser also generates alerts to avoid abnormal situations. Further, emphasize was given on analytical data analysis and advisory system to display the parameters of various sections of the sugar mill on the tab / mobile / pc etc. The study will be continued with the help of COEP for detailed analysis of the system.

### Rooftop solar photovoltaic system for generation of power to meet the off-season captive power demand in sugar mills

Study was taken up with an objective to find out suitable rooftop area for installation of the solar power system to meet the captive power demand of sugar mill during off-season and its techno economic feasibility. The sugar mill is operational for around 5 months as season period and requires power from state electricity distribution company (MSEDCL) to meet the off-seasonal captive demand for off-season maintenance, administrative offices, colony, supply of drinking water system etc. The sugar mills have off-season for 210-220 days, during this period incur huge expenditure on

captive power consumption at a tariff of Rs. 8.00 to 10.00 per KWH. The roof top solar system is environmental friendly and reduces the expenditure on cost purchase from MSEDCL. Hence existing policy of MSEDCL for maximum demand should be revised and it should be separate for season and off season. Electrical unit consumption demand is a major part of MSEDCL bill.

Extension of project for following study will be carried out along with COEP

- Options of connectivity on HT side for big solar plant
- Study of PPA limit of co-gen. with additional solar power
- Open access for solar power generation
- Costing and pay back

### The study on effective use and transmission efficiency of roller chain

Sugar mills are utilizing various types of chains in conveying cane & bagasse in particular and incurring substantial R & M expenditure every year, contemplating the same. Therefore, the study has been taken up to establish the overall impact of chain on sugar mill performance and required MOC for better life of chain while procurement. During the study, different problems faced by the sugar mill like roller jamming, wear of link plate, wear and elongation of chain, wear of sprockets, excessive noise etc. were reviewed.

It was noticed that, the MOC of the chain should contain less free ferrite and more perlite metallurgical microstructure (Fig-2) to have high tensile strength there by less chances of elongation and breakage of chain links.



Fig-2: less pearlite microstructure of chain link

Besides the mechanical properties, sugarcane juice is being acidic, necessary prevention of higher case hardness should be taken care to reduce the effect of the corrosion. Further, proper and timely lubrication is necessary to reduce sliding & rolling friction thus enhancing the life of chain and at the same time reduce the power consumption.

The average cost incurred on R & M of the chain is varying from Rs 1.30 to 4.81 per tonne of cane crushed. The project was concluded and with the MOU between VSI and COEP further study on MOC, transmission efficiency will be carried out during 2022-23.

#### **The study of combustion control system of bagasse fired boiler for sugar and cogeneration plants**

Combustion of fuel is a crucial area, therefore, for better performance of boiler this study was carried out. The control system includes the control of steam pressure directly manipulated with the speed of bagasse feeders, FD & SA air flow control according to the percentage of oxygen in dry flue gas. The oxygen level was taken as base to control excess air flow to have required turbulence in the furnace thereby maintaining appropriate draught, hot air temperature at the furnace plenum chamber etc.

Further study will be carried out with COEP during 2022-23 correlating percentage of carbon-di-oxide and percentage carbon-mono-oxide in the flue gas so as to obtain optimum combustion temperature and higher boiler efficiency.

#### **Memorandum of Understanding (MOU) with College of Engineering Pune (COEP)**

The objective of MOU is to encourage interaction between VSI and COEP to promote academic, need-based applied R & D as well as to develop and expand relationship with the sugar industry.



VSI and COEP will mutually design the electives in some specific areas for undergraduate and post graduate programme. VSI will offer internships to undergraduate and postgraduate programmes and can act as guides in project work/thesis if possible.

Need-based and applied for R & D programmes will be in the areas of mechanical, electrical & electronics, instrumentation, materials, composites & metallurgical science, conservation of energy and thermal systems, flow modelling & optimization, mutually designed with customization in the form of elective. Both parties will strive for progress of sugar industry through Academics, Extension and Research & Development.

#### **EXTENSION AND ADVISORY SERVICES**

The department provides consultancy for preparation of detailed project reports (DPRs), tender technical specifications, scrutiny of design & drawings, inspections of plant & machinery, supervision during erection & commissioning, technical audits and performance evaluation of the sugar, distillery captive power & co-generation projects.

The department was also involved in handling the projects of zero liquid discharge i.e. spent wash-fired incineration boilers with matching captive power.

During the year, 529 visits were paid to sugar mills, co-generation plants and distilleries for extending consultancy and extension services on specified aspects as under:

- Increasing the plant capacity utilization
- Increasing preparatory index
- Improving the mill extraction
- Increasing the imbibition % fibre and effective imbibition
- Reducing sugar losses in bagasse and mill sanitation
- Monitoring individual mill extraction and efficiency
- Conservation of utilities like water, steam and power
- Maximizing the power export to grid
- Enhancing the overall technical efficiency

The prominent success stories of the department as outlined below reveal that, outstanding contribution was towards improving the technical performance of sugar mills.



### **Ganesh SSK**

The sugar mill was facing the problems of boiler steam pressure, constant crushing rate and bagasse saving. As per the suggestion of VSI, the factory arrested some air and flue gas leakages of the boiler furnace zone and side walls. Because of this, the boiler steam pressure problem was solved and achieved bagasse saving. For maintaining constant crushing rate, DSM screen juice recirculation to mill was controlled and modification was done in mill imbibition system by adjusting hydraulic loads on the mills. As a result, slippage at mill no. 2 was reduced, constant crushing rate was achieved and improved milling results.

### **Pad. Dr. V V Patil SSK**

The sugar mill was facing the problem of crushing rate. It was observed that more quantity of bagasse recirculates with juice from rotary juice screen to the mill. It increases the load on mill and affected the crushing rate. Rotary juice screen washing was not in auto mode. Mechanically harvested cane was about 20% and dumped directly on cane carrier due to which there was a problem for uniform feeding of cane to preparatory devices. By adjusting cane feeding to near about 300 tons per day, crushing rate was increased. In addition, suggested some modifications in second mill Donnelly chute to increase crushing rate.

### **SM Kagal Taluka SSK**

Sugar mill was facing the problem of cane carrier jamming at cane chopper for higher crush rate due to higher cane layer in the carrier. Sugar mill has huge stoppages in cane carrier. It was suggested to install pre cane chopper in between the feeder tables to enhance the cane density and reduce the cane layer in the carrier. After installation of pre cane chopper, there was no jamming in cane carrier and cane crushing was done smoothly at 4800 TCD.

### **The Saswad Mali Sugar Factory**

Sugar mill was facing problem of low recovery as compared to nearby sugar mills. Suggestions were given for corrective re-setting of mill as per brix curve and apply hot water imbibition above 200% on fiber having temperature 82-85°C on the last mill. This helped to reduce pol & moisture % bagasse resulting in recovery improvement and smooth operation of the co-generation plant. In addition, the sugar mill practicing the two MCW pump was in operation at full speed,

when less steam was going to condenser. It was suggested to run the two MCW pump at 50% RPM to reduce the power consumption. After implementation, the sugar mill reduced the power consumption by 50 kWh and enhanced the export of power.

### **Sant Tukaram SSK**

The mill is having 15 MW DEC type co-generation power plant. The sugar mill practicing the two MCW pump was in operation at full speed, when less steam was going to condenser. It was suggested to run the two MCW pump at 50% RPM to reduce the power consumption. As a result, reduced the power consumption by 40 kWh and enhanced the export of power.

### **Swaraj Green Fuel and Power**

Sugar mill was facing problem of low recovery. Suggestions were given regarding corrective re-setting of mill as per brix curve and apply hot water imbibition above 200% on fiber having temperature 82-85°C before the last mill. The suggestions helped to reduce pol & moisture % bagasse resulting in recovery improvement and smooth operation of the cogeneration plant.

### **Pad. Dr. DY Patil SSK and SM Kagal Taluka SSK**

There is a medium pressure incineration boiler of 15 TPH operating at 45 Kg/cm<sup>2</sup> pressure and 400°C temperature with matching TG set of 1.5 MW BP type for disposal of spent wash and to meet the captive power consumption for 45 KLPD distillery project for both the mills. These projects were successfully commissioned during 2021-22 under the guidance of VSI.

### **KA Tope Samarth SSK, Unit 1**

The incineration boiler of 22 TPH having pressure 45 kg/cm<sup>2</sup>, temperature 400°C with matching TG Set of 2 MW BP type for disposal of spent wash and to meet the captive power consumption for 60 KLPD distillery project. This project was successfully commissioned during 2021-22 under the guidance of VSI.

### **Vilas SSK, Unit 2**

The sugar mill was facing the problems of low crushing rate, boiler pressure, and higher bagasse consumption. For stabilizing sugar plant and improving the crushing rate, following suggestions were implemented during off-season.

- Fibrizer drive turbine upgraded and swing type fibrizer installed in place of fixed hammer type fibrizer.
- Replacement of kicker by chopper.
- Auto cane feeding system fine-tuned.
- Mill setting provided by VSI.
- Boiler refurbished.

During the crushing season 2021-22, average crushing was improved from 2894 to 3264 TCD i.e. Rise of about 400 TCD.

#### **Datta Shetkari SSK**

The sugar mill was facing the problem of shortfall of steam for process. For balancing sugar plant, the old 10 TPH boiler was refurbished and taken into line, the steam from this boiler was provided to distillery instead of diverting steam from the co-gen boiler. This has made advantage to the sugar mill in process steam balance and enhanced the crush rate by 200 TCD.

#### **Narmada Khand Udyog**

As per the advice of VSI, the sugar mill has installed a SCADA based automation system for the mill including pressure feeders and auto cane feed control system which has resulted in increase of average crush rate @ 200 TCD.

#### **Sakhar Abhiyantriki Yantra and Tantra (Marathi Version)**

There are number of reference books available on the equipment of sugar mills in English version. The department has written a book in Marathi language (The local language in Maharashtra State). This book provides detailed information on various aspects of the sugar industry, quality of sugar cane, cane harvesting, cane supply & planning, cane handling, cane preparation, cane milling (milling tandem/diffuser), milling performance, boilers, steam & power co-generation system, juice concentration, clarification process, evaporation & crystallization, centrifugal, curing & cooling, drying, gradation of sugar, etc. Understanding and applying the information provided in the book will definitely help the sugar mill with substantial benefits.

#### **DETAILED PROJECT REPORTS (DPRs)**

The DPRs were prepared for green field sugar, modernization, expansion, co-generation, distillery

captive power, valuation, rehabilitation and revival of sick sugar mills.

#### **Green field sugar projects**

DPRs for green field sugar projects were prepared for five sugar mills viz. Zambad Udyog (2500 TCD), Sopanrao Dasal Agro (2500 TCD), Shripati Sugar (2500 TCD), Swami Samarth Sugar & Agro Industries (2500 TCD), Damanganga SSK (Gujarat) (1500 TCD along with 50 KLPD distillery).

#### **Modernization proposals**

Modernization proposals of four sugar mills viz. KS Kale SSK, Venkateshkrupa Sugar mill, Vilas SSK, Unit 1 and Mahuva Pradesh KUM were prepared. The aim was to reduce the steam and captive power consumption for enhancing the exportable power from cogeneration plants. In addition, emphasis was given for improving the technical performance and enhancing the capacity utilization.

#### **Expansion proposals**

DPRs for expansion of sugar mills prepared is given in table 1.

**Table 1: DPR for expansion of sugar mills**

Name of mill	Modernization-cum-Expansion (TCD)
Bhimashankar SSK, Karnataka	3500 to 6000
Datta Shetkari SSK (Revised)	7000 to 12000
Daund Sugar	7000 to 17500
KA Tope Samarth SSK, Unit 1	2500 to 5000
KA Tope Samarth SSK, Unit 2	2500 to 5000
KA Tope Samarth SSK, Unit 2 (Revised)	2500 to 7500
Krantiagrani Dr. GD Babu Lad SSK	5000 to 7500
Loknete Balasaheb Desai SSK	1250 to 3000
Nandi SSK, Karnataka	5000 to 10000
Pad. Dr. DY Patil SSK	2500 to 5000
Someshwar SSK	5000 to 7500
Venkateshwara Power Project, Karnataka	8000 to 12000



### By-product proposals / projects

The department was involved in the preparation of co-generation DPRs and tender documents for boilers, TG sets and balance equipments, electrical interfacing equipments in co-generation and distillery projects. Additionally, erection and commissioning of the following co-generation and distillery projects were also monitored.

### Co-generation proposals

The status of co-generation project proposals is given in table 2.

### Distillery captive power projects

The status of distillery captive power projects is given in table 3.

### Revival Report and SDF restructuring reports

The revival report along with the estimated cost to restart the mill was prepared for Yashwant SSK, Theur. In addition, SDF restructuring reports were prepared for Siddheshwar SSK, Kumthe; SS Vasantrao Kale SSK and Kumbhi Kasari SSK. The sugar plant valuation report was also prepared for Halsidhnath SSK, Karnataka.

### Consultancy to non-member sugar mills

The department provided consultancy to following non-member sugar mills for improving the technical performance (Table 4).

### Interviews conducted for selection of technical personnel

VSI engineers visited following sugar mills for selection of Managing Director, Co-generation Manager, Chief Engineer, Chief Chemist, Engineers and operating staff :

- Agasti SSK
- Chhatrarpti SSK
- Dnyaneshwar SSK
- Dudganga Vedganga SSK
- KA Tope Samarth SSK, Unit 1
- LPSV Patel SKUM, Chhattisgarh
- Malegaon SSK
- Nandi SSK, Karnataka
- SMS Kolhe SSK
- SM Kagal Taluka SSK
- Venkateshkrupa Sugar Mills
- Vighnagar SSK
- Vilas SSK, Unit 1

**Table 2: Details of co-generation project proposals**

Name of mill	TCD	Co-gen. Cap. (MW)	Boiler Cap (TPH) / Pressure (Kg/Cm <sup>2</sup> ) / Temp. (°C)	TG Cap. (MW) / Type BP/ DEC
<b>DPRs submitted</b>				
Zambad Udyog	2500	12.5	70/87/515	12.5/BP
Daund Sugar	17500	82	Existing 100/87/515 Proposed 160/87/515 x 02	Existing 18/DEC Proposed 32/BP x02
Someshwar SSK	7500	36	Existing 100/87/515 Proposed 100/87/515	Existing 18/DEC Proposed 18/BP
<b>Project under execution</b>				
KA Tope Samarth SSK, Unit 2	7500	26	Existing 60/45/480 Proposed 110/87/515	Existing 6/BP Proposed 20/BP
Kranti Sugar and Power	3500	12.5	75/87/515	12.5/BP
Nandi SSK (Karnataka)	10000	55.14	Existing 90/67/515 Proposed 220/87/515	Existing 18.14/ DEC Proposed 37/DEC
Shripati Sugar & Power	2500	12	70/87/515	12/BP
Venkateshwara Power Project (Karnataka)	12000	48	Existing 80,70/67/490 Proposed 140/73/515	Existing 15/BP & 8/DEC Proposed 25/BP

**Table 3: Distillery captive power projects**

Name of mill	Distillery Capacity (KLPD)	Boiler Capacity (TPH)/ Pressure (kg/cm <sup>2</sup> (g)) / Temperature °C	TG set Capacity (MW/Type)
<b>Project commissioned</b>			
Bhaurao Chavan SSK, Unit 1	60	22/45/400	3/BP
KA Tope Samarth SSK, Unit 1	60	22/45/400	2/BP
Mula SSK	45	22/45/400	2/BP
Pad. Dr. DY Patil SSK	45	15/45/400	1.5/BP
SM Kagal Taluka SSK	45	16/45/400	1.5/BP
Vilas SSK, Unit 1	60	22/45/400	2/BP
<b>Tender technical specifications submitted</b>			
Indreshwar Sugar	100	33/45/400	3/BP
Kukadi SSK	30	15/45/400	1.5/BP
Rajarambapu Patil SSK, Unit I	100	32/45/400	3/BP
Rena SSK	60	20/45/400	2/BP
Someshwar SSK	60	28/45/400	2.5/BP
Venkateshkrupa Sugar Mills	60	Old 40/45/490	3/BP
<b>Tender technical specifications and project under execution</b>			
Ashok SSK	45	22/45/400	2/BP
Dr. P Kadam Sonhira SSK	105	32/45/400	3/BP
Datta Shetkari SSK	100	40/45/400	4/BP
Gurudatta Sugars	100	Existing 22/45/440 Existing 40/45/500	Existing 2/BP Proposed 4/BP
Kadwa SSK	30	Existing 20/21/340	1.5/BP
KA Tope Samarth SSK, Unit 2	60	20/45/440	2/BP
Nira Bhima SSK	100	38/45/400	3/BP
NKJ Biofuels, Chhattisgarh	75	30/45/450	3.2/BP
Sharad SSK	45	15/45/400	1.5/BP
Udagiri Sugar	45	15/45/440	1.5/BP
Vighanhar SSK	60	25/45/400	2/BP
Vilas SSK, Unit 2	60	20/45/485	2/BP







**Table 4: Consultancy to non-member sugar mills**

Name of mill	State	Details
Saswad Mali Sugar Factory	Maharashtra	Technical assessment and improvement of sugar plant
Swaraj Green Power and Fuel	Maharashtra	Technical assessment and improvement of sugar plant
Nandi SSK	Karnataka	Modernization-cum-expansion from 5000 to 10000 TCD along-with co-generation 18.14 to 55.14 MW
Venkateshwara Power Project	Karnataka	Modernization-cum-expansion from 7000 to 12000 TCD along-with co-generation 23 to 48 MW
Mahuva Pradesh KUM, Bamnia	Gujarat	DPR for modernization of 3500 TCD
NKJ Biofuels	Chhattisgarh	30 TPH Boiler and 3.2 MW TG set for the distillery
LPSV Patel SKUM	Chhattisgarh	Performance improvement

### Topping cycle ratio certification

Department has scrutinized the topping cycle documents and issued certificates to five sugar mills viz. Malegaon SSK, VVD Manjara Shetkari SSK, Chhatrapati Shahu SSK, Someshwar SSK and Gurudatta Sugars.

### Preparation of tender technical specifications for plant and machinery

Tender technical specifications of machinery and equipments were prepared for the following sugar mills.

- **Ajinkyatara SSK**

Cane carrier extension by 15 m, 12.5T x 02 cantilever type unloaders with bridge, 7m x 8m feeder table, 40" x 80" x 03 mills, process house equipments for balancing crushing rate to 4500 TCD with 38% steam on cane

- **Datta Shetkari SSK**

12.5 T cane unloader trolley, 2500 mm width cane carrier, cane preparatory devices suitable for 2500 mm width viz. fibrizer, leveller, chopper, 50" x 100" mill, 40 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C incineration boiler, 4 MW BP type TG set, coal and ash handling system, HP & LP steam piping, DCS system, EOT crane and cooling tower, electrical package

- **KKRJP Kukadi SSK**

Incineration boiler of 15 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C and 1.5 MW BP type TG set

- **Rajarambapu Patil SSK**

Incineration boiler of 32 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C and 3 MW BP type TG set

- **Venkateshwara Power Project, Karnataka**

Cane preparatory devices suitable for 3000 mm carrier width, 50" x 100" x 02 mills, 5000 TCD process house, 140 TPH boiler, pressure 73 kg/cm<sup>2</sup>, temperature 515°C, 25 MW BP type TG set, MCC and PCC panels

- **Indreshwar Sugar Mill**

Incineration boiler of 33 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C, 3 MW BP type TG set, coal and ash handling system, HP & LP steam piping, DCS system, EOT crane and cooling tower

- **Nira Bhima SSK**

Incineration boiler of 38 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C, 3 MW BP type TG set, coal and ash handling system, HP & LP steam piping, DCS system, EOT crane and cooling tower

- **Vilas SSK, Unit 2**

Conventional boiler of 20 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 485°C, 2 MW BP type TG set, bagasse and ash handling system, HP & LP steam piping, DCS system, EOT crane and cooling tower.

- **Rena SSK**

2 MW BP type TG set, pressure 43 kg/cm<sup>2</sup>, temperature 480°C, HP & LP steam piping

- **Bhaurao Chavan SSK**

Water treatment plant of 15 m<sup>3</sup>/hr capacity, wet scrubber for bagasse fired boiler

- **Krantiagrani Dr. GD Bapu Lad SSK**  
Cane handling system, cane preparatory equipments, 36" x 72" x 04 mills, 80 TPH boiler, pressure 45 kg/cm<sup>2</sup>, temperature 480°C, process house equipments
- **Dr. P Kadam Sonhira SSK**  
Incineration boiler 32 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C, 3 MW BP type TG set, coal and ash handling system and EOT crane
- **Kadwa SSK**  
1.5 MW BP type TG set, PCC panels, dump condenser and cooling tower
- **Vighnahar SSK**  
Incineration boiler of 25 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 400°C, 2 MW BP type TG set
- **Gurudatta Sugars**  
4 MW BP type TG set
- **KS Kale SSK**  
Balancing crushing rate for 4500 TCD capacity, 35 m<sup>3</sup>/hr water treatment plant
- **Swami Samarth Sugar and Agro Ind.**  
Green field project of 2500 TCD along with 12 MW cogen.
- **Nandi SSK, Karnataka**  
Cooling tower for 5000 TCD
- **Malegaon SSK**  
2000 kW, 11 kV slip ring motor for fibrizer, 250 kW motor for centrifugal machine and its drive panel
- **Kranti Sugar and Power**  
33 kVA switchyard
- **Udagiri Sugar**  
Multi fuel boiler of 15 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 440°C and 1.5 MW BP type TG set
- **NKJ Biofuels, Chhattisgarh**  
Multi fuel boiler 30 TPH, pressure 45kg/cm<sup>2</sup>, temperature 450°C, 3.2 MW BP type TG set
- **KA Tope Samarth SSK, Unit 2**  
Complete milling tandem for 7500 TCD, complete parallel boiling house for 5000 TCD, 110 TPH, pressure 87kg/cm<sup>2</sup>, temperature 515°C boiler, matching 20 MW BP type TG set, electrical

distribution system for sugar mill, bagasse and ash handling systems, PRDS, LP & HP piping, 30 m<sup>3</sup>/hr water treatment plant, fire fighting system, multi fuel boiler of 20 TPH, pressure 45 kg/cm<sup>2</sup>, temperature 440c, 2 MW BP type TG set, bagasse and ash handling systems for boiler of 20 TPH, steam piping, DCS system, 15 M<sup>3</sup>/hr DM plant

- **Venkateshkrupa Sugar Mill**

3 MW BP type TG Set

#### Scrutiny of design and drawing of equipment

Scrutiny of design and drawing of equipment for 23 sugar mills were carried out.

#### Inspection of machinery and equipment (including virtual)

Inspection of various machinery and equipment for sixteen sugar mills was carried out.

#### Academic

The department is conducting regular academic courses such as Post-Graduate Diploma (AVSI) for graduate engineers. Besides, a one-week short-term training program is conducted for mill fitters, boiler operators every year. One-day workshops/ seminars are also conducted to give training and upgrade the technical knowledge of skilled and semi-skilled workers of sugar mills.

Tailor-made training programs conducted as per the requirement for technical staff from domestic and abroad. Under this program, the department organizes in-house training and visits to modern sugar mills and equipment manufacturer works. Hybrid Tailor-Made Training Programme on "Milling" for Balarampur Chini Mills Ltd., Groups, Haidergarh Unit (UP) was conducted during the year.



MoU between VSI and CMET

# Alcohol Technology and Biofuels



## ALCOHOL TECHNOLOGY AND BIOFUELS

The department is engaged in academic, research & development and extension activities in areas of alcohol production, biofuels and distillery effluent treatment. It provides guidance to the alcohol industry for achieving maximum productivity, efficiency and yield from various feedstocks, improving quality of various finished products such as Rectified spirit (RS), Extra Neutral Alcohol (ENA) and Fuel Ethanol and achieving Zero Liquid Discharge (ZLD). The department acts as a consultant/inspection agency for ongoing and proposed distillery projects based on Cane juice/syrup, B heavy (BH) molasses, C-molasses & non-molasses feedstock (grain, sugar beet, sweet sorghum), effluent treatment projects and Bio-CBG projects. In addition, technical inputs and guidance to various Government and non-Government agencies are also provided. The compilation of “Technical performance of VSI member distilleries in Maharashtra” affiliated to sugar mills of the state is published every year.

The department has received accreditation from National Accreditation Board for Testing and Calibration Laboratories (NABL) for analysis of spirits, Indian Made Foreign Liquors (IMFL), wines and beers. Department has Food Safety and Standards Authority of India (FSSAI) food licenses for wine manufacturing. The analysis of molasses, syrup, grains, spirits, potable liquor samples (Country Liquor and IMFL), wine, beer and denaturants is approved by the State Excise Department of Government of Maharashtra (GoM).

The regular post graduate course of MSc (Wine, Brewing and Alcohol Technology) affiliated to the Savitribai Phule Pune University (SPPU), Pune and a post-graduate Diploma in Industrial Fermentation and Alcohol Technology (DIFAT) are conducted. The students are recruited in various breweries, distilleries, wineries and bottling units across the country. In addition, need based short-term courses in the areas of Alcohol Technology, Biofuels and Effluent Treatment Technologies and the special training programme for officers in State Excise departments is also conducted.

The guidance was also provided to distilleries to work out most economical route for ethanol production from different feedstock (Cane juice/syrup, B heavy molasses, C-molasses & non-molasses feedstock). The department has carried out process validation for diversion of sugarcane juice/syrup and B heavy

molasses for ethanol production as per Department of Food and Public Distribution (DFPD), Ministry of Consumer Affairs, Government of India (GoI), guidelines.

The department has prepared Adequacy Assessment Reports (AAR) and Assessment of Validation Report for Effluent Treatment Plant (ETP) of distilleries located in Ganga basin as well as distilleries established in Maharashtra and Uttar Pradesh as per the directions given by the Central Pollution Control Board (CPCB).

For the inspection of Grossly Polluted Industries (GPIs) in 2021-22, CPCB has allotted the inspection work of 372 industries in Ganga and Yamuna basins to VSI as a third party inspection agency. VSI is a lead institute for sugar and distillery sector.

### RESEARCH AND DEVELOPMENT

Valorizing waste (vWa) from sugarcane industries via innovations in pre-treatment, bio-transformations and process intensification

This project is funded by Department of Biotechnology (DBT), GoI and Innovate, UK. The vWa consortium was formulated with following academic and industry partners from India and UK side. The UK partners are Queens University, Belfast (Lead Institute), Cranfield University and Nottingham University as academic/research partners; Nova Pangea Technologies and Green Fuel Research Limited as Industry Partners. The Indian partners are VSI, Pune (Lead Institute); IIT, Mumbai; IIT, Delhi; CSIR-IIP, Dehradun as academic/ research institutions and Vivira Process Technologies; Dhampur Sugar Mill, UP and Lokmangal Agro Industries, Maharashtra as Industry partners.

#### Objectives

- Composition analysis of sugarcane bagasse (SCB) samples using NREL protocols.
- Design and optimization of pre-treatment process.
- Anaerobic Digestion (AD) from sugarcane industry waste (Press mud cake (PMC) and SCB).
- Bio-butanol product recovery.
- Lactic acid production from ligno-cellulosic hydrolysate.

#### Results and Discussion

For *B. coagulans* NCIM 5648, the lactic acid titer of



almost 100 g/L and 97.5 g/L of lactic acid was achieved with synthetic media and 2G media (alkali treated enzyme hydrolyzed bagasse). Alkali recycle process required during pretreatment for lactic acid production. 50% alkali was recycled back to pretreatment without compromising lactic acid titer and yield.

AD was carried out on 200 L scale. Biogas production of 480 M3/t of dry PMC or 120 M3/t of wet PMC (70% moisture) was obtained. Biogas generation and yield was almost same for un-grinded PMC. AD pilot scale (50 M3) trials started from 3rd week of March 2022 at Nira-Bhima SSK using cavitated PMC/co-digestion of PMC & SCB (Fig. 1). vWa workshop was conducted on Mar.31, 2022 at VSI and the project was concluded.



Fig 1: AD pilot scale (50 M3) digesters at Nira-Bhima SSK

#### Future work

- AD pilot scale trial will be continued up to Dec. 2022.

#### Water mining-next generation water-smart management systems: Large scale demonstrations for a circular economy and society

There are ten technical universities (including VSI) and 29 technology partners involved in this project. The project was effectively started from Sep. 2020. India is not a partner country in horizon 2020. Therefore, VSI is not getting direct funding from EU.

#### Objectives

- Case study within the Industrial Mining group (WP6) on “Recycling of brines including organic compounds in the sugar production sector”.
- To remove organics from high and low strength effluents from distilleries.

#### Results and Discussion

Low strength and high strength effluents (raw spent wash/biomethanated spent wash) from distillery will be treated using High Pressure Oxidation (KVT) and Nereda Technology (TU Delft). Using Nereda

Technology, organic matter will be converted to value added bio-based polymers like Alginate (Kaumera extraction). Before conducting trials on (with High Pressure Oxidation from KVT and Nereda Technology from TU Delft) distillery effluents, raw and bio-methanated spent wash was analyzed and data was sent to KVT & TU Delft. This will be helpful to find out suitable effluent treatment technology (KVT & TU Delft) for effluent treatment. Preliminary market map for Indian distillery industry is submitted to Water Mining Market Mapping Team.

#### Future work

- VSI will send solid/liquid samples to TU Delft and KVT for preliminary trials.
- On the basis of trials, organic matter will be converted to value added bio-based polymers like Alginate (Kaumera extraction) using Nereda Technology.
- Potential technologies will be identified.
- Shortlisted technology market potential will be evaluated for distillery industry in India.

#### Green solvent assisted recovery of wax from press mud cake (PMC) and downstream processing of de-waxed press mud cake through bio-methanation and bio-composting

Source of funding: Rajiv Gandhi Science and Technology Center (RGSTC), GoM for three years (2021-24).

Numerous types of waxes are available in the market, such as fossil-based, bio-based and synthetic waxes. Fossil fuel based waxes includes paraffin wax, macro wax and microcrystalline wax. A few examples of bio based waxes are vegetable and carnauba wax.

The contribution of natural wax is only 4% but the scope of natural wax is expected to increase tremendously. This is due to the diminishing supply of petroleum, a source of paraffin wax together with the transition of public preferences to natural and greener products. On the other hand, most of the natural waxes are costly hampering their market growth and utility. Therefore, exploring different sources for natural wax is of vital importance for country like India. Moreover, the wax obtained from plant waste is more desired to avoid competition for feedstock with other agricultural and food industries. Consequently, wax extracted from the PMC, a waste product of sugar mills can become a promising candidate of natural wax.

## Objectives

- Extraction of sugarcane wax from PMC using different green solvents.
- To evaluate waxed and de-waxed PMC for biogas production.
- To optimize anaerobic digestion processes using de-waxed PMC.
- To study effect of de-waxing of PMC over the bio-composting.

## Results and Discussion

Wax recovery from PMC was carried out using orbital shaker and Soxhlet extraction methods for green solvents. Wax recovery of 6.0 g (using hexane) and 8.6 g (ethyl lactate green solvent) was achieved from 100 g of PMC for Orbital shaker method. Wax recovery of 9.6 g (using hexane) and 14.2 g (Isopropyl alcohol green solvent) was achieved from 100 g of PMC for Soxhlet extraction method. Un-grinded PMC and recycled solvent can be used without compromising wax recovery. RGSTC has given approval to use budget of centrifugal extractor for purchasing Batch reactor with stirring & refluxing facilities and Screw type extractor. To understand biogas potential of de-waxed PMC, anaerobic digestion experiment was initiated for de-waxed PMC.

## Future work

- Wax recovery from wet and dry PMC using different green solvents will be done with the help of batch reactor (with stirring & refluxing-mimic soxhlet condition) and screw type extractor.
- Waxed and de-waxed PMC will be utilized for biogas production and bio-composting

## Biomethanation of cellulosic waste

India imports nearly 50% of natural gas requirement, leading the GoI to set a target of reducing this import by at least 10% by 2022. GoI is promoting Waste / Biomass sources like agricultural residue (sugarcane trash & bagasse), cattle dung, PMC, municipal solid waste and sewage treatment plant waste, etc. for production of biogas. Thus, it can replace CNG in automotive, industrial and commercial areas to a great extent.

Through Sustainable Alternative towards Affordable Transportation (SATAT), OMCs have invited Expression of Interest (EoI) from Entrepreneurs/Co-operative societies/ Technology providers for production & supply of compressed

biogas (CBG). EoI call is aimed at supporting the phased setup of 5000 biogas plants spanning across India. Ministry of New and Renewable Energy, GoI has notified Central Financial Assistance (CFA) of Rs. 4.0 crore per 4800 kg of CBG per day with maximum assistance of Rs. 10.0 crore per project for CBG production. GoI has announced the basic price of Rs. 46/Kg CBG plus 5% GST (Rs. 2.3/Kg). Recently, the RBI has also included CBG plants under priority sector lending. As per the notification from the Department of Agriculture and Farmers Welfare, GoI, the fermented organic digestate coming out from digester of PMC/SCB/other agro-wastes is now approved as organic manure in Fertilizer Control Order (FCO). Considering initiatives taken by GoI, CBG production seems to be next golden opportunity for sugar industry to diversify in value added renewable Bio-fuels.

## Objectives

- To characterize bagasse from different sugar mills using NREL methods.
- To evaluate biogas production from anaerobic digestion of different pretreated bagasse on 20 L scale.
- To optimize and tune anaerobic digestion on 200 L scale.

## Results and Discussion

Anaerobic digester experiments were carried out on 200 L scale by feeding SCB after cavitation pre-treatment. Biogas generation of 100 L/day was achieved from SCB with 58% (v/v) methane. Biogas yield 251 M<sup>3</sup>/ton of dry feedstock of SCB was achieved. Experiments on co-digestion of PMC & SCB for biogas production were carried out. Biogas yield of 370 M<sup>3</sup>/ton of dry feedstock of PMC & SCB (co-digestion) was obtained on 200 L scale. Two pilot scale (50 M<sup>3</sup>) digesters were installed at Nira Bhima SSK. Feeding was initiated in 3<sup>rd</sup> week of March 2022.

VSI tractors have been converted in to dual fuel mode (CBG and diesel) and VSI will conduct performance trials of dual fuel mode tractors with the help of Central institute of Road Transport (CIRT), Pune.

## Future work

- Cavitated bagasse AD trials will be performed on 50 M<sup>3</sup> pilot digester
- PMC and SCB (co-digestion) will be performed on 50 M<sup>3</sup> pilot digester.



## **Second generation ethanol production through enzymatic route and/or using genetically modified microbial strains**

One of the most commonly examined ligno-cellulosic materials for second generation ethanol production is sugarcane bagasse. Bio-ethanol production from ligno-cellulosic biomass requires enzymatic hydrolysis of cellulose to release sugars that can be subsequently fermented by yeasts. For an economically viable ethanol production at the industrial level, the produced ethanol in fermentation must reach at least 5% (v/v).

### **Objectives**

- To optimize method for pre-treatment of bagasse.
- To study the effect of solid loading on hydrolysis and fermentation.
- To validate optimized protocol at 30 L fermenter scale.
- To recover/recycle enzyme for reducing cost of 2G ethanol production.

### **Results and Discussion**

Optimization process for 2G ethanol production from SCB on 30 L bench scale was completed and 7% (v/v) ethanol concentration and 80% fermentation efficiency was achieved with yield of 155-160 L / T of dry SCB. The fermented wash released through 2G ethanol process was distilled and evaluated for biogas generation. Biogas yield of 250 M<sup>3</sup> was achieved from one tonne of xylose (25 M<sup>3</sup>/T of SCB). Almost 50-60% of 2G ethanol production cost is due to use of imported enzymes. Experiment was carried out to recover these enzymes so as to reduce the cost of production. The enzyme recovery of 40-50% was achieved on flask scale. However, lab demo unit is required for further enzyme recovery work.

### **Future work**

- Purchasing of lab scale demo unit for enzyme recovery work will be carried out.
- Enzyme recovery work will be carried out using lab scale demo unit.

### **Pilot study on recovery of potash from incineration boiler ash**

On the basis of lab scale result (90-95% potash recovery) of the project entitled “Recovery of potash from incineration boiler ash” funded by Principal

Scientific Adviser (PSA) to the GoI, New Delhi, pilot scale study was planned to validate lab scale results.

### **Objectives**

- To design and develop the process flow diagram.
- To define specifications for process equipment and estimate cost of a pilot plant.
- To install and commission the pilot plant.
- To conduct trials and carry out further modifications in the process if required in order to optimize the process design and product specification.
- To operate and handover the pilot plant to the industry partner.

### **Results and Discussion**

KS Kale SSK provided financial assistance for this one-year pilot scale R & D project. Basic design engineering of the pilot scale plant was completed by VSI. After successful installation and commissioning of the pilot plant, trials are expected to commence from June 2022.

### **Future work**

- To fabricate, install and commission potash recovery pilot plant.
- To perform potash recovery pilot scale trials at VSI for two months.
- To shift pilot plant to KS Kale SSK site after fine tuning at VSI.
- To demonstrate and to help in understanding the working of pilot plant to KS Kale SSK team.

### **Commercialization of pre-clarification technology to improve alcoholic fermentation**

On the basis of pilot scale result (substantial reduction in cations of molasses (Na, K, Ca, Mg), Indian (201821039366) and US (16/850,281) patent, commercial scale work was planned to evaluate pilot scale results.

### **Objectives**

- To design, fabricate and install commercial scale pre-clarification technology.
- To investigate the effectiveness of proposed pre-clarification technology on fermentation efficiency.
- To evaluate the effectiveness of pre-clarification on downstream effluent system.
- To evaluate the merits & demerits and cost benefits of pre-clarification technology.

## Results and Discussion

The pilot plant was designed, erected and commissioned at Daund Sugar Ltd. The results obtained on pilot plant were submitted to the PRMC committee. As per the suggestions and recommendations received from PRMC, the technology will be commercialized with the help of an industry partner. Baramati Agro Ltd (BAL) has shown keen interest to carry out collaborative work and is ready to invest in commercialization of pre-clarification of molasses technology. The basic design engineering of commercial plant has been completed.

### Future work

- To work out costing of commercial plant for pre-clarification of molasses at BAL.
- Future work will be carried out as per the defined objectives.

### Microbial process for gluconic acid production

Gluconic Acid (GA) is a multifunctional carbonic acid belonging to bulk chemical, with outstanding properties, including extremely low toxicity, very low corrosiveness, and a capability of forming water soluble complexes with different metal ions. Due to these physiological and chemical properties, GA itself and its salts have found extensive demand in construction, chemicals, pharmaceuticals, food, beverage, textile, leather and other industries. Fermentation has been proved as efficient and dominant techniques for manufacturing GA.

### Objectives

- Screening of fungal strains for efficient GA production.
- Optimization of various parameters like pH, temperature, inocula, fermentation time for GA production.
- GA production from sucrose using optimized parameters.

### Results and Discussion

GA concentration of 95 g/L with 0.95 g/g-glc yield and 1.32 g/L/hr of productivity was achieved on shake flask scale using *Aspergillus niger* NCIM545 on shake flask scale. Further, flask scale results were validated on fermenter scale (11 L). GA concentration of 99 g/L with 0.99 g/g-glc yield and 2.06 g/L/hr of productivity was achieved on fermenter scale using CaCO<sub>3</sub> method. GA

concentration of 198 g/L with 0.98 g/g-glc yield and 1.65 g/L/hr of productivity was achieved on fermenter scale using KOH method.

### Future work

- GA production will be carried out by using sucrose containing synthetic media
- GA production will be carried out to see the effect of pH, temperature and agitation.
- Validation of shake flask scale results on fermenter scale.

### Process development for invert sugar production

Invert sugar is an equimolar mixture of glucose and fructose which can be obtained by the hydrolysis of sucrose. Invert sugar is 25% sweeter than regular sugar that is ideal for flavoured drinks as they need lesser sugar to achieve the same sweetness. It also exhibits properties like high osmotic pressure, freezing point depressant, better solubility and humid nature compared to the regular sugar. It is commercially an attractive product and has been extensively used in food industries, confectionaries, beverages industries, pharmaceuticals and bakeries. Diversification of the product portfolio of sugarcane biorefineries through the use of surplus sugar and sugarcane juice for the production invert sugar syrup will provide significant economic return to the sugar Industry and promote their economic competitiveness. Therefore, there is scope for sugar mills to diversify in invert sugar to improve their profitability.

### Objectives

- To optimize sucrose inversion using acid and enzymatic methods.
- To optimize sugarcane juice inversion using acid and enzymatic methods.
- To scale up the process of sugarcane juice and sucrose inversion.

### Results and Discussion

In 2020-21, acid and enzyme method was optimized for invert sugar production. Sucrose and sugarcane juice was inverted at 5 L scale using enzymatic hydrolysis. For 60% sucrose concentration, 91% inversion efficiency was observed. Similarly, for the inversion of sugarcane juice (20o brix), 92% inversion efficiency was observed. The shelf-life study of invert sugar solution (60%) was carried out. Project was concluded on March 31, 2022.





### **Traditional Vs scientific technologies for mahua spirit and heritage alcoholic beverages production-optimization, evaluation and training (Heritage Wine Policy)**

This project was of one-year duration funded by the Department of Commercial Tax, Government of Madhya Pradesh (GoMP).

As per GoMP, current policy on mahua liquor is for self-consumption. The proposed project is aimed towards empowering the tribal people and development of a heritage liquor with good shelf life incorporating possible traditional methods with maintenance of proper hygiene. End product should be nationally and internationally accepted so that GoMP will be able to make policy changes accordingly for participation of private players in collaboration with local/tribal youths.

#### **Objectives**

- To understand mahua fermentation and distillation process in tribal area.
- To study/compare the effect of pure cultures vs traditional practices on mahua fermentation.
- To optimize fermentation (pH, temperature, yeast count etc.) and distillation (different cuts, temperature, etc.) parameters for Mahua spirit production.
- To prepare overall material balance for the process of heritage mahua spirit production.
- To provide recommendation for mahua spirit, and liquor production processes.
- To conduct training programme on mahua liquor production for tribal youths.

#### **Results and Discussion**

Mahua fermentation was carried out on 11 L scale fermenter. Ethanol concentration of 7.5% was achieved during the fermentation. The fermented wash was further distilled to recover Mahua liquor. The middle cut (potable) of 400 ml having above 35% of ethanol concentration was obtained (about 40 L of potable alcohol with 35-40% (v/v) alcohol content was estimated from 100 kg of Mahua flowers). The pilot demo plant will be installed at two districts (Alirajpur & Dhindori) of MP. Engineering drawing and plant costing was provided to Govt. of MP for setup of pilot demo plant. Training to tribal youth (MP) was conducted for two weeks. Project was extended by the MP Govt. up to May 25, 2022.

#### **Future work**

- Detailed project report will be prepared.
- VSI will provide technical support for installation of demonstration pilot mahua spirit plant.

#### **Process development for Neera based liquor and vinegar production**

Neera sap extracted from Wild date palm (*Phoenix sylvestris* Roxb) is either consumed as fresh juice or processed into a broad array of products, including syrup, vinegar, sugar, wine and distilled liquor due to its high sugar contents. Neera and toddy is adulterated by the local people with either water or any sugar source which need to be studied. Neera has vast potential as the substrate for making a good quality wine (tari/toddy) or distilled liquor (arrack) due to its unique aroma which may find good export market. Also, strong natural flavour of tari/toddy may need modification to make it more appealing. The exploitation of neera can provide a solution to nutrition, livelihood and economic security of tribals by using available traditional wisdom as well as modern processing technology. Setting up of neera based wineries and distilleries can result in the economic upliftment of these tribals by generating employment opportunities.

In view of the above benefits, current project has been planned to develop a modern process for neera collection, its preservation and storage, kit development in relation to adulteration and further processing into wine (tari/toddy), liquor (arrack) and vinegar production through scientific methods.

#### **Objectives**

- Biochemical analysis and contamination study of neera.
- To identify parameters for preservation and storage of neera.
- To optimize fermentation parameters (pH, temperature, inoculum, etc) for wine (toddy/tori), distilled liquor and vinegar production.
- To optimize distillation process (different cuts, temperature, etc) for sensory improvement.
- To enhance flavor by blending of the distillates from different sources.

#### **Results and Discussion**

The project was undertaken by VSI after receiving request from the State Excise Department. Fungal cultures were procured from NCL, Pune for vinegar production. Neera and toddy sample was collected and

different parameters were analyzed. Neera was stored at room temperature, 4 oC and -80 oC to evaluate effect of temperature. The shelf-life study was under progress. Toddy production from neera was conducted at shake flask level at 30 °C. Alcohol concentration of 6.05% (v/v) was achieved. Also, vinegar production at shake flask level was conducted using synthetic media and Acetobacter aceti (NCIM 2251). Acetic acid concentration of 20 g/L was achieved.

#### Future work

- Future work will be carried out as per the defined objectives.

### CONTRACT RESEARCH PROJECTS

#### Scientific study on losses of malt spirit during maturation and ageing

Maturation of spirit is slow oxidation process and spirits become soft/smooth after maturation. Depending on the environment, the type of cask, its size, warehouse temperature and humidity, reactions proceed to differing degrees. Clearly, the role of maturation in the development of final spirit flavor is critically important. During maturation process, spirit losses may occur frequently due to various reasons. Due to the porous nature of cask wood, the malt spirit may diffuse out on the surface of the cask. It afterwards evaporates and is lost (called as Angel's share). The environmental factors such as humidity, temperature etc. may effect on the losses significantly. The losses may vary in different weather conditions and size, shape & type of cask wood used. Based on data to be generated during the proposed studies, standards can be developed for actual losses during malt spirit maturation.

United Spirits Ltd. (USL, a Diageo group company) has approached VSI to conduct scientific study on maturation of malt spirit and losses during its maturation. Aim of work is to conduct scientific study on maturation process of spirit, parameter affecting it and losses during maturation.

#### Objectives

- Effect of spirit maturation on its quality and maturation losses
- To analyze and compare the maturation data
- To identify and define guidelines for maturation losses
- To prepare report based on experimental study

### Results and Discussion

At VSI, twelve wooden cask were filled with malt spirit supplied by USL, Nashik storage study was conducted. Temp. and humidity is monitored thrice a day. Total average 7.97 kg of malt spirit loss per cask was observed for 6 Month (Oct. 2021 to Mar. 2022)

#### Future Work

- Future work will be based on the analysis of maturation losses at both site i.e. VSI and USL Nashik plant.

#### Bio-syrup storability study of Praj Industries Ltd. (PIL) at Jaywant Sugars Ltd (JSL)

The assignment of "Storability study of bio-syrup" stored at JSL by PIL was jointly conducted by the VSI and PIL.

#### Objectives

- To estimate the total reducing sugar (TRS) and volatile acidity (VA) of biosyrup.
- To conduct the microbial count of biosyrup.
- To conduct biosyrup to ethanol trial on industrial scale at JSL.

### Results and Discussion

Slightly fluctuations in the TRS content (74.67% to 74.32%) were observed during four to ten months of storage. The VA was slightly increased from 3685.1 mg/L to 5313.4 mg/L after six and seven month of storage. Bacterial count was observed in acceptable limit during ten months of storage. The viable yeast and wild yeast were not observed in all samples. However, there was no adverse effect seen on total sugar content. During whole ten-month storage, there is no degradation observed in biosyrup and also no changes in characteristics of biosyrup observed.

The fermentation trial of biosyrup was also conducted on industrial scale (4 fermenters of 230 M3 capacity in 45 KLPD distillery) at JSL. The alcohol concentration in the fermentation broth was 13.55% (v/v). By using biosyrup the fermentation efficiency achieved was 90.74%. This data of biosyrup fermentation is very similar to syrup fermentation data at JSL. The above trial was successfully completed.

### EXTENSION AND ADVISORY SERVICES

#### Detailed Project Reports (DPRs) and tender documents

DPRs and tender documents for new distilleries, modernization, expansion of existing units and ETPs completed are given in table 1.



**Table 1: DPRs and tender documents**

<b>Name of distillery</b>	<b>DPRs-Plant capacity and configuration</b>
<b>(Distillery, Spent wash evaporation plant, incineration boiler, turbine and CPU)</b>	
Ashok SSK	Expansion from 30 to 60 KLPD with ETP
Athani Sugars (Shahuwadi)	Expansion from 90 to 140 KLPD with ETP
Datta Shetkari SSK	Expansion from 60 to 160 KLPD with ETP
Daund Sugars	Expansion from 120 to 370 KLPD with ETP
Dr. P Kadam Sonhira SSK	Expansion from 60 to 105 KLPD with ETP
Halasiddhnath SSK	50 KLPD distillery plant with ETP
Jaywant Sugars	Expansion from 45 to 110 KLPD with ETP
Jawahar Shetkari SSK	100 KLPD distillery plant with ETP
KS Patil SSK	Expansion from 30 to 145 KLPD with ETP
Mula SSK	Modernization cum expansion from 30 to 40 KLPD and ongoing work of distillery plant from 45 to 60 KLPD with ETP
Nandi SSK Niyamit, KS	Expansion from 50 to 150 KLPD with ETP
Rajarambapu Patil SSK	Modernization cum expansion from 75 to 100 KLPD with ETP
Renuka Sugars, Munoli, KS	Expansion from 120 to 500 KLPD with ETP
Renuka Sugar, Unit 4	Expansion from 300 to 600 KLPD with ETP
Sant Tukaram SSK	45 KLPD distillery plant with ETP
Sharayu Agro Industries	270 KLPD distillery plant with ETP
Shripati Sugar & Power	45 KLPD distillery plant with ETP
SMSN Nagawade SSK	60 KLPD distillery plant with ETP
Vighnagar SSK	Expansion from 30 to 65 KLPD with ETP
Vitthalrao Shinde SSK	Expansion from 150 to 250 KLPD with ETP
<b>(Distillery, Biomethanation, Spent wash evaporation plant, spray dryer and CPU)</b>	
Dwarkadhish Sakhar Karkhana	Modernization cum expansion from 30 to 60 KLPD with ETP
KA Tope Samarth SSK, Unit 2	Expansion from 60 to 160 KLPD with ETP
Kunturkar Agro Industries and Kumbhi Kasari SSK	30 KLPD distillery plant with ETP
Mahuva Pradesh SKUM, Gujarat	Expansion from 35 to 55 KLPD with effluent treatment system
NKJ Bio-fuels, Chhattisgarh	100 KLPD distillery plant with ETP
NSL Sugars, Unit 3	Modernization cum expansion from 150 to 500 KLPD with ETP
Rena SSK	Expansion from 30 to 60 KLPD with ETP
Vilas SSK, Unit 2 & Venkateshkrupa Sugar Mills	60 KLPD distillery plant with ETP
Vishwasrao Naik SSK	Modernization cum expansion from 30 to 75 KLPD with ETP
<b>(Distillery, Integrated Spent wash evaporation plant and biocomposting)</b>	
Ajinkyatara SSK	Expansion from 30 to 45 KLPD with ETP
Swg. Ashokrao Bankar Sahakari Patsansta Lessee of KK Wagh SSK	Expansion from 30 to 45 KLPD with ETP
<b>(Distillery, Thin slop evaporation plant, decantation and mingler)</b>	
KSK BioEnergy	75 KLPD capacity grain based distillery plant with ETP

**Table 1: DPRs and tender documents (Contd.)**

Name of distillery	DPRs-Plant capacity and configuration
<b>(Ethanol plant)</b>	
LMGP Dnyaneshwar SSK	50 KLPD plant and molasses storage tank
SMSM Patil SSK	Expansion from 40 to 85 KLPD
Udagiri Sugar & Power	Expansion from 30 to 55 KLPD
<b>(Other)</b>	
Govt. of Madhya Pradesh	Mahua heritage liquor production and bottling unit (100 litres / day)
<b>Tender Documents</b>	
<b>(Distillery, Spent wash evaporation plant and CPU)</b>	
Ashok SSK	Modernization cum expansion of distillery plant from 30 to 60 KLPD with ETP
Datta Shetkari SSK	Expansion from 60 to 90 KLPD and expansion of ethanol plant from 30 to 135 KLPD with ETP
Dr. P Kadam Sonhira SSK	75 KLPD distillery with 40 KLPD ethanol plant with ETP
Indreshwar Sugar Mills	100 KLPD distillery plant with ETP
KKRJP Kukadi SSK	45 KLPD distillery plant with ETP
Kumbhi Kasari SSK	30 KLPD ethanol plant with ETP
Nira-Bhima SSK	75 KLPD distillery plant with ETP
Rajarambapu Patil SSK	Modernization cum expansion from 30 to 75 KLPD with ETP
Vighnagar SSK	Expansion from 30 to 65 KLPD with ETP
<b>(Distillery)</b>	
Vitthalrao Shinde SSK	100 KLPD distillery with ethanol plant
<b>(Distillery, Biomethanation, Spent wash evaporation plant, spent wash spray dryer or ATFD and CPU)</b>	
Dwarkadhish Sakhar Karkhana	30 KLPD distillery plant with ETP
KA Tope Samarth SSK, Unit 2, Vilas SSK, Unit 2 Venkateshkrupa Sugar Mills	60 KLPD distillery plant with ETP
Lok. Sundarraoji Solanke SSK	Expansion of distillery plant from 45 to 90 KLPD with ETP
NKJ Bio-fuels, Chhattisgarh	100 KLPD distillery plant with ETP
Rena SSK	Expansion of distillery plant from 30 to 60 KLPD with ETP
Sugar Grid	45 KLPD distillery plant with Effluent treatment system
<b>(Other)</b>	
Ajinkyatara SSK	Expansion of distillery plant from 30 to 45 KLPD with ETP (Integrated spent wash evaporation plant)
Bhaurao Chavan SSK, Unit 2	Cap. 6000 MT
Kumbhi Kasari SSK	30 KLPD ethanol plant, Spent wash evaporation, CPU & Molasses storage tank
LMGP Dnyaneshwar SSK	50 KLPD ethanol plant and Molasses storage tank
Udagiri Sugar & Power	Expansion of ethanol plant from 30 to 55 KLPD



### Adequacy assessment reports (AARs) for distillery ETPs in Ganga Basin and other states

As per the notification from CPCB, the department has taken initiative to assess the ETP performance of distilleries in the Ganga basin to comply with the prescribed norms of ZLD. VSI team carried out inspection of fermentation, distillation and ETP sections of 120 KLPD distillery capacity of RSL Distillery Pvt. Ltd, Karnal (Haryana State) and 120 KLPD molasses based distillery & 60 KLPD grain based distillery plant of Radico NV Distilleries Maharashtra Ltd, Aurangabad (Maharashtra). VSI team visited distillery site for inspection, took observations and discussed with concerned officers on various issues related to distillery, performance of ETP's, operational problems and collected necessary information. The AARs of distillery ETP's have been prepared and submitted to concerned distilleries.

### Technical offers and state level machinery purchase committee (SLMPC) meetings for distilleries and ETPs

Technical offers received from different suppliers were critically evaluated, comparative statements were prepared and submitted to the concerned distilleries and/or SLMPC. The department attended pre-bid, technical sub-committee and SLMPC meetings at MRSSK Sangh, Mumbai/ Pune for Dwarkadhish Sakhar Karkhana, KKRJP Kukadi SSK, Rajarambapu Patil SSK, LMGP Dnyaneshwar SSK, SMSM Patil SSK, Dr. P Kadam Sonhira SSK, Ajinkyatara SSK, Rena SSK, Vilas SSK, Unit 2, Venkateshkrupa Sugar Mills, Indreshwar Sugar Mills, NKJ Bio-fuels, Chhattisgarth, Lok. S Solanke SSK, KA Tope Samarth SSK, Unit 2, Vighnagar SSK, Ashok SSK, Nira Bhima SSK, Sahyadri SSK, Kumbhi Kasari SSK and Gurudatta Sugars.

### Recommendation for proposals

The department has provided technical recommendations required for setting-up of new distilleries, new ETPs and modernization/modification of distilleries and ETPs are mentioned in table 2.

Inspection of plant & machinery, consultancy services

During project execution, layout, GA, civil & structure drawings, PFDs, P & IDs were checked and approved. Consultancy services were provided to 18 distilleries including distillery plants, biomethanation, spent wash evaporation, biocomposting system, spent wash dryer and CPU as mentioned in the table 3.



Visit of the officers from Mantralaya to VSI



**Table 2: Recommendations for new distilleries, ETPs, expansion and modernization**

Name of distillery	Details of proposals
Dr. P Kadam Sonhira SSK	Expansion of distillery plant from 60 to 105 KLPD with ETP
Jaywant Sugars	Expansion of distillery plant from 45 to 110 KLPD with ETP
KA Tope Samarth SSK, Unit 2, Vilas SSK, Venkateshkrupa Sugar Mills, Unit 2	60 KLPD distillery plant with ETP
Rajarambapu Patil SSK	Expansion of distillery plant from 75 to 100 KLPD with ETP
Rena SSK	Expansion of distillery plant from 30 to 60 KLPD with ETP
Vighnagar SSK	Expansion of distillery plant from 30 to 65 KLPD with ETP
Someshwar SSK	Expansion of distillery plant from 30 to 60 KLPD with ETP
SMSM Patil SSK	Expansion of ethanol plant from 40 to 85 KLPD

**Table 3: Inspection of plant & machinery and consultancy services**

Name of distillery	Details
<b>(Distillery, spent wash evaporation and CPU)</b>	
Athani Sugars Ltd. (Shahuwadi)	90 KLPD distillery with ETP
Bhaurao Chavan SSK, Unit 1 and KA Tope Samarth SSK, Unit 1	30 to 60 KLPD distillery expansion with ETP
Gurudatta Sugars	90 KLPD distillery with ETP
KS Kale SSK, Mula SSK and Pad. Dr. DY Patil SSK	45 KLPD distillery with ETP
Rajarambapu Patil SSK	55 KLPD distillery with ETP
Sharad SSK, SM Kagal Taluka SSK	30 KLPD distillery with ETP
Vilas SSK, Unit 1	Spent wash evaporation plant and CPU
Vitthalrao Shinde SSK	90 KLPD ethanol with ETP
<b>(Distillery, Biomethanation, spent wash evaporation plant, spent wash spray dryer or ATFD and CPU)</b>	
Dwarkadhish Sakhar Karkhana	45 KLPD distillery ETP
KA Tope Samarth SSK, Unit 2	60 KLPD distillery ETP
<b>(Distillery, Biomethanation, spent wash evaporation plant, biocomposting and CPU)</b>	
Agasti SSK	30 KLPD distillery with ETP
Kadwa SSK	30 KLPD distillery with ETP
Sanjivani SSK	Spent wash evaporation plant
<b>Other</b>	
LMGP Dnyaneshwar SSK	50 KLPD ethanol plant, PESO storage and molasses storage tank

**Certification of distillery layout for tri party agreement with OMCs for ethanol production**

The department has certified the distillery layout for tri party agreement with OMCs for ethanol production (table 4).

**Table 4: Certification of ethanol plant as per EOI**

Name of distillery	Capacity (KLPD)
NSL Krishnaveni Sugars, Ramkrishnapur, Kothakota Mandal (Telangana)	150
NSL Sugars, (Karnataka)	100
Pioneer Distilleries, (Punjab)	200
Renuka Sugars, (Unit-IV) (Karnataka)	300
Renuka Sugars, Munoli (Karnataka)	380
Satish Sugars (Karnataka)	210
Ugar Sugars Works, (Karnataka)	645



**Process validation reports on “Mechanism for diversion of sugarcane juice or sugar syrup or sugar or BH molasses to produce ethanol”**

The Government has been exploring alternate routes for encouraging production of ethanol to bridge the demand and supply gap for the Ethanol Blending Programme (EBP). As per notification from DFPD, sugar mills are allowed to produce ethanol directly from sugarcane juice or sugar syrup or sugar or BH molasses.

AT & B and Sugar Technology department paid joint visits to the sugar mills & distilleries in Maharashtra and other states for verification and compliance of DFPD guidelines and collections of operational documents, analysis reports and certificates from Govt. authorities for preparation of validation reports. Process validation reports were prepared for 80 distilleries attached to sugar mills from Maharashtra, Uttar Pradesh and Karnataka for diversion of sugarcane juice or sugar syrup or sugar or BH molasses. These process validation reports will be helpful for the State Excise Department or any other agency designated by State Government to certify ethanol production routes.



### Technical feasibility and financial viability report for sugar and ethanol production

The department has provided guidance to distilleries to find most economical profitable route for ethanol production as per DFPD guidelines. Techno-economic feasibility worked out for sugar and ethanol production by considering four different routes (Conventional C-molasses, BH molasses, Partial sugarcane syrup in season & C-molasses during off-season and Partial sugarcane syrup in season & BH molasses during off-season).

During the year, around 75 distilleries in Maharashtra have used sugarcane syrup and BH molasses for ethanol production. Techno-economic feasibility of nine distilleries was carried out for different feedstock.

### Visits

The staff visited member and non-member distilleries in the state and other states, Government offices and Institutions for different assignments. The details of visits with assignments are given in Annexure - XII.

### Yeast culture bank

VSI developed yeast cultures (VSI 1011 & VSI 1003) were provided to member and non-member distilleries across the country. Based on the feedback received from the distilleries, it was found that the performance of yeast cultures provided by VSI was quite good. Total 21 yeast culture slants were provided.

### Analytical services

Various samples analyzed by wet chemical methods, gas chromatography (GC), GC-MS, HPLC, atomic absorption spectroscopy (AAS), Anton Paar and PMI are mentioned in table 5.

**Table 5: Samples analyzed by various analytical methods**

Name of sample	No. of samples analyzed by			
	Chemical / Wet analysis	GC, GC-MS, HPLC, ICand PMI	Atomic Absorption	Anton Paar
<b>Samples from State Excise Dept., Maharashtra</b>				
Beer	---	---	---	2791
Country liquor	6559	---	---	---
IMFL	---	---	---	13711
Molasses	2120	---	---	---
Wine	---	---	---	321
<b>Other</b>				
Cane juice syrup	31	---	---	---
Extra Neutral Alcohol	29	35	17	35
Ethanol	45	52	21	44
Excise Grain samples	220	---	---	---
Excise Denaturant and Bitterant	4310	9	---	---
Fermentability of molasses	1	---	---	---
IMFL	---	17	---	14
Material testing with PMI machine	9250	---	---	---
Molasses from distilleries and sugar mills	13	---	---	---
Molasses – Microbial analysis	20	---	---	---
Rectified spirit	21	25	8	26
<b>Total</b>	<b>22619</b>	<b>138</b>	<b>46</b>	<b>16942</b>

### Analysis and processing of sweet sorghum stalk

Seven different varieties of sweet sorghum samples received from M/s. UPL Limited, Hyderabad to find out its suitability for alcohol production. The Sweet sorghum varieties namely Sugar Graze, CSH22SS, Mega Sweet, ADV6601, ADV6620, ADV6627, ADV6634 were handed over to VSI by UPL. The seven different varieties of Sweet sorghum stalk were analyzed as well as processed to find out its suitability for alcohol production. Among seven varieties, ADV6601, ADV6620 and ADV6634 varieties offer comparatively better alcohol yield.

### Calibration work

The calibration was done for 264 Sykes hydrometers, ten specific gravity hydrometers, 18 brix hydrometers, 15 alcohol meters and 156 thermometers (total 463).

### NABL and FSSAI

Total 118 samples were analyzed under NABL (Beer & wine samples - 57, IMFL - 50 and RS, ENA, Ethanol - 11 samples)

### Improving performance of distillery units

Services rendered to distilleries in improving performance and addressing process problems are stated in brief as under:

#### Dhampur Sugar Mills, Asmoli (UP)

The distillery unit approached VSI for fermentation performance improvement. During the visit, fermentation process observations were taken for various parameters. Following suggestions were given;

- Optimum nutrient dose was recommended for fermentation process.
- Existing culture vessels can be used for ADY (Active dry yeast) activation and activated ADY can be transferred to pre-fermenter, which will be helpful for increasing initial cell biomass of pre-fermenter and later to fermenter.
- The optimal feeding rate should be used to increase alcohol concentration in fermented wash.
- Existing fermenter capacity was not adequate to conduct fermentation process smoothly, therefore, suggested to install new fermenter of 1200 M<sup>3</sup> capacity.
- In the premises of sugar mill and distillery unit, all gutters should required proper slope and cleaning to avoid process contamination in fermentation process.

#### DCM Shriram Sugars, (UP)

The distillery unit has approached VSI for fermentation process problem on syrup route. VSI team has paid visit to distillery unit. For the syrup fermentation, the average retention time of fermenter was 52 hrs and alcohol percentage varies in between 8 to 10% (v/v) in fermented wash. To improve/reduce the retention time and to achieve consistent alcohol percentage in fermented wash 11-12% (v/v).

#### Following actions were taken

- Fermentation process temperature was maintained at 35 oC with the help of steam condensate.
- Fermenter feeding pattern was changed by adding water and nutrient step by step instead of one-time addition.
- Maintained yeast cell counts in the fermented wash around 2.5-3.0 x 10<sup>8</sup> cells/ml.
- Residual sugar was kept below 0.6% (w/w) in fermented wash.

As a result, the fermentation retention time was reduced from 52 hrs. to 42 hrs. and improved the alcohol percentage in fermented wash from 11% to 12% (v/v).

#### Vighnagar SSK

The distillery unit approached VSI for optimization of fermentation process to achieve high alcohol percent in fermented wash. During the visit, it was observed that the distillery unit has installed single fermenter (Biostil Fermentation Technology). Therefore, following suggestions were given:

- To install new fermenter in existing fermentation house to increase retention time of fermented wash.
- To monitor and maintain the standard parameters (Sugar %, temp., nutrient dose, yeast cell count, dissolved solids and spent wash recycle etc.) of fermenters to achieve high alcohol percent.
- After installation of new fermenter the alcohol percentage in fermented wash was increased from 7.0 % to 8.5% (v/v) and total alcohol production was increased from 30,000 lits. to average 35,000 lits. per day.

#### Lok. S Solanke SSK

The distillery unit approached VSI for problem of fermentation process of sugarcane syrup mode to get consistency in alcohol percent in fermented wash and ethanol production. During the visit, it was observed





that the fermentation process has severe contamination of rod shaped bacteria and other yeast species. The microbial observations and analysis of syrup, pre-fermenter, fermenter and other streams were carried out to find out the source of contamination. Following suggestions were given,

- To change the feeding pattern of pre-fermenter and fermenters.
- To develop fresh yeast culture in culture vessels, pre-fermenter and transfer developed yeast culture continuously to fermenter.
- To optimize the nutrient dosing to achieve consistency in alcohol percentage and its production.
- To maintain hygienic and clean condition in sugar mill as well as in distillery.

After changes in feeding pattern of fermenter and maintaining hygienic conditions in sugar mill as well as in distillery plant, the alcohol percentage in fermented wash was increased from 8.0% to 11.0% (v/v) and total alcohol production was increased from 55,000 lits. to average 60,000 lits. per day.

#### **SMS Kolhe SSK**

The distillery unit approached VSI for problem of leakages at ethanol plant recovery column bottom segment, reboiler tube & shell side and vacuum pump. VSI team has paid visit to distillery unit and carried out observations of ethanol plant. The leakages occurred due to low pH of fermented wash and ethanol from cane syrup route.

Suggestion was given for replacement of existing recovery column bottom segment and reboiler by new one having MOC-SS-316.

#### **Indreshwar Sugar Mills**

The mill approached VSI for facing problem of production of ethanol in 45 KLPD ethanol plant. On the basis of observations, it was suggested that molecular sieve quantity in sieve bottles and heat transfer area of recovery column should be increased.

#### **Technical guidance to Government and non-Government organizations**

The member distilleries require administrative and financial clearances from the statutory bodies for replacement of their old machinery and to set-up of new projects. Therefore, the department provided guidance to Commissioner of Sugar, SLMPC and sugar mill purchase committees. In addition, the guidance was

provided to DFPD, CII, MoEF, AIDA, Ethanol Association of India, Distillers' Association of Maharashtra (DAM), CPCB, MPCB, ISMA, Maharashtra and Karnataka State Excise Department.

The department has conducted special training programme for State Excise Officers, GoM. The training involves production and storage of alcohol from sugar, sugar cane juice/syrup, B-Hy molasses, damaged grains, alcohol yields from different raw materials and alcoholic beverages.

#### **Technical performance of VSI member distilleries and effluent treatment plants affiliated to sugar mills in Maharashtra**

The department published a booklet entitled "Technical Performance of VSI Member Distilleries in Maharashtra for the Year 2019-20 and 2020-21". Eighty-three distilleries were functional in 2020-21. The data on technical performance of distilleries for previous five years is presented in table 6.

#### **Recognition**

It is a matter of pride for the Institute that Prof. SV Patil, Head & Technical Adviser, Alcohol Technology & Biofuels, for his valuable contribution in the alcohol industry was appointed as Chairman of the Expert Committee constituted by CPCB to formulate the action plan/ charter for up-gradation of manufacturing process technology, ZLD system and adaptation of best practices for effective implementation of ZLD by distilleries identified as discharging effluents in to river Ganga main stream and its tributaries.

#### **Academic**

The department is involved in conducting autonomous DIFAT course and MSc (Wine, Brewing and Alcohol Technology) course affiliated to the SPPU, Pune. The students of MSc (WBAT) and DIFAT 2019-21 batches were placed in the following companies.

- Adie Broswon Breweries Pvt. Ltd., Khopoli
- Brewcrafts Microbrewing India Pvt. Ltd., Pune
- First Brew House, Pune
- Goa Brewing Company, Panji
- Royal Oak Microbrewery, Mumbai
- Shree Renuka Sugars Ltd., Athani
- Shree Renuka Sugars Ltd., Munnoli
- Sula Wines Pvt. Ltd., Nasik
- Yavasura Brewing LLP, Pune

**Table 6: Technical performance of VSI member distilleries in Maharashtra**

Technical Parameter	Year				
	2016-17	2017-18	2018-19	2019-20	2020-21
Production capacity (million L/300 days) considering all distilleries.	954.00	972.00	1086.00	1099.50	1153.50
Production capacity (million L/300 days) Based on received information	672.00	729.00	850.00	682.80	889.46
Number of distilleries whose information was compiled	50	52	57	50	58
Average net working days	136.00	148.00	197.00	151.00	140.00
C- molasses consumed (million tonnes)	1.230	1.405	2.142	1.344	1.020
B-heavy molasses consumed (million tonnes)	--	--	0.166	0.265	0.682
Sugarcane juice consumed (million tonnes)	--	--	0.057	0.182	1.007
Alcohol produced (million lit.)	335.09	383.35	635.53	457.82	574.95
Average fermentation efficiency (%)	89.75	89.90	89.89	89.76	89.75
Average Distillation Efficiency (%)	98.63	98.51	98.52	98.48	98.46
Recovery of Alcohol (Lit./tonne of C-molasses)	272.27	272.78	271.46	266.55	274.82
Recovery of Alcohol (Lit./ tonne of BH-molasses)	--	--	301.37	321.66	316.84
Recovery of Alcohol (Lit./tonne of cane)	--	--	82.05	78.93	77.93
Capacity utilization (%)	54.22	53.47	77.31	67.05	64.64



**Inauguration of the workshop 'Valorizing waste from sugar & allied industries' jointly organized by VSI and UK partners**

**Commissioner of State Excise, GoM, Divisional Dy. Commissioner of Excise, Pune, Asstt. Joint Commissioner, Molasses & Alcohol and Superintendent of Police, Pune visited VSI**



# Environmental Sciences



## ENVIRONMENTAL SCIENCES

The sugar and allied distillery is currently in a very positive phase brought about by the developments following the introduction of the National Biofuels Policy. The Government of India is encouraging the production of fuel ethanol and has brought forward the target for achieving 20% blending with petrol from 2030 to 2025. However, there have been developments which also indicate that environmental regulations and their implementation will become increasingly stringent. The National Green Tribunal has issued directions to CPCB to ensure running of sugar ETPs year round and interlocking of pollution control systems (for air & water) with production process. This presents new challenges for the industry. The department assists the sugar and allied industry in addressing environmental issues through research, consultancy and teaching/training.

The research focuses on finding sustainable solutions to environmental problems including waste reduction, treatment and disposal. The consultancy services include environmental impact assessment (EIA), environmental audits (EA), and preparation of project reports for establishment and up-gradation of effluent treatment plants, environmental monitoring and analysis. The department was reaccredited by NABET for the fourth time for carrying out EIA studies and accredited by NABL as per ISO 17025:2017. Human resource development in the area of environment is addressed through conducting MSc and PhD programs in Environmental Sciences, short term training programs for industry personnel and sponsored programs from Central Pollution Control Board (CPCB). The department also organizes workshops on current environmental issues and latest regulations to keep the industry updated on these issues. It also communicates with MoEFCC, CPCB & MPCB regarding issues of environmental importance concerning the sugar and allied distillery industry.

### RESEARCH

#### Assessment of workplace air quality in various sections of a sugar mill/allied units

The main sources of air pollution from sugar & distillery industry are mill section, sulphitation section, pan section, sugar godown, sugar house, boiler house, bagasse yard, fermentation section, storage tank areas,

etc. The major pollutants are particulate matter, carbon dioxide, sulphur dioxide, nitrogen oxide and carbon monoxide. Monitoring of areas for PM10, PM2.5 & SO<sub>x</sub> in different sugar mills was carried out in crushing season. Studies on SO<sub>x</sub> 2 levels in sugar godown/storage are also in progress. Along with this SO<sub>x</sub> content off freshly stored sugar is also being monitored so as to correlate with emissions in storage areas. Air Quality Index was calculated based on last season's monitoring data.

Study of the health effects on workers-questionnaires were collected from 60 workers exposed to these polluted areas. Health check-up of workers with higher exposure-could not be done as mills are not willing for testing of workers. Work is in progress for mitigation strategies to reduce particulate matter in indoor air of sugar mills. This is being done with Sugar Engineering dept.

#### Assessment of occupational noise levels in sugar/allied units

Noise is an insidious industrial pollutant found in almost every industry and the sugar/allied industry is no exception. This study started last year was continued by monitoring the occupational noise levels in sugar mills with allied distillery units. One cycle of monitoring in different areas of sugar mill and distillery has been completed at Malegaon SSK, KS Patil SSK and Rajarambapu Patil SSK. Areas of high noise in mills have been identified as boiler, turbine, milling section, bagging areas and distillation section in distilleries.

Workers were interviewed to assess the effects of noise. Mitigation strategies with design aspect are being discussed and planned with sugar engineering department.

#### Monitoring the water footprint of the sugar industry

Water footprint is one of the measures of sustainability. The water footprint of a product is the volume of freshwater used to produce the product, measured over the full supply chain. Water footprint has three components blue, green and grey water footprint.

- The blue water footprint (WF blue) is the volume of water consumed by the process.



- The green water footprint (WF green) is the volume of rainwater evapotranspired and incorporated by the process.
- The gray water footprint (WF gray) is an estimate of the fresh water needed to dilute load of pollutants.

The objective of this study is to create benchmarks for water usage in the sugar industry. The work has focused on water footprint from sugar processing. Primary data has been collected from two sugar mills and is being processed

### Carbon dioxide sequestration using a biocatalyst and utilize the product of the reaction to grow algal biomass for bio fuel purpose

Carbon sequestration is the process of capture and storage of atmospheric carbon dioxide, so as to prevent its entry in the atmosphere for long time. Plants act as a carbon sink by absorbing CO<sub>2</sub> for photosynthesis process and convert it into glucose and its polymers. Algae have a good potential of carbon sink and to produce bio-fuel. However, studies show the cost of algae cultivation as a prime limiting factor to scale up the technology. The present research is an integration of carbon sequestration and low cost cultivation of algae using sugar mill effluent.

The research experiments were divided into two parts. In the first part, CO<sub>2</sub> captured using bio-catalyst and converted into bi-carbonate. Red blood cells (RBCs) of goat were used as a crude source of bio-catalyst. Bi-carbonate produced in the reaction was supplied to an alga - *Chlorella* for its own growth. Measuring the biomass increase after supply of bicarbonate water/wastewater to *Chlorella* was the second part of the experiment. The algal biomass growth was monitored in terms of change in its optical density at 24 hr interval, using UV spectrophotometer.

In the first part, efficiency of biocatalyst was tested through a simple experiment. In this, CO<sub>2</sub> bubbled in the water with bio-catalyst (experimental) and without bio-catalyst (control) for 20, 40 and 60 seconds. Fig.1 shows a sizable quantity of bicarbonate synthesis in the experimental flasks.

In the second part, the produced bicarbonate of first experiment was used to grow *Chlorella*. Growth of the alga was observed for 120 hr i.e. five days. Fig. 2 shows that the growth of *Chlorella* was maximum for set A in which maximum bicarbonate produced (CO<sub>2</sub> bubbled

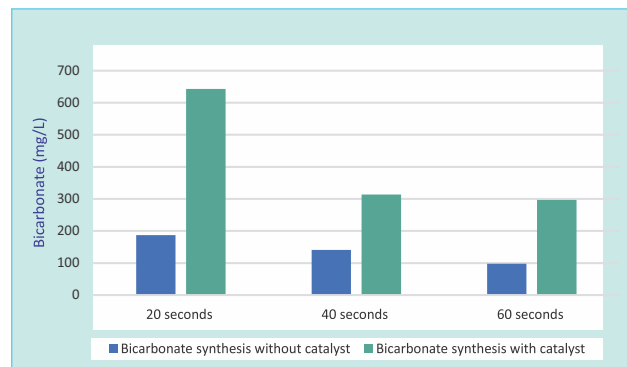


Fig. 1: Bicarbonate synthesis with and without bio-catalyst

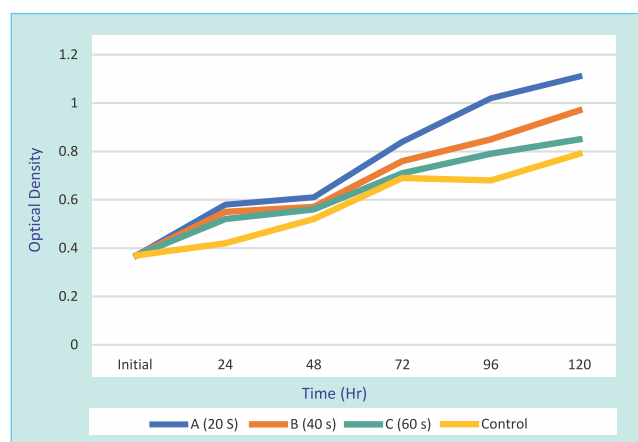


Fig. 2: Change in the biomass of *Chlorella* observed - in case of set A supplied with bicarbonate produced in 20 seconds, set B supplied with bicarbonate produced in 40 seconds, set C supplied with bicarbonate produced in 60 second and control set (without bio-catalyst)- for 120 hr.

for 20 seconds in the first experiment). Set A and B showed maximum growth rate at 72 hr and 96 hr observation period which was significant as compared to control. Second part of the experiment using sugar mill effluent was unable to perform this year.

Findings of the above experiment-

- Waste CO<sub>2</sub> gas can be used in the process of bicarbonate synthesis using biocatalyst
- Available research literature reveals that wastewater can be used as a medium to cultivate algae
- Cost of algae cultivation that hinders its use for biofuel production can be overcome by use of biocatalyst
- Increase in the algal biomass observed in the second part of the experiment underlines importance of the research

## EXTENSION AND ADVISORY SERVICES

### Environmental Impact Assessment (EIA)

Environmental Impact Assessment is the environmental management tool which helps decision makers to understand impacts of industrial/infrastructure projects. It is a crucial part of the environmental clearance process in India. Establishment and expansion of most industrial/infrastructure projects require prior Environmental Clearance (EC) from the Ministry of Environmental Forests & Climate Change (MoEFCC). MoEFCC accepts EIA reports only from consultants accredited by National Accreditation Board for Education and Training (NABET) of Quality Council of India (QCI). The Institute is accredited for three sectors viz. sugar, distillery & thermal power (co-generation) since 2011 and currently in its fourth accreditation cycle. The National Biofuels Policy, 2018, has encouraged the establishment of new distilleries and expansion of existing ones. Both these require EC and in past three years a large number of projects have been completed by the department. The projects/work performed under EIA consultancy services during the year is summarized in table 1.

### Compliance of environmental clearance (EC)

EC is issued to industries with general and specific conditions, which have to be complied mandatorily. Six-monthly compliance reports are to be submitted by the industry to concerned regional offices of MoEFCC. In case, expansion of a project is planned, then certification of EC compliance report by RO, MoEFCC is essential after site visit. The department also offers its services for preparation of such compliance reports for sugar and distillery industry. Guidance is also given for preparation of such reports. The status of work in this regard is given in table 2.

### Sugar ETP consultancy

The sugar ETP consultancy consists of preparation of DPRs/detailed specifications/ tender documents for new ETP/ condensate polishing unit (CPU)/ spray pond over flow treatment. Sewage treatment plant (STP); up-gradation of existing ETP/CPU, trouble shooting for operation and maintenance of these units, ETP adequacy, ETP performance assessment. The details of the ETP consultancy for sugar mills is given in table 3.

### ETP troubleshooting and waste water minimization

The department has developed expertise in ETP wastewater minimization and ETP troubleshooting. Sugar mills viz. AB Sugars Ltd, Punjab; Doiwala Sugars Co. Ltd., Uttarakhand; Modi Sugar Ghaziabad, Uttar Pradesh and SBEC Sugar Ltd., Hariyana were visited for providing services.

Following mills approached VSI for guidance to identify and solving the ETP/CPU operational problems.

#### Doiwala Sugar Company

Doiwala Sugar company, Uttarakhand is a co-operative sugar mill working since 1930 and having a crushing capacity of 2500 TCD and ETP capacity of 500 m<sup>3</sup>/day. It was observed that the sugar mill ETP has a rectangular type secondary clarification tank with a very high retention time due to which dead sludge was floating on the surface of the clarification tank. As the crushing season was about to start, mill management was not able to construct a new circular type secondary clarifier. It was suggested to convert the existing rectangular type clarification tank into three equal compartments by constructing a partition wall and use these compartments in series. As a result, this modification of ETP improved sludge settling and sludge removal efficiency of the secondary clarification tank and mill did not face the sludge floating issue throughout the crushing season.

#### Rajarambapu Patil SSK

The current crushing capacity of the mill is 7000 TCD and ETP capacity is 700 - 1000 m<sup>3</sup>/day. It was found that lime addition was being done equalization tank due to which load of inorganic suspended solids increased in the aeration tank. This caused disturbance in aeration tank after a few days and efficiency of treatment decreased. The main cause of this problem was unavailability of primary clarification system. In addition, the sugar mill ETP has two secondary clarifiers working in parallel flow with adequate collective capacity, therefore the team suggested utilizing one of these clarifiers as primary clarifier by making piping and pumping arrangements. The sugar mill implemented the suggestion and the operational issue in the aeration tank has been resolved as well as treated effluent clarity improved. However, ETP up-gradation has been suggested in coming off-season to improve performance.



**Table 1: Summary of EIA consultancy**

Client	Project	Highlights of work	Status /Remark
Ankur Biochem (P) Ltd., Jharkhand	Expansion of grain-based distillery from 200 to 500 KLPD	Provided guidance for compliance of EC of 200 KLPD unit.	This compliance is essential to process the case further
Chhatrapati SSK, Majalgaon	New 45 KLPD molasses based distillery	State Expert Appraisal Committee (SEAC) recommended the project. SEIAA asked to submit town planning approved layout of the project.	Project layout has been submitted to town planning for approval
Dwarkadhish Sakhar Karkhana	Expansion of molasses-based distillery from 30 to 90 KLPD	Preparation of environment management plan for processing proposal under B2 category.	
Halasiddhanath SSK, Karnataka	New 50 KLPD molasses based distillery	Project was presented to SEAC, Karnataka which recommended the project SEIAA, Karnataka.	EC granted by Karnataka SEIAA
Kadwa SSK	New 30 KLPD molasses based distillery	Presented the case to SEAC, Maharashtra which recommended the project. SEIAA asked to submit town planning approved layout of the project.	Project layout has been submitted to town planning for approval
KA Dr. GD Bapu Lad SSK	Expansion of molasses- based distillery from 60 to 90 KLPD	EAC of the MoEFCC recommended the project for environmental clearance.	EC granted by MoEFCC
Kranti Sugar and Power	New 45 KLPD molasses-based distillery		Project on hold by the client
Kumbhi Kasari SSK	EC for expansion of sugar, co-generation and molasses-based distillery		Project on hold by the client
Kunturkar Sugar and Agro Private Ltd.	New molasses based distillery of 30 KLPD capacity	ToR granted by SEIAA, EIA report was prepared and public hearing completed. Final EIA report submitted to SEAC/SEIAA.	SEAC meeting is awaited
Lok. Sundarraoji Solanke SSK	Expansion of existing distillery from 45 to 90 KLPD	SEIAA has recommended and issued the EC. Proposal for No increase in pollution load (NIPL) processed was prepared and submitted to MPCB.	EC granted by Maharashtra SEIAA. No Increase in pollution load certificate was issued by MPCB
Maa Mahamaya SSKM, Chhattisgarh	New molasses-based distillery		Project on hold by the client
Malegaon SSK	Expansion of distillery unit	Visit to the factory and detailed discussions with the client for the same. Preparation of compliance report of existing environmental clearance is in progress.	Data awaited from the client
NKJ Biofuels (P) Ltd. (Bhoramdeo SKUM) Chhattisgarh	New 80 KLPD molasses based distillery	EIA report was prepared and public hearing completed. Presentation made online to SEAC/SEIAA Chhattisgarh. Proposal for amendment in the EC for change in the feed stock, submitted to SEIAA.	EC granted by Chhattisgarh SEIAA. Awaiting SEIAA meeting for consideration of proposal for amendment

**Table 1: Summary of EIA consultancy (Contd...)**

Client	Project	Highlights of work	Status /Remark
Pad. Dr. P Kadam Sonhira SSK	Expansion of sugar unit from 7000 to 10000 TCD and molasses based distillery from 60 to 135 KLPD	Environmental management plan of the expansion project was prepared and submitted under B2 category. The project was presented to EAC of the MoEFCC.	EC granted by MoEFCC
Rajarambapu Patil SSK	Expansion of molasses-based distillery from 75 to 150 KLPD	EIA report was prepared and public hearing completed. Project was presented to EAC Industry II.	EC granted by MoEFCC
Shiur Sakhar Karkhana	New 30 KLPD molasses-based distillery project	EIA report was prepared and public hearing completed. Project was presented to SEAC, Maharashtra which recommended the project. Submitted the town planning approved layout of the project to SEIAA	Awaiting SEIAA meeting for consideration of town planning approved layout and recommendation of EC
Shreenath Mhaskoba SK	Expansion of molasses-based distillery unit from 55 to 155 KLPD	Preparation of environment management plan was in progress	
Someshwar SSK	Expansion of sugar unit from 5500 to 8000 TCD, Co-gen. from 18 to 36 MW and molasses based distillery from 30 to 90 KLPD	EIA report was prepared and public hearing completed.	Public hearing proceedings awaited
Sopanrao Balkrishna Dhasal Agro Product	New 60 KLPD molasses-based distillery	Submitted final EIA report to SEAC/SEIAA and presented the case to these authorities.	Project received the EC
Sugar Grid	New 120 KLPD molasses-based distillery unit	Prepared and submitted final EIA report to the EAC Industry II. EAC asked for some additional data related to the project.	Compliance of the queries raised by EAC was in progress
Tokai SSK	New 30 KLPD molasses based distillery		Project was on hold by the client
Udagiri Sugar & Power	Expansion of molasses based distillery from 30 to 55 KLPD	Environmental Management Plan was prepared and application submitted for EC under B2 category	Awaiting SEAC/SEIAA meeting for consideration of the proposal
Vilas SSK, Unit 2	New 60 KLPD molasses based distillery	ToR granted by SEIAA, Maharashtra. EIA report was prepared and submitted. Public hearing completed.	Awaiting SEAC/SEIAA meeting for consideration of proposal
Vitthalsai SSK	New 30 KLPD molasses based distillery	EIA report was prepared and submitted and public hearing completed. Project was recommended by SEAC, Maharashtra to SEIAA. SEIAA has asked to submit town planning approved layout of the project.	Project layout has been submitted to town planning for approval
VVD Manjara Shetkari SSK	Expansion of molasses based distillery from 60 to 120 KLPD	Preparation of compliance report of existing EC was in progress.	This compliance is essential to process the case further.





**Table 2: Summary of environmental compliance reports**

Client	EC compliance for	Highlights of work and status
Khandoba Distillery Limited,	Molasses based distillery of 150 KLPD and 6 MW co-generation unit	Submitted six monthly compliance report for Jan. to Jun. 2021 and work of the report for Jul. to Dec. 2021 was in process
Malegaon SSK	Existing sugar unit of 8250 TCD and co-gen. unit of 35 MW	Draft of compliance report submitted to the client for checking
Rajarambapu Patil SSK, Unit 1	Expansion of sugar unit 5000 TCD & co-gen. unit of 28 MW	Assisted the mill in preparing EC compliance report and preparing for visit of officer of MoEFCC RO, Nagpur
Shreenath Mhaskoba Sakhar Karkhana	Expansion of distillery from 30 to 55 KLPD alongwith sugar unit expansion 2500 to 6000 TCD	Assisted the mill in preparing EC compliance report and preparing for visit of officer of MoEFCC RO, Nagpur
Someshwar SSK	Sugar unit of 5500 TCD, co-gen unit of 18 MW and molasses based distillery of 33 KLPD	Six monthly compliance report submitted to MoEFCC regional office, Nagpur
VVD Manjara Shetkari SSK	Existing 60 KLPD molasses-based distillery	Draft of compliance report submitted to the client for checking

**Table 3: Details of ETP consultancy**

Client	Details
<b>New Sugar ETP</b>	
Kranti Sugar & Power	Detailed specification & layout prepared. Attended technical bid and approved drawings received from supplier
Malegaon SSK (ETP Relocation)	Inspection of commissioning
Someshwar SSK	Inspection of erection work. Commissioning in process
Uttam Sucro Tech (For Panipat Co-operative Sugar Mill)	Inspection of erection work. Assistance in ongoing commissioning work
<b>ETP Upgradation for Sugar Unit</b>	
Lok. Baburao Patil Angar Agro Ind.	Technical specifications prepared and upgradation work of existing ETP was completed. Commissioning work was in process
Sant Tukaram SSK and Lok. Sundaraoji Solanke SSK	Inspection of erection work. Commissioning in process
Shahabad Co-operative Sugar Mill, Hariyana	Technical specifications & tender documents prepared and submitted
SMS Kolhe SSK, Kumbhi Kasari SSK and Athani Sugar Bambaede Unit	Detailed civil and electro-mechanical specifications were prepared. Mill has executed the suggested upgradation in ETP and plant is under commissioning stage
The Ganga Mauli Sugar and Allied Ind.	Detailed civil and electro-mechanical specifications were prepared
<b>New Condensate Polishing Unit (CPU)</b>	
Ashti Sugar, Shreenath Mhaskoba Sakhar Karkhana	Prepared detailed civil and electro-mechanical specifications. Construction work was in progress
Kranti Sugar & Power and Chhatrapati SSK	DPR preparation was in process
Sant Tukaram SSK	Detailed civil and electro-mechanical specifications and tender documents were prepared. Attended technical bid meeting.
Sharad SSK	Prepared detailed civil and electro-mechanical specifications and layout

**Table 3: Details of ETP consultancy (Contd..)**

Client	Details
SMS Kolhe SSK	DPR preparation in process
Someshwar SSK	Prepared detailed civil and electro-mechanical specifications and layout. Techno-Commercial approval form commissioner of Sugar awaited
<b>Spray Pond Overflow Treatment Plant</b>	
KA Dr. GD Lad SSK, Lok. Baburao Patil Angar Agro Industries	Draft civil and electro-mechanical specifications prepared. DPR preparation in process

### ETP adequacy

CPCB has been regularly visiting mills and in case of doubtful operation of ETP, mills were asked to get the ETP adequacy report from third party institutes like VSI. ETP adequacy was also suggested as a part of CPCB GPI inspection reports. In addition, MPCB also adds the condition of getting ETP adequacy reports in its CtO (Consent to Operate). ETP adequacy was carried out at nine sugar mills during the year.

### Adequacy of air pollution control equipment

Sugar mills use bagasse fired boilers which generate particulate pollutants. If air pollution control devices installed in such mills are not adequate, it can result in severe impact on air quality. Along with ETP adequacy, CPCB or MPCB are now also asking certain mills for third party adequacy report of their air pollution control equipment. The department studied and prepared adequacy report of air pollution control equipment for Rajarambapu Patil SSK, Unit-2 and Sharayu Agro Industries.

### Environmental monitoring and analysis

The laboratory of the department is accredited by the National Accreditation Board for Testing and

Calibration Laboratories (NABL). The scope of accreditation covers >75 parameters of water, wastewater, air, noise, soil, compost and solid/hazardous waste. All NABL accredited laboratories of the Institute are now amalgamated and following the new standard ISO 17025:2017. Environmental monitoring was carried out at five sugar mills.

In addition, the laboratory analyzed samples from sugar mills, farmers, housing complexes and other industries. The details of samples analyzed are given in table 4.

**Table 4: Details of samples analyzed**

Type of Sample	Number
Water	59
Waste water	201
Solid waste	33
Compost	23
Soil	4
Ambient air and stack emission	54
Noise monitoring locations	50
<b>Total</b>	<b>424</b>



The workshop “Aazaadi ka Amrut Mahotsav” jointly organized by Maharashtra State Federation of Cooperative Sugar Factories, Sugar Commissionerate and VSI



### **Inspection of GPIs in the Ganga & Yamuna basin**

VSI was given an assignment of inspection of grossly polluting industries (GPIs) in the Ganga and Yamuna basin by CPCB. This inspection was carried out by third-party institutes (TPIs) like VSI, Pune; NSI, Kanpur; IIT, Delhi and Roorkee and NEERI, Nagpur. A team from VSI inspected several industries as a part of this work. The staff of the department was involved in the inspection of 132 industries including sugar, distilleries, textile, chemical, fertilizer and other industries.

### **Workshop and online demonstration on EC, compliances, violations and uploading of EC on Parivesh portal**

The MoEFCC has taken steps to improve EC process and also to bring transparency. As a part of this, all industries should upload the information of their existing ECs online on Parivesh portal to help in the effective implementation of the EC condition. In order to help sugar mills in this aspect, an online workshop and demonstration under the auspices of “*Aazaadika Amrut Mahotsav*” was organized in collaboration with Maharashtra Federation of Co-operative Sugar Factories, Sugar Commissionate, Government of Maharashtra and VSI.

In the presentation on “Environmental Clearance Compliances and Violations”, the difference and various notifications pertaining to the issue were explained. The participants were informed about the special provisions for EC available for ethanol projects and the applicability of NIPL and B2 category. The presentation stressed on the seriousness of complying with the EC conditions and the fines for various violations.

Online demonstration of registration of a project on Parivesh portal of MoEFCC and uploading of the EC documents in the same was given.

### **Correspondence with CPCB/MPCB regarding issues of environmental importance**

Environmental issues concerning the sugar and allied industry are coming to the forefront with increased awareness in stakeholders. The National Green Tribunal (NGT) is also issuing orders in this regards and environmental regulations are becoming more stringent. The department works together with

MPCB/CPB regarding such issues of environmental significance pertaining to the industry.

Directions were issued by CPCB for sugar mills under Section 18 (1) (b) of the Water (Prevention and Control of Pollution) Act, 1974 as per the orders of the Hon'ble NGT wherein, it will now be mandatory for sugar mills to run their ETP all year round. This was done on the basis of issues created by some sugar mills in UP. The technical problems regarding the implementation of this order were communicated to Chairman, CPCB with a request to as for technical review of this condition by Hon'ble NGT.

### **Formulation of norms and assessment of data for Environmental Awards**

The Institute started conferring “*Late Kisan Mahadeo alias Abasaheb Veer Award* for the Best Environmental Conservation” for sugar mills and allied distilleries from the crushing season 2016-17 and an award for best environmental officer/manager from the crushing season 2018-19. The department formulates the norms for this award. Assessment of applications received for both the above mentioned awards from various mills was carried out to identify the best work in environmental conservation and the best environmental manager.



### Work on selection committee

Staff of the department has been part of interview panel for selection of environmental officer for sugar mills.

### Academic

Staff of the department have been part of academic evaluation for the following Institutes/ Universities as experts/external examiners.

### “She Is” Book on women working on SDGs in India

The year 2021 is the beginning of the “decade of action” to realize the Sustainable Development Goals by 2030. It is a matter of pride that the work of Dr. Deepali Nimbalkar has been profiled in the book “She Is: Stories of Women Advancing the Sustainable Development Goals in India”. This book, launched in November 2021, showcases the journeys of 33 women leaders in their respective fields and also in the realization of the 17 SDGs through their work.

Dr. Nimbalkar has also been a jury member for the selection of 75 Indian women in STEAM (Science, Technology, Engineering, Arts & Mathematics) for the second edition of the book which commemorates 75 years of Indian independence. The announcement of the selection was made by the Principal Scientific Advisor to the Government of India on Women's day i.e. March 8, 2022.

University / Institute	Examination/evaluation
Department of Environmental Sciences, SPPU	<ul style="list-style-type: none"> <li>• PhD admission interviews</li> <li>• MSc (Environmental Sciences) dissertation presentation &amp; viva voce</li> <li>• MSc (Urban Water Sanitation) dissertation presentation &amp; viva voce</li> </ul>
Bharati Vidyapeeth Institute of Environment Education & Research.	<ul style="list-style-type: none"> <li>• Pre PhD course work evaluation.</li> <li>• MSc (Environmental Science &amp; Technology) dissertation presentation &amp; viva voce</li> </ul>



Training under the research project funded by Principal Secretary, Dept. of Commercial Tax, Govt. of Madhya Pradesh and Ministry of Tribal Affairs, GoI

# Electronics and Computer



## ELECTRONICS AND COMPUTER

The department is engaged in R & D and consultancy for the computerization of different user operations in a sugar mill. Several sugar mills are using the software developed by the Institute. The demand for this software has increased considerably and maintenance service for this software is provided by the department. The department is also involved in electronics projects with other departments within the Institute. The staff is engaged in teaching, training, maintaining the Institute's computers and LAN system.

### RESEARCH AND DEVELOPMENT

#### Design and development of microcontroller based low cost weather station

The weather stations are installed at VSI's Manjari and Amboli farm. Weather Station of Amboli Farm is updated this year with new Rainfall, Humidity and Wind Direction Sensor. Weather station is modified for department of environment sciences where stored data on per hour basis for the entire day is captured in USB storage device. This information is useful to the department for their assignment in environment clearance and impact assessment.

#### VSI sugarcane seed demand software

This software will help farmers and sugar mills to demand for different varieties of sugarcane seed. This information is made available to farm department. It will help to produce the preferred seed in the required quantities. Hence, gaps between supply and demand of sugarcane seed can be minimized.

#### VSI sugar ERP

VSI sugar ERP was developed in VB/VB.net-Oracle and Crystal reports. Presently, 23 modules of this software are being used by sugar mills and allied industries. The newly developed dot net version of this software has added features such as small size, user friendly and highly effective.

#### Advantages of VSI sugar ERP

- The cost of VSI sugar ERP is 50% less than commercial software available in the market.
- The software supports multilingual facilities like Marathi, Kannada, Hindi and Gujarati and is user friendly to operate and easy to customize.
- The software helps sugar mill for transparent and systematic work flow, standardization of reports for minimizing paper work and MIS reports are available on single click.

- The software is consisting of 23 modules. Capability to integrate all the modules whether installed as a whole or module-wise. It is implemented in 92 sugar mills of Maharashtra, Karnataka, Goa, Gujarat and abroad (Uganda).
- The software is designed using latest technology like RDBMS database and Dot Net.
- Fully controlled by appropriate authentication and authorization access rights.
- Immediate SMS notification to farmers and H&T-contractors with tonnage details as soon as the vehicle is emptied on weigh-bridge.
- Open-ended design makes further development/enhancements very easy.
- Online refreshing Dash-Board with real-time crushing status, number of vehicles in cane-yard rawmaterial (cane) available in cane-yard at any moment weigh-bridge status.
- Centralized database with security features.
- Reliable, prompt and assured aftersales service to the entire satisfaction of users.
- Better management and full utilization of existing resources.
- Information integration for effective working.
- Better analysis and planning capabilities.
- Reports, graphs and charts gives higher performance visibility.
- GST E-invoice enabled.

The modules installed at different locations during the year are given in table 1.

#### Store inventory, purchase and store accounting

The front-end look of existing store inventory module was modified to make it more effective, impressive and readable. The facility for maintaining separate information for porter and transporter was provided additionally. Some modules were redesigned as per customer specification. In sub module, store costing, a separate option was provided for processing under the heading item transaction processing. It was found useful for displaying reports such as stock ledger, closing stock statement, job wise and main store summary report which reduced the required time for displaying the report.

#### Sugar sale and godown management

Sugar mills sell sugar by calling tenders. The sugar sale module was modified to incorporate this information. Software was also modified to enable



**Table 1: Installation of modules**

Name of mill	Module name
Ashok SSK	Sugar sale and godown management, financial accounting, molasses sale
Cane Agro	Store inventory, purchase and store costing
Jawahar Shetkari SSK, Unit 2	Distillery
SMS Kolhe SSK	Weigh bridge
Bhimashankar SSK, Karnataka	All modules
Prabhulingeshwar, Karnataka	Sugar manufacturing and chemical laboratory analysis

**Table 2: Installation of GST e-invoice**

Module name	Name of mill
GST e-invoice	Bhimashankar SSK, Karnataka, Prabhulingeshwar, Karnataka, Ashok SSK, Jawahar Shetkari SSK, Unit 1 and 2, Sharad SSK, Someshwar SSK, Vighnagar SSK, Anuraj Sugar, Shrigonda SSK

contract with sugar purchaser and automatic maintenance of sugar stock and sugar purchase ledger. Various reports generated such as tender allotment, party wise balance, sale summary, periodic and GST.

#### **Time office**

The modifications were made in the Time office software module. Detailed record of grade change, section, designation, bank, increment, payment process locking facility, provision of different type supplement payment such as retention, back salary, overtime, bonus, reward, leave encashment, PF related reports such as ECR file creation, income tax related reports, auto voucher facility for account, monthly reports of slip, pay sheet (section and department wise summary), bank list (deduction wise, earning wise), PF statement, yearly report of employee (year wise summary, department wise summary, deduction wise summary), all leave balance facility etc.

#### **Financial accounting**

The financial accounting software has the facility to operate in bilingual mode i.e. English and local language. Additional improvements such as double entry accounting, financial year wise partitioning, user rights and data security customization based on client requirements, voucher passing level authentication, division wise and consolidated reports maintenance, center wise cost recovery of deduction, cane account system integration with account, interest calculation based on fortnight etc. were made.

#### **Distillery**

This system covered molasses purchase, daily production and billing for distillery. Billing system for distillery product like RS, ENA, SDS, ODS, ethanol along with remove notice, gate pass, sample slip, TP.

All excise report such as Form B, C, D, E and F were provided. Auto voucher could be generated for each invoice to maintain sub ledger.

#### **Sugarcane management**

Cane plantations records of many farmers from various villages have been managed through this module as these records are linked to harvester, transporter, farmer and information regarding cane plantation for issuing field slip. The system was made tamper proof and user friendly. Reports such as variety wise, circle wise, village wise, cane type wise, crop type wise cane plantation were provided. Detailed harvesting program was generated to help in effective implementation increasing the sugar recovery. In addition, recovery based harvesting program facility was provided. Cane plantation registration, cancellation, transfer facility was embodied in the program.

#### **Weigh Bridge**

Automatic cane weight is being recorded without any intervention through weigh bridge module. This module was designed with new MIS reports due to which management get information at a glance and helps for planning best harvesting schedule to improve recovery. This module provides facility for field slip feeding to ensure error free entry for information pertaining to farmer, harvester, transporter, bullock cart etc. This ensures speedy operation of weigh bridge and avoids malpractices. Weight slip can be edited with proper rights. Facility of recording cane sent to other mills for crushing is also provided. The reports are generated automatically.

#### **Sugarcane farmer billing**

New sugarcane farmer billing method was developed which facilitated generation of the bill for

any period with facility of determining interest if any. Bill generation for cane supply to other mills is also provided. Facility for cheque printing on pre-printed stationery is also provided. Variety wise bill is possible in this module. Farmer ledger is maintained in cane account. Financial auto voucher facility is also generated.

### **Harvesting and Transport billing**

A new user-friendly version of harvesting and transport billing was developed and implemented. It helps the mill to set transporter/harvester rate, rate of deposit, rate of commission, facility of billing of harvesting and transporting for cane diverted to other mill, advance balance recovery from linked transporter or harvester etc. This module is linked with cane account and has interface with financial activity and HT billing. Ledger is provided to such transporter and harvester. It has now become possible to maintain a single account for a person having different roles such as harvester or transporter or bullock cart operator.

### **Sugarcane deposit**

In this module data of refundable and non refundable deposits were compiled. Deposits deducted from farmer billing are automatically transferred to the deposit module and quarterly or yearly interest is processed as per requirement. While processing required deduction are automatically deducted. Required reports for account like deposit ledger, interest payment slip for farmer and section-wise, village-wise summary reports were generated

### **Sugar share**

This module caters to the requirement of member code, certificate numbers, number of shares, share amount, date of membership, gender, age etc. Election lists and various summary reports for the election can be generated.

### **Sugar manufacturing and laboratory analysis**

This module dealt with the process material, production and progress chemicals etc. in the sugar manufacturing process. It carries out the necessary calculations and produces various reports on sugar production and mill performance.

### **Molasses sale, press mud and other sale**

This module handles activities of molasses, press mud and other sale. This includes invoice, receipts, daily reports, frequently required reports, periodic reports and stock reports.

### **Petrol Pump**

This module handles activities like cash sale, credit sale for farmers, employees and transporter contractors. Software was modified to enable contract with purchaser and automatic maintenance of stock and purchase ledger. Various reports are generated such as party wise balance, sale summary, periodic and GST.

### **Member sugar sale**

This module handles activities like member sugar sale, employee sugar Sale, guest sugar sale, yearly sugar allotment with NFC card writing and NFC card reading facility and allotment of sugar sale as per the different conditions of sugar mill. Various reports are generated such as member-wise balance, category-wise balance, sale summary, periodic reports.

### **Sugar SMS**

Sugar SMS software is useful for communicating the information regarding cane bill payments of the farmers deposited in their accounts of the concerned banks in their area. It was assumed that in most of the rural areas, the mobile technology has been spread. With this module SMS regarding cane payment can be generated and will be sent on farmer's mobile number.

### **GST E-invoice**

As per GST council, sugar mill has to upload each invoice online with E-way bill. Using invoice facility, sugar mill can upload invoice online as soon as invoice generates along with E-way bill. After uploading sugar mill will issue invoice copy with QR code and E-invoice details such as IRN no., acknowledge no., date etc. Sugar mill can cancel invoice online.

### **Case study tour to Bagamoyo sugar Ltd, Tanzania**

Bagamoyo Sugar Limited (BSL), is a sugar manufacturer in Tanzania, the second-largest economy in the East African Community. BSL placed an order for VSI sugarERP software for Agriculture management system, Workshop management, Sugar manufacturing, laboratory analysis and time office. VSI team visited the mill and discussed the requirements of software.

### **Academic**

The department is involved in teaching and training of various courses viz. Sugar Instrumentation, Alcohol Technology & Biofuels, Sugar Technology, Sugar Engineering Diploma and Environmental Sciences.



# Instrumentation



## INSTRUMENTATION

Many innovative solutions are required to manufacture sugar and its by-products with consistent high quality at low cost. The electricity and steam are the major costs in process. Consumption of the same can be calculated, monitored and controlled to match the actual demand of individual stations in the plant. This can have a direct impact on the overall energy consumption. Now-a-days, due to increased competition, the sugar production has become a cost sensitive business. Therefore, robust, durable and accurate process instrumentation & automation systems are of utmost importance. Their increased performance ensures the quality of various products and the sugar manufacturing processes can be optimized without any compromises in process efficiencies. Department's activities are concentrated in this direction. The various activities performed during the year restated below in brief.

### **Importance of pressure reducing stations to maintain higher crush rates**

Sahyadri SSK installed two automatic pressure reducing stations (32 to 7 Kg/cm<sup>2</sup> and 7 to 1 Kg/cm<sup>2</sup>) in crushing season 2010-11. In the middle of 2021-22 crushing season, the mill was not able to maintain desired crush rate due to severe steam pressure fluctuations at evaporator station. After detailed investigations, improper working of 7 to 1Kg/cm<sup>2</sup> pressure reducing station was observed. This was due to malfunctioning of electronic card. In view of this, the required components were replaced and successful offline testing of system was carried out. The system was re-commissioned which has resulted in smooth cane crushing at desired rate.

### **Role of steam flow meters in enhancing power generation**

In sugar industry, steam from boilers is utilized to meet turbine & process requirements as per in-house and grid load variations. To balance the steam generation and consumption, steam flow measurement plays an important role. During the season, Malegaon SSK was facing difficulties in achieving desired total load of 30 MW on power turbines. The mill engineers were suspicious to raise the load because of differences in steam flow readings at turbine inlet & outlet about 10-12 TPH. In order to resolve this issue, calibration work of flow meters was carried out with considerations of flow nozzle data sheets, online pressure and temperature compensations etc. This has resulted in maintaining the desired load on power turbines around 30 MW throughout the season.

### **Rehabilitation of auto cane feed control system:**

Shankar SSK, Sadashivnagar was closed for 4-5 seasons. During crushing season 2021-22, the mill requested for rectification of ACFC system. In the sugar mill frequent jamming was taking place due to non-uniform load on cane preparatory devices and improper synchronization between cane and rake carriers. Accordingly, the system performance was observed in depth. The necessary rectification and modification in power supply & control cards was carried out. The system was brought into working condition which in turn helped the mill to achieve desired crushing rate.





## Project work

Under the pandemic situations, the major project documentation work in I&C related to distilleries as well as sugar mills was carried out with various manufacturing companies almost in online mode. However, critical inspection of DCS & PLC systems was carried out at mill site/company works as per requirements. During the year, it is observed that I&C related activities such as instrument specifications, P&I drawings, ranges of input & output devices, configuration of PLC/DCS, finalizing control philosophies etc. were carried out mainly in distilleries rather than sugar plants, the details of which are as under:

### Distillery projects

- Agasti SSK
- Bhaurao Chavan SSK, Unit 1
- Gurudatta Sugars
- Kadwa SSK
- KA Tope Samarth SSK, Unit 1
- KA Tope Samarth SSK, Unit 2
- LMGP Dnyaneshwar SSK
- Mula SSK
- Pad. Dr. DY Patil SSK
- Pad. Dr. PK Sonhira SSK
- Rajarambapu Patil SSK, Unit 1
- Sharad SSK
- SM Kagal Taluka SSK
- Vilas SSK, Unit 1

### Modernization / Expansion of sugar plants

- KS Kale SSK
- Nandi Sugars, Karnataka
- Someshwar SSK



## Critical problems in analog polarimeters

In the era of digitalization, instruments used in sugar laboratory are going through rapid changes. However, the analog polarimeters are still in use in many sugar mills because of its advantages like acquainted operations, lesser operational and maintenance cost, non-dependency on air-conditioner, non-availability of spares in time etc. Shreenath Mhaskoba and Gokul Sugar mills were facing problems in analog polarimeters. The detail investigations of these polarimeters at the Institute revealed that the problems were in objective lens, eyepiece, prism alignment & scale. With appropriate rectification and alignments, both polarimeters are brought in working condition and tested satisfactorily. The mills have successfully carried out pol measurements with these polarimeters without any trouble throughout crushing season.



### Microwave based thermostatic irradiation system

The tissue culture section and instrumentation dept of Institute had undertaken R&D project viz. Microwave based thermostatic irradiation system for synthesis of low molecular weight chitosan/ chitosan nano particles with financial funding by MPCB; Mumbai. This is a three-year project. The expected work in first year could not be carried out due to the pandemic situations. However, RFP/ detail technical discussions with interested parties, tender formalities, technical & commercial bids have been completed during the year. Further work will be continued.

### Automatic combustion control in cogeneration plants

Since 2020-21, the department had undertaken R&D project viz. 'Study of automatic combustion control in co-generation plants' in association with sugar engineering department. During the year 2020-21, eleven sugar mills were visited to study the working performance of installed combustion control loops. Based on the this study and discussions with sugar engineers, it was decided to carry out further detailed study in three sugar mills viz. Sant Tukaram SSK, SMB Thorat SSK and Someshwar SSK. It was observed that the working performance and desired boiler efficiencies were achieved in three sugar mills by maintaining percent O<sub>2</sub> in flue gases by automatically

controlling RPM of FD fan as well as bagasse feeders.

Further study of combustion control loop by maintaining desired levels of Carbon monoxide & Carbon dioxide in flue gases will be carried out.

### Calibration of in-house scientific instrument

In order to cater the need of sugar industry, various laboratories of the Institute are carrying out R&D activities. Different sophisticated scientific instruments/equipment are used for this purpose. It's timely maintenance and calibration work is of prime importance for ensuring authenticity. During the year, department has completed calibration work of 113 instruments as per ISO requirement and rectification work of 61 instruments/equipment.

### Visits

In order to improve the working status of instrumentation and control, 84 visits were given to 50 sugar mills during the year. In addition, 651 instruments of 35 sugar mills were rectified, standardized and commissioned at the mill as well as Institute site.

### Academics

In pandemic situation, it was quite challenging to complete the syllabus of different AVSI courses in-time. As per the situations, the department had conducted online as well as offline classes for regular courses of the Institute.



'Use of Retro Fitment Kits for CBG / CNG for Agricultural Tractors' jointly organized by VSI and Central Institute of Road Transport, Pune

Programme of Global launch of 'Biosyrup' jointly organized by MRSSK, Sangh, Jaywant Sugars Ltd. and Praj Industries Ltd.



# Annexures



## AWARDS OF EXCELLENCE

The Institute recognizes extraordinary performance annually by conferring awards of excellence to the sugar mills, distilleries, employees working in sugar mills, distilleries, farmers and employees of Vasantdada Sugar Institute. The details of the awards for this year are as under:

- Late Vasantdada Patil award for the best overall performance  
- **Krantiagrani Dr. GD Bapu Lad SSK Ltd., Dist. Sangli**
- Late Vilasraoji Deshmukh award for the most innovative factory  
- **Daund Sugar Pvt. Ltd., Dist. Pune**
- Late Karmayogi Shankarraoji Patil award for the best overall financial management in Maharashtra  
- **Udagiri Sugar and Power Ltd., Dist. Sangli**
- Late Dr. Appasaheb alias SR Patil award for the best cane development performance  
- **Dr. Patangrao Kadam Sonhira SSK Ltd., Dist. Sangli**
- Late Raosahebada Pawar award for the best distillery  
- **Sharayu Agro Industries Ltd., Dist. Satara**
- Late Kisan Mahadev alias Abasaheb Veer award for the best environmental conservation  
- **Rajarambapu Patil SSK Ltd., Unit 1, Dist. Sangli**

The following sugar mills received zone-wise awards for achieving high technical efficiency.

### Awards for technical efficiency

Prize	Sugar Mill		
	South Zone	Central Zone	North-East Zone
First	YM Krishna SSK Dist. Satara	Daund Sugar Ltd. Dist. Pune	KA Tope Samarth SSK, Unit 1 Dist. Jalna
Second	Dr. P Kadam Sonhira SSK Dist. Sangli	Nira Bhima SSK Dist. Pune	Baramati Agro Ltd., Unit 2 Dist. Aurangabad
Third	Jaywant Sugars Ltd. Dist. Satara	SMS Kolhe SSK Dist. Ahmednagar	–

Note : No sugar mill is found suitable for the third prize in North-East zone

Zone-wise awards to sugar mills for best work in cane development and efficient financial management are given below.

### Awards for cane development and financial management

Award	Sugar mill		
	South Zone	Central Zone	North-East Zone
Cane Development	Jawahar SSK Dist. Kolhapur	Dwarkadhish Sakhar Karkhana Dist. Nasik	Natural Sugar and Allied Industries Ltd., Unit 1 Dist. Osmanabad
Financial Management	Sahyadri SSK Dist. Satara	Dwarkadhish Sakhar Karkhana Dist. Nasik	KA Tope Samarth SSK, Unit 2 Dist. Jalna



VSI also gives awards to farmers for achieving highest sugarcane yield at Zonal and State level. The list of awardees is given below:

**Awards for season-wise highest sugarcane yield in the zone and state**

Name of farmer and sugar mill	Sugarcane variety	Yield (t/ha)	Name of Award
<b>SOUTH ZONE</b>			
Mr. Ashok Tatoba Jadhav, Pad. Krantiveer Dr. NN HK Ahir SSK, Dist. Sangli	Co 86032	306.90	First in Pre-seasonal planting
Mr. Vishwas Ramchandra Shendge, Ajinkyatara SSK, Dist. Satara	Co 86032	202.60	First in Seasonal planting ( <i>Suru</i> )
Mr. Balwant Maruthi Patil, Rajarambapu Patil SSK, Unit 2, Dist. Sangli	Co 86032	212.75	First in Ratoon
<b>CENTRAL ZONE</b>			
Mr. Gulab Dasharath Kakuste, Dwarakadish SK Ltd, Dist: Nasik.	CoM 0265	270.00	First in Pre-seasonal planting
Mr. Anandrao Namdev Bondre, Nira Bhima SSK, Dist: Pune	CoM 0265	265.25	First in Seasonal planting ( <i>Suru</i> )
Mr. Abasaheb Tulsiram Bodake, Nira Bhima SSK, Dist: Pune	CoM 0265	207.40	First in Ratoon
<b>NORTH-EAST ZONE</b>			
Mr. Sunil Sangram Kunthe, Vilas SSK, Unit 2, Dist: Latur	CoC 671	255.42	First in Pre-seasonal planting
<b>STATE</b>			
Mrs. Vimal Dhondiram Pawar, Ajinkyatara SSK, Dist: Satara	Co 86032 (Pre-seasonal)	323.45	Late Yashwantrao Chavan
Mr. Vishwanath Dhondiba Holsambare, Vilas SSK, Unit 2, Dist. Latur	VSI 08005 ( <i>Suru</i> )	330.68	Late Vasantnao Naik
Mrs. Sulochana Mohanrao Kadam, Rajarambapu Patil SSK, Unit 2, Dist. Sangli	Co 86032 (Ratoon)	277.06	Late Annasaheb Shinde

Note: As per rules and regulations of the Institute no farmer was found eligible for Oos Bhushan award for pre-seasonal, seasonal and ratoon planting in north-east zone.



The outstanding performance by individuals in their field of work is recognized by the Institute by way of individual awards. The following individuals received awards for their performance.

**Awards for outstanding performance**

Award	Awardees and Organization
Best Managing Director	Mr. AP Shewale, Loknete MGP Dnyaneshwar SSK, Dist: Ahmednagar
Best Chief Accountant	Mr. VR Savrikar, Daund Sugar Ltd., Dist: Pune
Best Chief Chemist	Mr. ST Sawant, Rajarambapu Patil SSK, Unit 1, Dist, Sangli
Best Chief Engineer	Mr. SV Patil, Udgiri Sugar & Power Ltd., Dist.: Sangli
Best Distillery Manager	Mr. PS Kale, Daund Sugar Ltd., Dist: Pune
Best Environmental Officer	Mr. K. Gaikwad, Nira-Bhima SSK, Dist: Pune
Best Cane Development Officer	Mr. SP Bhalekar, Pandurang SSK, Dist: Solapur
Best VSI Employee(s)	Mr. PG Patil, Technical Adviser, Sugar Engineering
	Mr. PV Ghodke, Scientist, Agriculture Sciences & Technology
	Mr. AB Deshmukh, Scientist, Alcohol Technology & Biofuels
	Mr. LS Dalvi, Sr. Analytical Chemist, Sugar Technology
	Mr. JD Raibhar, Driver, Administration



**Celebration of 46<sup>th</sup> Foundation Day of VSI in presence of Dr. Sushil Solomon, Vice President, International Association of Professionals in Sugar & Integrated Technology and Mr. Sunil Kumar Ohari, General Manager (Project), UP Co-operative Sugar Factories Federation Ltd., Lucknow**





## MEMBERSHIP OF OTHER ORGANIZATIONS

### Organization membership

The membership of national and international associations related to sugar and allied industries has renewed. This includes:

#### National

- Biotech Consortium India Ltd. (BCIL)
- Indian Association of Special Libraries and Information Centers (IASLIC)
- Maharashtra Economic Development Council (MEDC)
- Maratha Chamber of Commerce, Industries and Agriculture (MCCIA)
- Society for Sugarcane Research and Development (SSRD)
- South Indian Sugarcane and Sugar Technologists' Association (SISSTA)
- Sugar Technologists' Association of India (STAI)
- The Energy and Resources Institute (TERI)

#### International

- Australian Society of Sugarcane Technologists Ltd. (ASSCT)
- International Consortium for Sugarcane Biotechnology (ICSB)
- International Society of Sugar Cane Technologists (ISSCT)
- Sugar Industry Technologists Inc. (SITI)
- World Association of Beet and Cane Growers (WABCG)

## INSTITUTIONAL COMMITTEES

### Institutional Bio-Safety Committee

- |   |                   |
|---|-------------------|
| • Dr. K Harinath Babu, Sr. Scientist, VSI                     | Chairman          |
| • Dr. Anuradha Upadhyay, Principal Scientist, ICAR-NRCG, Pune | DBT nominee       |
| • Dr. Vidya Gupta, Scientist-G, NCL, Pune                     | Outside Experts   |
| • Dr. SK Raut, Consultant Physician, Pune                     | Biosafety Officer |
| • Dr. PN Tawar, Sr. Scientist, VSI                            | Internal Experts  |
| • Dr. SG Dalvi, Scientist, VSI                                | Internal Experts  |
| • Dr. TD Shitole, Scientific Officer, VSI                     | Internal Experts  |
| • Dr. RM Devarumath, Scientist, VSI                           | Member Secretary  |



Visit of AICRP(S) monitoring team to VSI

## VSI OFFICIALS ON VARIOUS COMMITTEES

### Mr. Shivajirao Deshmukh, Director General

- Member, International Consortium for Sugarcane Biotechnology (ICSB)
- Member, International Society of Sugar Cane Technologists (ISSCT)
- Member, Screening Committee, Sugar Development Fund (SDF), Government of India
- Member, Executive Committee, Yashwantrao Chavan School of Rural Development, Shivaji University, Kolhapur
- Member (Group of expert), Committee appointed by Punjab State Federation of Co-operative Sugar Mills Limited for revival of old sugar mills
- Member, Command Area Water Productivity Working Group, Government of Maharashtra

### AGRICULTURAL SCIENCES AND TECHNOLOGY

#### Dr. K. Harinath Babu, Senior Scientist

- Governing Body member, KK Wagh College of Agriculture Biotechnology, Nasik, Maharashtra

#### Mr. BH Pawar, Senior Scientist

- Indian Phytopathological Society (IPS)

#### Mr. PP Shinde, Scientist

- Member-Command Area Water Productivity Group, Government of Maharashtra.
- Member- Study Group for trash issue of cane harvested by harvesting machines formulated by Commissioner of Sugar, Government of Maharashtra

#### Mr. BJ Takalkar, Scientific Officer

- Member, Advisory Committee, All India Radio and Television

#### Ms. SD Ghodke, Head & Scientist

- Member of ICUMSA, National Committee

### SUGAR TECHNOLOGY

#### Dr. RV Dani, Head & Technical Adviser

- Member, Project Review & Steering Group meeting, Department of Information Technology, Government of India, New Delhi
- Member, Bureau of Indian Standards (BIS)- FAD2 committee
- Member, Expert Committee formed by CPCB for clean Ganga Mission

#### Dr. RN Bhosale, Technical Adviser

- Member, Indian National Committee of ICUMSA for the subject raw sugar, white sugar and plantation white sugar
- Associate Referee: ICUMSA for the period of 2018-24 for the subject raw sugar, white sugar and plantation white sugar

#### Dr. VPSidanale, Senior Sugar Technologist

- Member, Technical Committee, Deccan Sugar Technologist's Association of India, Pune
- Council member, Sugar Technologist Association of India, New Delhi



### SUGAR ENGINEERING

#### Mr. RA Chandgude, Head & Technical Adviser

- Member, Co-generation Project Implementation And Coordination Committee, Government of Maharashtra
- Member, State Level Machinery Purchase Committee, Government of Maharashtra
- Member, Energy and Cost Audit Committee, Government of Maharashtra
- Member, Committee appointed by Government of Maharashtra for expansion of bagasse based co-generation projects under renewable energy policy
- Member (Group of experts), Committee appointed by Punjab State Federation of Co-operative Sugar Mills Limited for the revival of old sugar mills
- Member, Committee for co-operative awards for the best co-operative organization
- Member, Committee for boot basis co-generation projects

### ALCOHOL TECHNOLOGY AND BIOFUELS

#### Prof. SV Patil, Head & Technical Adviser

- Member, Standing Technical Advisory Committee formulated by State Excise Department, Government of Karnataka.
- Member, Committee formulated by State Excise Department, Government of Maharashtra, for issues related to microbreweries.
- Member, State Level Machinery Purchase Committee (SLMPC)
- Member, Distillers' Association of Maharashtra (DAM)
- Member, Committee formulated by State Excise Department, Government of Maharashtra, for revision of expected alcohol yield from various grains, Sugarcane juice, Sugarcane syrup, BH-molasses, Sugar and use of denaturant.
- Member, Expert Committee constituted by Maharashtra Pollution Control Board (MPCB) for certification of "No Increase in Pollution Load (NIPL)".
- Member, Committee constituted by Government of Maharashtra for speedy implementation of sugarcane juice to ethanol policy announced by Government of India.
- Chairman of the Expert Committee constituted by CPCB to formulate Action Plan/Charter for distilleries in Ganga basin
- Member, Expert Appraisal Committee (Industry-II) of Ministry of Environment Forest & Climate Change (MoEF & CC) for Environment Impact Assessment of projects for grant of Environment clearance
- Member, Expert Committee constituted by Uttarakhand Pollution Control Board (UKPCB) for certification of "No Increase in Pollution Load (NIPL)".
- Member, Expert Committee formulated by CPCB for examination of proposals submitted by industrial units under the scheme for "extending financial assistance to sugar mills for enhancement and augmentation of ethanol production capacity"

### ENVIRONMENTAL SCIENCES

#### Dr. (Ms.) DS Nimbalkar, Head & Senior Scientist

- Member, Board of Studies in Environmental Sciences, Savitribai Phule Pune University
- Chairman, Examinations of MSc Environmental Sciences, Savitribai Phule Pune University
- Member, Women Complaints Committee, NRC Grapes, Manjari, Pune
- Member, Jury for the selection of 75 Indian women in STEAM (Science, Technology, Engineering, Arts & Mathematics) for the second edition of the book "She Is" commemorating 75 years of independence.
- Vice Chancellor's nominee & Member, Board of Studies in Environmental Sciences, New Arts Commerce and Science College, Ahmednagar

## PUBLICATIONS

### AGRICULTURE SCIENCES AND TECHNOLOGY

**Bhoomika MK, Chakraborty S, Dalvi SG, Satpute SK (2022)**

Chitosan and its Derivatives: Promising biomaterial in averting fungal diseases of sugarcane and other crops

Journal of Basic Microbiology

62(5)

533-554

**Dalvi SG (2021)**

Assessment of genetic diversity in promising sugarcane mutants developed through chemical mutagenesis

Ann Agric Crop Sci.

6(4)

1-5

**Dalvi SG, Suprasanna P (2021)**

Studies on radiation processed polymers mediated biochemical and molecular responses and relevance to enhancing plant productivity

Editor Naeem Ghauree in Radiation-Processed Polysaccharides:

Emerging Roles in Agriculture, Pub.- Academic Press-Elsevier

335-369

**Dalvi SG, Tawar PN, Suprasanna P, Dixit GB, Theerth Prasad D (2021)**

EMS-Based in vitro mutagenesis and mutant screening for smut resistance with agronomic traits in sugarcane

Sugar Tech

23(4)

854-864

**Dalvi S, Wani K, Ithape D, Suprasanna P, (2021)**

Potential of biopriming with irradiated chitosan for sugarcane micropropagation,

editor naeem ghauree in radiation-processed polysaccharides

Emerging Roles in Agriculture, Pub Academic Press-Elsevier

179-204

**Deshmukh PS (2021)**

Spectral reflectance properties of vertisols and associated soils of Nagpur district in Maharashtra.

Journals of the Indian Society of Soil Science

69, (01)

21-27

**Gaikwad HD, Hasabnis SH, Suprasanna P, Dalvi SG (2021)**

Electron beam irradiated chitosan elicits onion enhancing antioxidant properties combating resistance to Purple Blotch Disease (*Alternaria porri*)

Int. J. of Radiation Biology

98(1)

100-108

**Ghodke PV, Patil AS (2021)**

Agronomic evaluation of tropical sugarbeet genotypes in Maharashtra

Proceedings of 66<sup>th</sup> Annual Convention of DSTA

42-43

**Ghodke SD, Mali BG, Shinde AS (2021)**

Biological reclamation of saline sodic soil using halophilic / halotolerant microorganism to increase crop yield

Proceedings of 50<sup>th</sup> Golden Jubilee Annual Convention of SISSTA

76-82

**Ghodke SD, Mali BG, Shinde SB (2021)**

Study of exo-polysaccharide producing bacteria from sugarcane rhizosphere and their impact on growth, yield and quality of sugarcane under water stress condition in pot culture studies

Proceedings of 79<sup>th</sup> Annual Convention of STAI

154-161

**Ghodke SD, Nigade KG (2021)**

Role of consortium of beneficial microorganisms to enhance yield and quality of sugarcane ecosystem

Proceedings of 66<sup>th</sup> Annual Convention of DSTA

59-65



**Ghodke SD, Nigade KG (2021)**

Studies of Entomopathogenic nematode against white grub control in sugarcane crop  
Proceedings of 50<sup>th</sup> Golden Jubilee Annual Convention of SISSTA  
83-86

**Hapase RS, DS Pawar and JM Repale (2021)**

The response of promising midlate maturing sugarcane genotypes in different agro-climatic regions of Maharashtra State  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
73-81

**Kalwade SB, Devarumath RM (2021)**

Rapid profiling for sugar estimation in sugarcane by using hplc-ri and genetic evaluation by using RAPD molecular markers  
Indian Journal of Biotechnology and Pharmaceutical Research  
9(2)  
1-9

**Kharade JP, Deshmukh PS, Surwase SA (2021)**

Influence of organic inputs on sugarcane yield and soil fertility  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
73-78

**Mahadevaiah C., Prakash Hapase, V. Sreenivasa, Ramesh Hapase, H K Mahadeva Swamy, C. Anilkumar, K. Mohanraj, G. Hemaphabha and Bakhi Ram (2021)**

Delineation of genotype x environment interaction for identification of stable genotypes for tillering phase drought stress tolerance in sugarcane  
Scientific Reports  
11  
18649

**Muley AB, Pandit AB, Singhal RS, Dalvi SG (2021)**

Production of biologically active peptides by hydrolysis of whey protein isolates using hydrodynamic cavitation  
Ultrasonics Sono Chemistry  
71  
1-13

**Nigade KG, Ghodke SD, Pisal SP (2021)**

Studies of plant growth promoting rhizobacteria for enhancing cane and sugar yield of sugarcane crop  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
167-172

**Nigade KG, Ghodke SD, Manjul US (2021)**

Evaluation of efficiency of entomopathogenic nematode against white grub in sugarcane crop  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
162-166

**Purankar MV, Nikam AA, Devarumath RM and Suprasanna Penna (2022)**

Radiation induced mutagenesis, physio-biochemical profiling and field evaluation of mutants in sugarcane cv. CoM 0265  
International Journal of Radiation Biology,  
DOI: 10.1080/09553002.2022.2024291

**Shinde PP (2021)**

Scheduling of irrigation mulch with mulch under surface irrigation in sugarcane crop  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
73-77

**Shinde PP (2021)**

Mechanized harvesting of sugarcane  
Proceedings of XV Agricultural Science Congress  
19

**SUGAR TECHNOLOGY**

**Bhosale RN, Panda S, Dani RV (2021)**

Implementation of technologies based on various principles for improving production efficiency of sugar mills  
Proceedings of 66<sup>th</sup> Annual Convention of DSTA  
350-359

**Panda S, Bhosale RN, Gopalkrishnan N, Dani RV (2021)**

Implementation of methodology- improvement of production efficiency & financial benefit of sugar mills  
Proceedings of 50<sup>th</sup> Golden Jubilee Annual Convention of SISSTA,  
166-174

**Panda S, Ghorpade RN, Patil RR, Dani RV (2021)**  
An option of conventional refined sugar production during diversion of cane sugar mills feed stocks for bio-ethanol production  
Proceedings of 50<sup>th</sup> Golden Jubilee Annual Convention of SISSTA  
229-237

### SUGAR ENGINEERING

**Chandgude RA, Patil PG (2021)**  
Enhancement of mill performance by adopting low-speed milling in the sugar industry  
International Sugar Journal  
756-761

**Chandgude RA, PG Patil (2021)**  
Innovative and sustainable options for improving juice extraction efficiency  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
262-273

**Chandgude RA, Patil PG, Deshmukh PU, Sripatnala SS (2021)**  
Disposal of distillery spent wash through incineration technology  
Proceedings of 50<sup>th</sup> Golden Jubilee Annual Convention of SISSTA  
122-129

**Sripatnala SS, Chandgude RA, Nalawade SP, Shitole DN (2021)**  
Augmenting Mill Performance through Productive Imbibition  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
223-238

### ALCOHOL TECHNOLOGY

**Patil DA, Joshi SU, Konde KS, Patil SV (2021)**  
Critical and wholistic techno-economic analysis of options of B-heavy molasses and cane syrup use in a sugar mill-distillery complex,  
Proceedings of 66<sup>th</sup> Annual Convention of DSTA  
289-300



**Patil SV, Konde KS, Behera S (2022)**  
Bio-Circular economy: An opportunity for diversification for sugar industries in Compressed Biogas (CBG) and organic fertilizer production  
Sugar Technology  
DOI: 10.1007/s12355-022-01130-6

**Patil SV, Singh S, Behera S, Konde KS (2021)**  
Bio-Circular Economy: Opportunity for diversification for sugar mills in waste to energy (Biofuels) Field: Compressed Biogas (CBG) and organic fertilizer.  
Proceedings of 79<sup>th</sup> Annual Convention of STAI  
395-409

### ENVIRONMENTAL SCIENCES

**Deshmane AB, Jadhav VP, Ghole VS (2022)**  
Sugar mill effluent treatment using fixed film algal photo-bioreactor and reuse of treated water  
International Journal of Scientific and Research Publications  
12(1)  
518-527

**Deshmane AB, Jagadale S, Nalavade VM (2022)**  
Phyco-Remediation of Sugar Mill Effluent using *Chlorella vulgaris*  
International Journal of Engineering Research & Technology (IJERT)  
11(2)  
491-494

**Nimbalkar DS (2021)**  
A journey of blending sustainability with sweetness  
She Is: Stories of women advancing the Sustainable Development Goals in India. Ed. Elsa Marie D'Silva.  
Notion Press, Chennai  
5  
51-58

### Book Chapter

**Eloka-Eboka AC, Maroa S, Behera S (2021)**  
Algal Biofuels - Technologies, Scope, Opportunities, Challenges and Applications, In: Ray R.C (Editor)  
Sustainable Biofuels Opportunities and Challenges.  
Elsevier  
Chapter-16  
449-470



## POSTER PRESENTATION

### International Conference on Sugarcane Research: Sugarcane for Sugar and Beyond (CaneCon2021), ICAR-SBI, Coimbatore, TamilNadu, India

#### **Deshmukh PS, Surwase SA (2021)**

Effect of splits of potassium application on yield and juice quality of sugarcane

#### **Ghodke PV, Patil AS (2021)**

Role of PGR's in sugarcane productivity

#### **Ghodke SD (2021)**

Effect of graded levels of consortium of iron & zinc solubilising microbial liquid bioinoculant on yield & quality of sugarcane

#### **Hapase RS, Repale JM, Shivajirao Deshmukh (2021)**

VSI 12121 (VSI 08005) a newly released midlate maturing, high sugared, drought tolerant and high fiber sugarcane variety for Peninsular India

#### **Kotgire GS, Yadav JH, Atre GE, Pawar BH (2021)**

In Vitro efficacy of fungicides, bio-agents and chitosan against *Fusarium moniliformae* - a causal organism of pokkah boeng disease in sugarcane

#### **Manjul U, Gaikwad S, Ghodke SD, Hapase R (2021)**

Effect of application of different entomopathogenic fungi (EPF) for control of white fly in sugarcane crop

#### **Repale JM, Hapase RS (2021)**

Assessment of promising sugarcane clones for cane and sugar yield for Maharashtra

#### **Shinde PP (2021)**

Enhancing sugarcane productivity with fertigation technique

#### **Yadav RG, Shitole TD (2021)**

Field evaluation of IPM Technology against early shoot borer, *Chilo infuscatellus* (Snellen) in sugarcane

#### **Dani RV, Panda S, Ghorpade RN, Patil RR (2021)**

Remedial measures to bring down cost of production of plantation white sugar  
Webinar arranged by ASSCT

#### **Deshmukh VS, Nimbalkar DS (2021)**

Estimation of workplace particulate pollutants in sugar industry  
27<sup>th</sup> International Conference of Physical Sciences on Recent Advances in Earth Sciences by Dr. Rammanohar Lohia Avadhi University, Ayodhya

#### **Deshmukh PS, Hingmire VB (2022)**

Geostatistical modeling and soil fertility assessment for sugarcane growing soils in tropical region of Maharashtra  
National seminar on managing soils in a changing climate organized by ICAR NBSS & LUP, Nagpur

#### **Nimbalkar DS (2021)**

Environmental clearance compliances and violations  
Workshop and online demonstration on Environmental Clearance, compliances, violations and uploading of EC on Parivesh Portal organized by VSI under Aazadi ka Amrut Mahotsav

#### **Patil PG (2021)**

New AC drive system for efficient operation of batch centrifugal  
International Technical Conference & Exhibition on Electrical Rotating Machines (ELROMA)

#### **Patil SV (2021)**

Storability study of biosyrup the programme of global launch of biosyrup: A new sustainable feedstock for production of ethanol  
Jaywant Sugars Ltd.

#### **Patil SV (2021)**

STAI Webinar: "Bio-circular economy: Opportunity for diversification for sugar mills in waste to energy (Biofuels) Field: Compressed Biogas (CBG) and Organic Fertilizer

#### **Patil SV (2021)**

Value added products from waste biomass  
vWa workshop at VSI entitled - Valorizing waste from Sugar & Allied Industries

## PRESENTATIONS

#### **Chandgude RA (2021)**

Latest development in sugar milling  
International Technical Conference & Exhibition on Electrical Rotating Machines (ELROMA)

## SEMINARS / WORKSHOPS / TRAINING PROGRAMMES / MEETINGS

### D) SEMINARS/ WORKSHOPS/TRAINING PROGRAMMES ORGANIZED BY VSI

Date	Particulars
Apr. 23, 2021	Webinar on “Oxygen production in sugar mills - way forward”
Jul. 2, 2021	Webinar on “Opportunities for sugar/distillery industry in Compressed Biogas (CBG) Sector”
Aug. 9 -14, 2021	Training programme for Balarampur Chini mills Ltd. and mill engineers of ten sugar mills on the “milling plant”
Aug. 13, 2021	Workshop and online demonstration on “Environmental Clearance, compliances, violations and uploading of EC on parivesh portal”
Aug. 28, 2021	Workshop on “Progress of CDAS and conduct of adaptive research trials of promising genotype CoVSI 18121 with Co 86032”
Aug. 30, 2021	Interactive meet on “Use of retro fitment kits for compressed biogas (CBG)/Compressed Natural Gas (CNG) for Agricultural tractors”
Sep. 7-8, 2021	Training programme on “Modern technologies in sugarcane agriculture” sponsored under National Food Security Mission (NFSM) for Aurangabad and Latur Districts in Maharashtra
Sep. 9 - Oct. 26, 2021	Training programme on “Agri-clinic and Agri-business Management” under Institute of Agricultural Extension Management (MANAGE), Hyderabad
Sep.13-15, 2021	Training programme on “Modern technologies in sugarcane agriculture” for Madhya Pradesh
Oct. 1, 2021	National Seed Day
Oct. 23, 2021	Workshop on “Management of soil fertility and characterization of salt affected soil”
Nov. 27, 2021	Workshop on “Sugarcane ratoon management“
Dec. 25, 2021	Review of CDAS and guidelines for VSI’s cane development award
Jan. 10-28, 2022	Training programme on “Traditional Vs Scientific technologies for Mahua spirit and heritage alcoholic beverages production-optimization, evaluation”
Jan 22, 2022	Workshop on “Crop protection in sugarcane” (Virtual Mode)
Feb. 18, 2022	Training programme for State Excise Trainee Officers of Government of Maharashtra on “Overview of distilleries and alcoholic beverage industry”
Feb. 26, 2022	Workshop on “Integrated water management in sugarcane”
Mar. 26, 2022	Workshop on “Sugarcane management in stress condition”
Mar. 31, 2022	Workshop on “Valorizing waste from sugar & allied industries ” organized by VSI and UK partners







## Annexure V (Contd.)

### II) PARTICIPATION IN SEMINARS/WEBINARS/WORKSHOPS/TRAINING PROGRAMMES BY VSI SCIENTISTS

Title	Scientist(s) participated
Azadi ka Amrut Mahostav lecture series organized by Indian Academy of Sciences Apr. 23, 2021	Mr. RV Burase
STAI webinar on “Setting up bio-CNG projects for the financial health of sugar factories” Apr. 28, 2021	All staff of AT & B department
BUSHI India webinar on “Know how - Kjeldahl Protein (Nitrogen) analysis” Apr. 29, 2021	Ms. NM Naik
Workshop on ‘Research Metrics’ organized by SPPU, Pune May 4, 2021	Mr. VS Deshmukh
Agilent Technology webinars on “Method development for gas chromatography analysis of biofuels” “Pharma Analysis for Learning tools for improves your skills”; “GC-MS enhance productivity school series” and “Online tools to help reduce GC method development” May 7, Aug. 11, Sep. 7, Nov. 16, 2021	Ms. SM Havale
Agilent Technology webinar on “Azadi ka Amrut Mahotsav” of NSI Kanpur on production of Bio-CNG from filter cake & potash rich fertilizer from incineration boiler ash May 10, 2021	Dr. KS Konde, Mr. DA Patil, Mr. RV Godage, Ms. SM Havale
NSI webinar on “Sugar industry -potential for providing bio-energy and oxygen” May 10, 2021	Mr. DA Patil
Virtual symposium on ‘Digitalization in Covid Era by Power Petroleum & Process Automation 2021’ organized by ISA, Maharashtra Jun. 11, 2021	Mr. DN Gare, Mr. SG Kaduskar
International Conference on Sugarcane Research (CaneCon2021), at ICAR SBI, Coimbatore (TN) Jun. 19-22, 2021	Mr. Shivajirao Deshmukh, Dr. RS Hapase, Mr. BH Pawar, Dr. JM Repale, Dr. GS Kotgire Mr. US Manjul, Mr. GE Atre, Dr. (Ms.) PS Deshmukh, Dr. AS Patil, Mr. SA Surwase, Mr. PV Ghodke, Mr. PP Shinde, Ms. SD Ghodke, Mr. BG Mali, Ms. KG Nigade, Mr. RG Yadav, Dr. TD Shitole
BUSHI India webinar on “Detection methods in chromatography” Jun. 24, 2021	Ms. NM Naik
Webinar on ‘Opportunities for sugar, distillery industry in CBG sector’ Jul. 02, 2021	Mr. Shivajirao Deshmukh, Mr. DN Gare



## Annexure V (Contd.)

Title	Scientist(s) participated
Separation Science lecture on “Testing, method development for identification and analysis of polar compounds” Jul. 5, 2021	Ms. SM Havale
Webinar on “How to achieve effective Distillation” by Lab India Instruments Jul. 8, 2021	Ms. NM Naik
Webinar on “LGC AXIO proficiency testing-utilizing proficiency testing to optimize performance” by GLOBAL PT provider LGC, UK Jul. 26, 2021	Ms. NM Naik
Webinar on “Ground water regulation and conservation” by Forbes Marshall Jul. 28, 2021	Dr. KS Konde, Mr. DA Patil, Mr. RV Godage,
CHNSO analyzer by Mr. Barun Maji of Elementar Aug. 3, 2021	Dr. KS Konde, Mr. SA Patil, Mr. S Behera, Mr. RV Burase, Dr. ST Devkar, Ms. NM Naik, Ms. SM Havale
Virtual conference, “Green Sugar Summit 2021” Aug. 5-6, 2021	Mr. VP Ghule
NSI and AIDA webinar on “Grain based distilleries - operations and Economics” Aug. 10, 2021	Dr. KS Konde, Mr. DA Patil, Mr. RV Godage
Evolution of organic elemental analysis flash smart EA: Modularity, Features and benefits, Skytech Systems India P. Ltd., Thane Aug. 17, 2021	Dr. ST Devkar, Ms. NM Naik, Ms. SM Havale
Presentation on “Lyza 5000 wine analyzer tech webex” organized by Anton Paar Sep.1, 2021	Dr. ST Devkar, Mr. RV Burase, Mr. RR More, Mr. VP Ghule, Ms. SM Havale, Ms. NM Naik,
Science of air quality monitoring and measurement, IITM ENVIS, Pune Sep. 6-7 2021	Mr. VS Deshmukh
Webinar on “Atma Nirbhar Bharat efforts at STI Institutions in Maharashtra” by DST, Govt. of India Sep. 8, 2021	Mr. P Nikam
Webinar on “Overview of sample preparation techniques and GC solutions” Sep. 21, 2021	Dr. ST Devkar
50 <sup>th</sup> Golden Jubilee Annual Convention of SISSTA, Bengaluru Oct. 1-2, 2021	Ms. SD Ghodke, Mr. S Panda
Webinar on “Energy data management” organized by International Energy Agency, NITI Aayog and Prayas Oct. 4-29, 2021	Mr. RA Chandgude
79 <sup>th</sup> Annual Convention of STAI, Kanpur - Virtual Oct. 4-5, 2021	Mr. PP Shinde, Ms. SD Ghodke, Ms. KG. Nigade, Mr. BG. Mali



## Annexure V (Contd.)

Title	Scientist(s) participated
ISMA webinar on “Ethanol Blending Programme” Oct. 8, 2021	Mr. Shivajirao Deshmukh, Dr. KS Konde, Mr. DA Patil, Mr. RV Godage
Webinar on “Latest laboratory equipments for testing /testing methods of wheat and wheat products during entire supply chain system” by RFMFOI Oct. 12, 2021	Dr. ST Devkar
Webinar on “The Unmet R&D needs of the Indian alcoholic beverage industry” Oct. 12, 2021	Mr. VP Ghule
Biennial workshop of AICRP on sugarcane Oct. 21-22, 2021	Mr. BH Pawar, Dr. GS Kotgire Mr. GE Atre
International conference on ‘Recent advances in earth sciences’ organized by Dr. Ram Manohar Lohiya Avadh University, Ayodhya Oct. 26-27, 2021	Mr. VS Deshmukh
66 <sup>th</sup> Annual Convention of DSTA Oct. 30-31, 2021	Dr. RN. Bhosale, Dr. KS Konde, Mr. SA Patil, Mr. DA Patil, Mr. PV Ghodke Ms. SD Ghodke
XV Agricultural Science Congress, Varanasi Nov. 13-16, 2021	Mr. PP Shinde
Webinar on “sustainable mobility-ethanol talks India-II” Nov. 17, 2021	Mr. DA Patil, Mr. VP Ghule
Waters webinar on “Tools and techniques for retaining and separating polar compounds” “Metrohm for IC application and “Sweet truth for Honey analysis & Selection of column” Nov. 26, Dec. 2 and Dec. 5, 2021	Ms. SM Havale
Workshop on “Biosyrup storability study” organized by PRAJ Industries at Jaywant Sugars Ltd. Dec. 3, 2021	All Staff of AT & B department
Webinar on “Disinfection technologies Food & Beverage Industries” organized by HACH, DHR, India Dec. 10, 2021	Mr. RV Burase
Training on ‘Implementation of circular economy in educational institutions’ Dec. 14-16, 2021	Mr. VS Deshmukh Mr. Aftab Momin
Two-days Asia Africa Symposium on ‘Agribuisness’ organized by Navsari Agriculture University, Navsari (Gujarat) Jan. 16-17, 2022	Dr. GS Kotgire
Webinar on “Innovations for Tomorrow: Alcoholic drinks and beyond” organized by Firmenich Jan. 20, 2022	Mr. VP Ghule

**Annexure V (Contd.)**

<b>Title</b>	<b>Scientist(s) participated</b>
e-workshop on 'Mushroom production technology : Challenges and Opportunities' organized by Dr. PDKV Akola Feb. 1-3, 2022	Dr.GS Kotgire
e-workshop on 'Organic farming: steps towards sustainability' organized by Dr. PDKV Akola Feb. 7-9, 2022	Dr. GS Kotgire
National webinar on 'Conservation Agriculture in India: Myths, realities and way forward organized by MPAUT 000, Udaipur, and Rajasthan. Feb. 17, 2022	Dr. GS Kotgire Mr. GE Atre
FSSAI webinar on "Series edible oil analysis with FSSAI" Feb. 21, 2022	Ms. SM Havale
STAI webinar on "Issues and way forward for ethanol production from sugarcane syrup" Feb. 24, 2022	Dr. KS Konde, Mr. DA Patil, Mr. RV Godage, Mr. VP Ghule
Separation science seminar on "LC basic and method development" Mar. 3, 2022	Ms. SM Havale
Training on 'Uncertainty measurement and decision rule as per ISO/IEC 17025:2017' Mar. 13-15, 2022	Dr. RN Bhosale, Mr. YP Kadam, Dr. HN Hingane, Ms. Anjali Tilekar
High speed blowers for mechanical vapour recompression processes by Piller Vapofan Germany Mar. 24, 2022	All Engineering staff
National seminar on managing soils in a changing climate at ICAR NBSS&LUP, Nagpur Mar. 24-26, 2022	Dr. (Ms.) PS Deshmukh



**MoU between ICAR's Directorate of Floriculture Research (DFR), Pune and VSI**



**MoU between National Remote sensing center, ISRO, Department of Space, GoI and VSI**



III) PARTICIPATION IN MEETINGS BY VSI SCIENTISTS

Title	Scientists participated
Video conference meeting by TRI - SEN Turbo machinery control system May 5, May 12, 2021	Mr. RA Chandgude, Mr. DN Gare, Mr. SB Thorat, Mr. SG Kaduskar
Online pre-research planning meeting, MPKV, Rahuri Jun. 8, 9, 10, 11, 2021 and Feb. 3, 4, 9, 2022	Ms. SD Ghodke, Mr. US Manjul, Ms. KG Nigade, Mr. BG Mali, Mr. RG Yadav
Meeting with Joint Director, Sugar, MS on "Effect of diversion of juice, syrup and BH for ethanol production on FRP Jun.10, 2021	Dr. RV Dani, Mr. S Panda, Mr. RR Patil
Meeting with WABCG regd. sugarbeet and sugarcane crops Jun. 14, Nov. 08, Nov. 15, Nov. 22, 2021	Mr. Shivajirao Deshmukh, Mr. Sambhaji Kadu Patil, Mr. PV Ghodke
Meeting with officer of Ministry of Electronics & Information Technology on Brix sensor at VSI Jul. 01, 2021	Dr. RV Dani
Meeting with Deputy High Commissioner and Administrative Manager, Bangladesh to study the scope of work in Bangladesh Sugar Industry Jul. 09, 2021	Dr. RV Dani
Meeting for discussion on Nano urea at MPKV Rahuri Jul. 12, 2021	Ms. SD Ghodke, Ms. KG Nigade
Online meetings with FAO-NRAA officials on sugar beet project Jul. 23, Aug. 24, Sept. 07, Oct. 06, Oct. 08, 2021	Mr. Shivajirao Deshmukh Mr. PV Ghodke, Dr. AS Patil
Meeting with Director BARC regarding seed project Aug. 11, 2021	Mr. PV Ghodke
CBG Plus solutions P. Ltd. Business & Technology Overview by Mr. Shirish Ganu Aug. 12, 2021	Dr. KS Konde, Mr. SA Patil, Mr. S Behera, Mr. RV Burase, Dr. ST Devkar, Ms. NM Naik, Ms. SM Havale
Online meeting of BoS Environmental Sciences Sep.1, 2021 and Feb. 3, 2022	Dr. (Ms.) Deepali Nimbalkar
Meeting by SEAC I Maharashtra to understand the issues in composting/incineration of distillery spent wash for deciding whether to continue composting as a method of spent wash treatment & disposal in EC of distilleries $\leq 45$ KLPD (Virtual) Sep. 28, 2021	Dr. (Ms.) DS Nimbalkar, Dr. AB Deshmane, Dr. Alkat EA, Dr. Patil VP
AICRP(S) group meeting at IISR, Lucknow (Virtual) Oct. 21-22, 2021	Dr. RS Hapase, Mr. PP Shinde, Mr. BH Pawar, Mr. PV Ghodke, Mr. RG Yadav, Dr. (Ms.) PS Deshmukh
Meeting with scientist from SAMEER, Mumbai regarding brix automation Nov.16, Dec.17 2021	Dr. RV Dani

Annexure V (Contd.)

Title	Scientists participated
Roundtable on “Accelerating Gender Equality” and book launch of “She Is: Stories of Women Advancing the Sustainable Development Goals in India” hosted by US Consulate General, Mumbai Dec. 17, 2021	Dr. (Ms.) DS Nimbalkar
Meeting of Technology Transfer Association at Science & Technology Park, SPPU, Pune Dec. 22, 2021	Dr. (Ms.) DS Nimbalkar
Meeting regarding “Effluent treatment in distilleries producing ethanol exclusively from sugarcane juice/syrup” in Mantralaya, Mumbai Jan. 6, 17, 2022	Dr. (Ms.) DS Nimbalkar
Meeting with Director (Admin); MD, MRSSK Sangh; MD, WISMA on permission for Khandasari sugar plants in the state at Commissioner of Sugar office Jan.18, 2022	Dr. RV Dani, Mr. ST Chavan
Research review meeting at MPKV Rahuri, Feb. 9, 10, 15, 2022	Mr. BH Pawar, Mr. PV Ghodke, Mr. RG Yadav, Ms. SD Ghodke, Dr. GS Kotgire, Mr. GE Atre, Ms. KG Nigade, Dr. AS Patil
Meeting with Hon. President regarding drone technology at KVK, Baramati Feb. 19, 2022	Mr. Shivajirao Deshmukh, Dr. (Ms.) PS Deshmukh
Meeting on single window portal (PARIVESH-CPC Green) with accredited EIA consultants with Joint Secretary, MoEF&CC Feb. 21, 2022	Mr. Shivajirao Deshmukh, Dr. (Ms.) DS Nimbalkar, Dr. AB Deshmane
Meeting with Mr. Prataprao Pawar, Dr. Sanjeev Tambe and NCL scientists regarding applications of artificial intelligence Feb. 22, Mar. 1, 15, 22, 2022	Dr. RV Dani, Dr. RN Bhosale, Mr. RA Chandgude, Dr. (Ms.) DS Nimbalkar
Discussion with software engineers from Commissioner of sugar office regarding software input data for FRP calculation Mar. 5, 2022	Dr. RN Bhosale
Meeting on Single Window Portal (PARIVESH -CPC Green) with accredited EIA consultants, Joint Secretary, MoEF&CC Feb 21, 2022	Dr. (Ms.) DS Nimbalkar, Dr. AB Deshmane
Training programme on newly installed CHNSO analyzer instrument for operation, calibration and analysis Mar. 2-9, 2022	Dr. ST Devkar, Ms. NM Naik Ms. SM Hawale
Online meeting by CPCB with expert institutes regarding management of environmental issues in sugar and distillery industries located in Ganga and Yamuna basin Mar. 11, 2022	Dr. (Ms.) DS Nimbalkar, Mr. KA Uphade
Research planning meeting, MPKV, Rahuri. Mar. 21-23, 24, 25, 2022	Mr. BH Pawar, Dr. GS Kotgire Dr. AS Patil, Ms. SD Ghodke, Mr. US Manjul, Mr. BG Mali Ms. KG Nigade,
23 <sup>rd</sup> ICSB meeting (Online) Mar. 31, 2022	Mr. Shivajirao Deshmukh



## Annexure VI

### LECTURES DELIVERED BY VISITORS AT VSI

Date	Subject	Name of the speaker / Organization
Oct. 10, 2021	Incineration boiler updated technology	Mr. Sangamnerkar Urja – Disha boiler technology
Mar. 15, 2022	Prospective use of Artificial Intelligence in Sugar & Allied Industries	Dr. Sanjeev Tambe, Adjunct Prof. ICT, Mumbai

## Annexure VII

### INVITED LECTURES BY VSI SCIENTISTS

Date	Subject	Place	Speaker
Aug. 1-2, 2021	Laboratory equipment and analytical methods	Balrampur Chini Mills Ltd., UP	Dr. RN Bhosale, Mr. LS Dalvi
Aug. 5-8, 2021	Sugar manufacturing Process		Dr. RN Bhosale, Mr. S Panda, Mr. DB Sapkal
Sep. 08, 2021 Sep. 14, 2021	Advanced planting techniques in sugarcane and ratoon management	Organized by NFSM and Ramdeo sugar, Housangabad	Mr. PV Ghodke
Sep. 15, 2021 Nov. 25, 2021	Agronomic aspects of Sugarbeet cultivation	Datta Shetkari SSK	Mr. PV Ghodke
Sep. 23, 2021	INM for sustainable sugarcane production	Krantiagrani Dr. GD Bapu Lad SSK	Dr. (Ms.) PS Deshmukh
Sep. 30, 2021	Sugarbeet cultivation & Processing	Virtual meeting with Yavatmal farmers	Mr. PV Ghodke
Nov. 14, 2021	Mechanized harvesting of sugarcane	XV Agricultural Science Congress, Varanasi	Mr. PP Shinde
Feb. 09, 2022	Importance of soil testing for sustainable sugarcane production	Krantiagrani Dr. GD Bapu Lad SSK	Mr. SA Surwase
Mar. 29, 2022	Reclamation of salt affected soils	Malegaon SSK	Dr. (Ms.) PS Deshmukh
Mar. 21-22, 2022	Calculations for FRP of recovery during diversion of BH molasses, Syrup + BH molasses, Syrup, Mixed Juice	Office of the Commissioner of Sugar, MS, Pune	Mr. RR Patil, Mr. S Panda, Mr. K Gangadhar, Mr. N Mahana



## RADIO AND TELEVISION PROGRAMMES

Date	Topic	Name of Scientist
<b>All India Radio</b>		
Aug. 28, 2021	<i>Oos pikatil humani kidiche niyantran</i>	Ms. KG Nigade
Sep. 9, 2021	<i>Havaman badlacha oos pikavar rogachya drishtikontoon honara parinam</i>	Mr. BH Pawar
Sep. 16, 2021	<i>Oosavarril khodkidiche ani kandikidiche eekatmik niyantran</i>	Mr. RG Yadav
Sep. 20, 2021	<i>Oos pikavaril rogasath pratibadhatmak upay ani avlamb</i>	Mr. GE Atre
Sep. 23, 2021	<i>Oos todani yantranacha vapar - Fayade ani maryada.</i>	Mr. PP Shinde
Sep. 24, 2021	<i>Oos pikat panawar adhalnare rog, tyache mahatva ani niyantran</i>	Dr. GS Kotgire
Sep. 28, 2021	Sugarcane varieties for preseason planting	Dr. RS Hapase
Oct. 10, 2021	<i>Purva hangami oos sheti kifayatshir kashi karal</i>	Mr. BJ Takalkar
Jan.14, 2022	<i>Khodava peek aarthikdrushta faydyache</i>	Mr. BJ Takalkar
<b>Doordarshan</b>		
Oct. 5, 2021	Sugarcane varieties for preseason planting	Dr. RS Hapase
Nov. 25, 2021	<i>Antar mashagatisathi aujarancha vapar</i>	Mr. PP Shinde
Jan. 28, 2022	<i>Thibak sinchanadware khatancha vapar</i>	Mr. PP Shinde



Inauguration of 'Oos Sheti Dnyanyag' training program

Inauguration of 'Oos Sheti Dnyanlaxmi' training program







## AWARDS

Award	Awardees	Article
Mydur Anand Gold Medal in 50 <sup>th</sup> Annual Convention of SISSTA	Mr. S Panda, Dr. RV Dani, Mr. LS Dalvi, Mr. RR Patil	Effective control of microorganisms - tool for revenue gain
Second prize for presentation in International Conference on Sugarcane Research: (CaneCon2021)	Dr. JM Repale, Dr. RS Hapase	Assessment of promising sugarcane clones for cane and sugar yield for Maharashtra

### PhD Awards

Name	Title of Thesis	University / Subject	Name of Guide
Mr. RV Burase	Bio-methanation of high brix spent wash	Dr. Babasaheb Ambedkar Marathwada University <b>Subject: Microbiology</b>	Dr. RD Joshi, Head & Principal, Yogeshwari Mahavidyalay, Abejogai

## PATENTS

### Alcohol Technology and Biofuels

1. US (16/850,281) patent was published on “Method for pre-clarification of molasses to improve the fermentation efficiency thereof”
2. Indian (201821039366) patent was published on “Method for pre-clarification of molasses to improve the fermentation efficiency thereof”
3. Indian (202021008352) patent was published on “Method for pretreatment of lignocellulosic biomass using recycled acid and alkali in lactic acid production”.
4. Indian (202021025284) patent was filed on “Method for ethanol production from sugar by addition of spent wash as nutrient supplementation”
5. Indian patent (202021049490) was filed on “Process for recovery of potassium salts from incineration boiler ash in molasses-based distilleries”.

### Agriculture Sciences and Technology

#### • Sugarcane planter

The two row sugarcane planter developed by VSI has been granted the patent (334616) by Controller General of patent for twenty years. The planter has been commercialized on royalty basis to Rohit Krishi Industries Ltd., Pune and Deccan Farm Equipments, Kolhapur for large scale adoption by the farmers.

### Memorandum of Understanding (MoU)

- MoU with National Remote Sensing Centre (NRSC), ISRO, Department of Space, Govt. of India, Hyderabad for establishment of field equipment for validation of soil moisture products.
- MoU with ICAR's Directorate of Floriculture Research (DFR), Pune for collaborative research.
- MoU with BARC for two years 2019 to 2022 for different activities of cane development.
- MoU with National Institute of Abiotic Stress Management, Malegaon for collaborative research.
- MoU with Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli for sustainable management of abiotic and biotic stresses and yield improvement in different crops
- Material Transfer Agreement (MTA) was signed between VSI & ICRISAT for evaluation of super early pigeon pea varieties under sugarcane based cropping system at VSI.

### Publications

#### Annual

- Performance of Sugar Mills in Maharashtra
- Financial Performance of Sugar Mills in Maharashtra
- Technical Performance of VSI Member Distilleries in Maharashtra
- *Oos Sheti Dnyanyag*: A comprehensive guide for sugarcane farming (Hindi and Marathi)

#### Chandgude RA (2021)

- “Sugar Engineering Yantra and Tantra” Book in the *Marathi* language published

## DISTINGUISHED VISITORS

- Mr. Md. Lutfur Rahman, Dy. High Commissioner, Bangladesh Deputy High Commission in Mumbai along with Mr. Shaheem Chowdhary, Administrative Officer
- Mr. Venkata Ravi, Assistant Cane Commissioner Bodhan, Telangana State
- Mr. Ganga Reddy, Chairman Cane Council, Telangana State
- Team from Maharashtra State Excise, GoM
  - Mr. Kantilal B. Umap, Commissioner of State Excise
  - Mr. Prasad Survey, Divisional Dy. Commissioner of Excise
  - Mr. Yatin Sawant, Asst. Joint Commissioner
  - Mr. Santosh Zagade, Superintendent of Police, Pune
- Mr. Anup Kumar, Principal Secretary, Co-operation and Marketing, GoM
- Mr. Shekhar Gaikwad, Sugar Commissioner, GoM
- Dr. Sushil Solomon, Vice-president, International Association of Professionals in Sugar & Integrated Technology
- Mr. Sunil Kumar Ohari, General Manager (Projects), UP Co-operative Sugar Factories Federation Ltd., Lucknow
- Dr. Sanjeev Tambe, Adjunct Prof. ICT, Mumbai
- Team from College of Engineering, Pune
  - Dr. BB Ahuja, Director
  - Prof. MS Sutaone, Deputy Director
  - Prof. AG Thosar, Dean R & D
- Team from Mantralaya, Mumbai
  - Mr. Ankush P. Shingade, Deputy Secretary,
  - Mr. Pramod M. Valanj, Under Secretary,
  - Mr. Prashant R. Pimple, Section Officer,
  - Mr. Prakash A. Waghmare, Asst. Section Officer,
  - Mr. Shailesh S. Surve, Asst. Section Officer



Training programme for State Excise Officers, GoM



Visit of farmers of Cane Development Council Maggi, Telangana State



## VISITS TO OTHER INSTITUTES

### National

- Agharkar Research Institute (ARI), Pune, Maharashtra
- Agriculture Research Station, Napne
- Agriculture Research Station, Sankeshwar, UAS, Dharwad, Karnataka
- Agriculture Research Station, Shirgaon, Ratnagiri, Maharashtra
- Agrosurg, Vasai, Maharashtra
- Bhabha Atomic Research Center (BARC), Mumbai, Maharashtra
- Bharati Vidyapeet Deemed University, Pune, Maharashtra
- Central Sugarcane Research Station, Padegaon, Satara
- Chhattisgarh Environment Conservation Board, Chhattisgarh
- College of Engineering, Pune
- Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra
- Institute of Plasma Research, Gandhinagar, Gujarat
- Maharashtra Pollution Control Board (MPCB), Pune/ Mumbai, Maharashtra
- Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra
- Main Sugarcane Research Station, NAU, Navsari, Gujarat
- National Chemical laboratory (NCL), Pune, Maharashtra
- National Institute of Abiotic Stress Management, Baramati, Maharashtra
- National Research Centre (NRC) for Grapes, Pune, Maharashtra
- Navsari Agricultural University, Navsari, Gujarat
- Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad
- Regional Sugarcane Research Station, Hingoli, Maharashtra
- S.K. College of Agriculture and Research Station, Kawardha, Chhattisgarh
- Savitribai Phule Pune University (SPPU), Pune, Maharashtra
- Shivaji University, Kolhapur, Maharashtra
- Society for Applied Microwave Electronics Engineering and Research, Mumbai
- Veer Narmada South Gujarat University, Surat, Gujarat
- Zonal Agricultural Research Station, Powerkheda, Madhya Pradesh
- Zoological Survey of India, Pune, Maharashtra





## VISITS BY TECHNICAL PERSONNEL

Particulars	No. of visits
<b>Agricultural Sciences and Technology</b>	
Research activities	69
Farm development and Management	38
<i>Oos Bhushan</i> plot verification/ prize winners	34
Hybridization, Amboli	18
Pest and disease management	17
Inspection of seed plots	10
Demonstration/Adaptive trial	10
Participation of seminars/ workshop/ conference/meeting	6
Cane development activities/ varietal identification	6
Farmers rallies	3
Consultancy for cane development	2
Promotional cane development award scheme	2
Verification of flood affected area and guidelines	2
Other visits-sugar beet	2
Mill test	1
Low recovery	1
<b>Total</b>	<b>221</b>
<b>Sugar Technology</b>	
GPI's Inspection	212
Validation visits for BH/Syrup diversion for ethanol production	86
Extension services including modernization of sugar plant	60
To improve the overall technical performance	25
ETP consultancy & adequacy assessment	18
Conservation of steam, power and water	13
Research and development	10
Off-seasonal maintenance	9
Preparation of tender technical specifications, scrutiny of design and drawing of equipment	9
Guidance for water and waste water management	6
Selection of candidates for technical posts in sugar mills	6
Analytical services	6
To improvement capacity utilization and minimize sugar losses in boiling house	6
Conference / Seminar / Workshops	3
Educational visits	2
Other visits	2
<b>Total</b>	<b>473</b>
<b>Sugar Engineering</b>	
Extension services including modernization of sugar mills (VC + Offline)	163
Inspection of machineries (VC + Offline)	75
Pre-bid, SLMPC and cogeneration coordination committee meetings (VC + Offline)	69
Distillery captive power projects	66
Cogeneration projects (VC + Offline)	40
Machinery manufacturers meetings (VC + Offline)	35
Research and development Projects (VC + Offline)	19
Non-member sugar mills	9
SDF / NCDC / MSEDCL meetings (VC)	8
Conference / Seminar / Workshop / Training programmes (VC)	7
Other visits	38
<b>Total</b>	<b>529</b>



**Annexure XII (Contd.)**

<b>Particulars</b>	<b>No. of visits</b>
<b>Alcohol Technology and Biofuels</b>	
Inspection of project execution and performance of distillery plants	116
CPCB, GPI	111
Cane juice /BH molasses to ethanol production	80
Meetings at Sugar Commissionerate office, MRSSK and SLMPC	28
Inspection of plant and machinery at vendor's workshops	26
Board of Directors meetings for distillery projects	20
Technical committee meetings for distillery proposal	16
Troubleshooting of process problems and related issues	9
Pilot plant of CBG at Nira Bhima SSK	6
Research project work at Jaywant Sugars	5
Distillery modernization proposals	5
Interviews of distillery personnel	5
Inspection of plant and machinery of existing distilleries	4
Seminars / Workshop / Training / Others	4
CPCB expert committee meeting	3
Adequacy Assessment Report preparation- Evaluation of distillery ETP's performance	2
Online academic meeting, BoS, Ahmednagar College	2
Online review meeting vWa & RGSTC project	2
Contract research project work at DIAGIO, Nashik	2
CIRT, Pune visit for retro fitment of kits for CBG tractors	2
CBG plant of Spectrum Renewable Energy, Rohtak (Haryana)	1
Meeting with CoEP team and Dr. Sanjeev Tambe on AI	1
<b>Total</b>	<b>450</b>
<b>Environmental Sciences</b>	
CPCB GPI	132
Technical consultancy (ETP, CPU, STP, adequacy & revalidation work)	63
EIA related work (Public Hearing, Data collection, meetings)	16
Monitoring (Air, Water, Noise)	7
Compliance related work	4
Meetings at MoEFCC, MPCB, Mantralaya	3
Meetings for collaborative work	2
<b>Total</b>	<b>227</b>
<b>Electronics and Computer</b>	
VSI sugarERP software installation and maintenance	200
Demonstration of VSI sugarERP	3
VSI sugarERP software Case study to Bagamoyo sugar Ltd, Tanzania	1
<b>Total</b>	<b>204</b>
<b>Instrumentation</b>	
Co-generation / Distillery Project Work	41
Rectification and Calibration Work	29
Advisory Services	13
Training/ Seminar	1
<b>Total</b>	<b>84</b>
<b>Grand Total</b>	<b>2188</b>

## ABBREVIATIONS AND ACRONYMS

%	Percentage/ Percent	CII	Confederation of Indian Industry
µg	Microgram	CL	Country liquor
2G	Second generation	CMV	Cauliflower Mosaic Virus
AAR	Adequacy Assessment Report	CNG	Compressed Natural Gas
AAS	Atomic absorption spectroscopy	CoM	Coimbatore & Maharashtra
AC&ABC	Agri-Clinics and Agri-Business Centres	CoN	Coimbatore+ Navsari
ACFC	Auto Cane Feed Control	CoVC	Coimbatore+ Visvesvaraya
AD	Anaerobic Digestion	CoVSI	Coimbatore+ Vasantdada Sugar Institute
ADY	Active Dry Yeast	CPCB	Central Pollution Control Board
AICRP –S	All India Coordinated Research programme on sugarcane	CPU	Condensate Polishing Unit
AICRP	All India Coordinated Research Project on Sugarcane	CSK HPKV	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya
AIDA	All India Distillers Association	CSRS	Central Sugarcane Research Station
ARI	Agharkar Research Institute	CV	Coefficient of Variation
ARS	Agriculture Research Station	DAM	Distillery Association of India
AST	Agriculture Sciences and Technology	DAP	Di Ammonium Phosphate/ Days after planting
ATL	Accredited Test Laboratories	DAS	Days after sowing
ATMA	Agriculture Technology Management Agency	DBSKKV	Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth
AVSI	Associateship of Vasantdada Sugar Institute	DBT	Department of Biotechnology
B:C	Benefit : cost	DCS	Distributed Control System
BAL	Baramati Agro Ltd.	DFPD	Department of Food and Public Distribution
BARC	Bhaba Atomic Research Station	DIFAT	Diploma in Industrial Fermentation and Alcohol Technology
BBrMV	Banana Bract Mosaic Virus	DNA	Deoxyribonucleicacid
BBTV	Banana Bunchy Top Virus	DOGR	Directorate of Onion & Garlic Research
BCIL	Biotechnology Consortium India Limited	DPR	Detailed Project Report
<i>betA</i>	<i>Choline dehydrogenase</i>	EBP	Ethanol Blending Programme
<i>betB</i>	<i>Betaine aldehyde dehydrogenase</i>	EC	Electrical Conductivity/ Environmental Clearance
BH	B heavy	ELISA	Enzyme-Linked Immunosorbent Assay
bp	base pair	ENA	Extra Neutral Alcohol
BSA	Bovine serum albumine	EOI	Expression of Interest
BSV	Banana Streak Virus	ESB	Early Shoot Borer
CAAST	Centre for Advanced Agricultural Science and Technology	ETP	Effluent Treatment Plant
CBG	Compressed bio gas	EU	European Union
cc	cubic centimeter	FAO	Food & Agriculture Organization
CCS	Commercial Cane Sugar	FCO	Fertilizer Control Order
CD	Critical Difference	FD	Forced Draft
CFA	Central Financial Assistance	FE	Fermentation Efficiency
CFU	Colony forming unit		
CIB	Central Insecticide Board		



## ABBREVIATIONS AND ACRONYMS

Fig.	Figure
FSSAI	Food Safety and Standards Authority of India
FVT	Final Varietal Trial
G/Gm	Gram
GA	Gluconic acid
GAD	General Arrangement Drawing
GC	Gas chromatography / General Collection
GC-MS	Gas chromatography mass spectrometry
GF	Genetic Fidelity
GoI	Government of India
GoM	Government of Maharashtra
GoMP	Government of Madhya Pradesh
GPIs	Grossly Polluted Industries
GR	Glutathione reductase
GUS	$\beta$ -glucuronidase
Ha	Hectare
HCl	Hydrochloric acid
HPLC	High pressure liquid chromatography
hr	hour
HR	Hand Refractometer
IARI	Indian Agriculture Research Institute
IC	Ion Chromatography
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crop Research Institute for Semi Arid Tropics
IGKV	Indira Gandhi Krishi Vidyapeeth
IISR	Indian Institute of Sugarcane Research
IMFL	Indian Made Foreign Liquor
INB	Internode borer
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IRAP	Inter-Retrotransposon amplified polymorphism
ISH	Interspecific Hybrid
ISMA	Indian Sugar Mills Association
ISO	International Organization for Standardization
ISSR	Inter Simple Sequence Repeat
IVT	Initial Varietal Trial
JSL	Jaywant Sugars Ltd
K	Potassium
K <sup>+</sup>	Potassium ion

Kg	Kilogram
KLPA	Kilo Liter Per annum
KLPD	Kilo Liter Per Day
Lit.	Liter
Lok.	<i>Loknete</i>
Ltd.	Limited
MANAGE	National Institute of Agricultural Extension Management
MAP	Months after planting
MED	Multiple effect distillation
MHAT	Moist Hot Air Treatment
ml	Milliliter
MLT	Multilocation Trials
mM	milli molar
mmhg	Millimeter of mercury
MOP	Murite of Potatash
MOU	Memorandum of Understanding
MP	Madhya Pradesh
MPCB	Maharashtra Pollution Control Board
MPKV	Mahatma Phule Krishi Vidyapeeth
MPUAT	Maharana Pratap University Agriculture and Technology
MS	Maharashtra State
MW	Megawatts
N	Nitrogen
Na <sup>+</sup>	Sodium ion
NABCB	National Accreditation Board for Certification Bodies
NABL	National Accreditation Board for Testing and Calibration Laboratories
NaCl	Sodium chloride
NAU	Navsari Agriculture University
NBS	New Brunswick Scientific
NBSS&LUP	National Bureau of Soil Survey & Land Use Planning.
NCIM	National Collection of Industrial Microorganisms
NCL	National Chemical Laboratory
NCS-TCP	National Certification System for Tissue Culture Raised Plants
NFCSF	National Federation of Co-operative Sugar Factories
NFSM	National Food Security Mission
NIASM	National Institute of Abiotic Stress Management

## ABBREVIATIONS AND ACRONYMS

NIPB	National Institute of Plant Biotechnology	SBC	Sugarcane Breeding Center
NMC	Number of millable cane	SBI	Sugarcane Breeding Institute
NMCG	National Mission for Clean Ganga	SCB	Sugarcane bagasse
NPQ	Non-Photochemical quenching	SDS-PAGE	Sodium deodilesulphate polyacrylamide gel electrophoresis
NRAA	National Rainfed Area Authority	SED	Sugar Engineering Diploma
NRCG	National Research Centre for Grapes	SLMPC	State Level Machinery Purchase Committee
OSD	Officer on Special Duty	SM	<i>Sahakar Maharshi</i>
P & ID	Process and Instrumentation Diagram	SPCB	State Pollution Control Board
P&I	Piping & Instrumentation	Spp	Species
PC	Polycross	SPPU	Savitribhai Phule Pune University
PCR	Polymerase chain reaction	SRS	Sugarcane Research Station
PDKV	Punjabrao Deshmukh Krishi Vidyapeeth	SSK	<i>Sahakari Sakhar Karkhana</i>
PDN	Padegaon	ST	Sugar Technology
PESO	Petroleum and explosives safety organization	STAI	Sugar Technologist's Association of India
PF	Pre-fermenter	Std	Standard
PFD	Process flow Diagram	SWOT	Strengths, weakness, opportunities and threats
PFR	Pre-feasibility report	T	Tonnes
PFVT	Pre Final Varietal Trial	t/ha	tons per hectare
PIL	Praj Industries Ltd.	TC	<i>Trichogramma chinois</i>
PLC	Programmable Logic Controller	TCP	Tissue Culture Raised Plants
PMC	Press mud cake	TCPUs	Tissue Culture Production Units
PMI	Positive material identification	TE	Tris-Ethilune diamine tetra acetic acid
PPM	Part per million	TP	<i>Trichogramma pretiosum</i>
PPPR	Partly by paper partly by research	TPH	Tons per hour
PRMC	Project Review and Monitoring Committee	TRO	Turkey Red Oil
PSA	Principal Scientific Adviser	TRS	Total reducing sugar
QCI	Quality control of India	TS	Total solids
R&D	Research & Development	UAS	University of Agriculture Sciences
RDF	Recommended dose of fertilizer	USDA	United State Department of Agriculture
RFP	Request For Proposal	USL	United Spirits Ltd
RGSTC	Rajiv Gandhi Science and Technology Center	VI	Virus Indexing
RiMu	Radiation induced mutagenesis	VSI	Vasantdada Sugar Institute
RPM	Revolutions per minute	vWa	Valorization of waste
RRC	Research Review Committee	WABCG	World Association of Beet & Cane Growers
RS	Rectified Spirit	WBAT	Wine, Brewing and Alcohol Technology
RS & JRS	Regional Sugarcane & Jaggary Research Station	YLD	Yellow Leaf Disease
SATAT	Sustainable Alternative towards Affordable Transportation	ZLD	Zero Liquid Discharge
SAU's	State Agricultural University's	ZVT	Zonal Varietal Trial







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