VSI

संशोधनेन संवृद्धिः

ISO 9001:2015

Vasantdada Sugar Institute

42nd Annual Report 2017-18

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Vasantdada Sugar Institute

Manjari Bk., Pin 412 307; Dist. Pune, Maharashtra, India .
Phone: (020) 26902100, Fax: (020) 26902244
E-mail: vsilib@vsnl.com | Website: www.vsisugar.com

Published by
Mr. Shivajirao Deshmukh
Director General

Editorial Committee
Mr. KR Patil, Head & Technical Adviser
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Mr. Deepak Patil
Mr. Sanjay Dawari

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FOREWORD

The global sugar output in 2017-18 season was 194.07 million tonnes (raw value) as compared to previous season's production of 179.38 million tonnes (raw value). The sugar production was higher than the consumption (183.62 million tonnes raw value) that results in increase in stock to consumption ratio of sugar to 41.31% from 37.73% (2016-17).

Global stocks for 2018-19 are forecast to remain above 49 million tonnes (raw value) due to near-record global production and led by record production in both India and Thailand. In the absence of renewed export subsidies, stocks are projected to grow to burdensome levels in Pakistan. However, stocks in China are expected to fall as safeguard measures remain in effect, limiting imports from large supplying countries. Global production is down by 4 million tonnes to 188 million tonnes due to lower production in Brazil, Pakistan, and the European Union more than offsets record crops in India and Thailand. Exports are down slightly, while consumption is up due to growth in markets.

As far as the Indian sugar availability is concerned, the opening stock of sugar for the season 2017-18 was 3.94 million tonnes and the production was 32.28 million tonnes (white value) which was 59.33% more than the last season (20.26 million tonnes) mainly because of increase in sugar production of major states viz. Uttar Pradesh, Maharashtra, Karnataka and Gujarat, substantial increase in areas under sugarcane in Maharashtra, Gujarat and increase in cane yield in Karnataka, and in Uttar Pradesh, both area & cane yield increased by 3.42% & 12% respectively over previous season with more area under the high yielding & high sugar content varieties Co 0238, Co 0239 and Co 0118 that improved sugar recovery% cane significantly.

The opening stock of Indian sugar for the season 2018-19 is estimated to 10.4 million tonnes and production to 32.4 million tonnes thus, the total availability would be 42.8 million tonnes. The expected consumption of around 26 millions and exports including crystal, refined and raws is estimated to 5 million tonnes leaving a worrisome closing stock of 11.8 million tonnes.

Maharashtra produced 10.72 million tonnes (white value) of sugar during 2017-18 and it surpasses the previous high sugar production record of 10.51 million tonnes (2014-15). The estimates for the season 2018-19 will be 9.7 million tonnes which is likely to be lower due to rainfall deficiency in grand growth phase, drought conditions and wide spread infestation of white grub. In Maharashtra, 10.87 lac ha sugarcane area is available for crushing season 2018-19. Due to drought condition, around 1.2 lac ha sugarcane area is infested by white grub. This pest was prominent in drought prone area and light soils. It is estimated that there will be 20-25% loss in cane yield. White grub infestation was around 20%, 18% and 10% area in central, south and north-east Maharashtra, respectively. For the effective management of white grub, adoption of Integrated Pest Management (IPM) practice continuously for 3-4 years is necessary. Therefore, sugar mills should implement IPM technology on large scale on campaign basis to avoid future untoward damages.

The Government of India has taken proactive policy decisions to facilitate export of sugar by

granting transport incentive and production incentive on cane crushed for the period from 1st October 2018 to 30th September 2019 and made financial provision of Rs. 5538 crores. The Government of India is also firm and positive to export 5 million tonnes and would look in to the matters whether mills can export sugar produced in season 2017-18 or even in prior years, mills who have not completed export quota of previous 2 million tonnes scheme are eligible to export under current export of 5 million tonnes. In view of these decisions, mills should expedite contracts for raws and whites on priority. Considering the sugarcane available for the current season, mills should start crushing season with production of raw sugar. Mills should take the opportunity of export till March 2019. It should also be ensured that submission of all documents of post export should be expedited and make efforts to market aggressively white sugar in domestic market pan India. With these measures, the carry over stock will be under control that will help the stability in sugar price. It is also a welcome move of the Government of India in releasing the bio-fuel policy in September 2018.

On VSI front, the report highlights the activities undertaken during the year. The Institute is playing a proactive role in the integrated nutrient and integrated disease & pest management through applications of Institute's liquid bio-fertilizers & bio-agents controlling different diseases & pests and maintaining soil & plant health. This endeavor is instrumental in saving chemical fertilizers, improving soil fertility, reducing environmental pollution and enhances sugarcane yield. In collaboration with Bhabha Atomic Research Center (BARC), the Institute has developed bio-stimulator to improve sugarcane yield by inducing abiotic and biotic stress tolerance. The new Indo-UK collaborative project on "Valorising waste from sugarcane industries via innovations in pre-treatment, bio-transformations and process intensification" formulated in association with IITB, IITD & CSIR-IIP from India and Queens's University Belfast, Cranfield University and Nottingham University from UK has been submitted for joint funding from DBT and Innovate-UK. In research area, the Institute is working closely and in co-ordination with CPCB, MPCB, ICAR, IISR, SBI and State Agriculture Universities.

The sugarcane yield and recovery is stagnant over the years in the state. In order to motivate cane growers, the scheme for cane development has been launched to give incentive to sugar mills. The scheme envisages the efforts and implementation by mills in cane development during the planting season i.e 2017-18, 2018-19 and 2019-20 will be considered for award. The first prize will be Rs. 10 million, second Rs. 7.5 million and the third Rs. 5.1 million which will be awarded based on the performance based on different parameters finalized for the scheme. I am happy that 64 sugar mills have participated in this campaign.

The Institute has time and again demonstrated tireless efforts and exemplary dedication of scientists and employees. I take this opportunity to place on record 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

With the increasing stock of sugar in the country and expected bumper sugarcane production in the coming year, Government of India has also taken proactive role in allowing fuel ethanol production from B-heavy molasses & sugarcane juice and has raised the fuel ethanol price to be produced from these feedstock from Rs.47.13 to Rs. 52.43 and Rs. 59.13 per liter respectively (ex-factory). At the same time, fuel ethanol price to be produced from C molasses has been also raised to Rs. 43.46 per liter (ex-factory) for the season 2018-19.

The scope of raw materials to be used for fuel ethanol has been widened and now fuel ethanol can also be produced from B-heavy molasses, sugarcane juice, sugar containing materials such as sugarbeet & sweet sorghum and starch containing materials such as corn, cassava, damaged food grains. Amongst the additional raw materials allowed, B-heavy molasses and sugarcane juice can be directly utilized by the sugar mills for fuel ethanol production in existing distilleries with minimal process and infrastructure modifications.

In view of this policy, sugar mills should take benefit and make ethanol from B-heavy or from direct juice. This will enable the mills to divert sugarcane to ethanol.

This policy of Government of India will provide new opportunities as well as new challenges such as :

1) Technological - to process these new feedstock in the existing set up of sugar mills, distilleries and downstream effluent treatment plants
2) Economical - to understand the economics of diverting sugar through B-heavy molasses and / or sugarcane juice to fuel ethanol production and
3) Other challenges like storing fuel ethanol produced from B-heavy molasses / sugarcane juice separately than fuel ethanol produced from C molasses.

This policy will help to balance the stocks of sugar and ethanol in the country in the coming year. Therefore, the sugar mills should take maximum benefits of this ethanol policy to achieve economic stability.

Hon. President has emphasied the issue of sugarcane productivity and announced scheme of prizes for best performance in cane development programme. In our mills, cane development department needs to be strengthened by giving necessary training to keep themselves updated in latest technologies in cane development. I strongly feel, the mill authorities need to focus on cane development which will help cane growers and mills also.

Dilip Walse-Patil
Vice-President

FROM THE DESK OF DIRECTOR GENERAL

I am indeed very happy to present this 42nd Annual Report of Vasantdada Sugar Institute for the period 2017-18. The Indian sugar industry is passing through a very peculiar situation. Due to higher sugar production in the current sugar season, domestic sugar prices have remained depressed since the commencement of the season. The mills did not get expected realization and they were unable to honor the commitment of cane price. Sugar output this year was 32.28 million tonnes, compared with 20.26 million tonnes in the previous year. India consumes around 25 million tonnes a year.

Following is a brief summary of the prominent activities carried out and accomplishments in various disciplines.

Hon. President, VSI announced the scheme of prizes to give stimulus for the enhancement of seed production, sugarcane production and sugar recovery. A committee comprising of thirteen members formulated under the Chairmanship of Hon. Mr. Dilip Walse-Patil, Vice-President of VSI has finalized various parameters that would be considered for the award. As of now, 64 sugar mills from Maharashtra have participated in this scheme.

During the year under report, a midlate maturing genotype VSI 12121 (VSI 08005) developed at the Institute's Sugarcane Breeding Center, Amboli, has been accepted for the release by Research Finding Release Committee (RFRC) of MPKV, Rahuri to be presented in the Joint Agresco scheduled to be held in May 2018. This genotype is high yielding and high sugared as compared to Co 86032 in Maharashtra. This genotype possesses fast growing tendency than other varieties. It has no pithiness, having slightly high fiber, drought tolerant, good ratooning ability and resistant to foliar diseases and is moderately resistant to borers.

A midlate maturing variety CoVSI 03102 having high cane yield, high sugar recovery, erect growing, resistance to rust and sparse flowering especially in high rainfall areas of Maharashtra has been notified by the Central Seed Committee on 24th January 2018.

In Soil Chemistry, the targeted cane yield of 125 t/ha was achieved in ratoon crop through drip irrigation coupled with bio-fertilizer & 75% RDF using Soil Test Crop Response (STCR) technique of fertilizer application.

The method of humic acid extraction from lignite was developed and prepared potassium humate containing 12% humic acid. In addition, formulation of water soluble solid micronutrient mixture namely VSI- Microsol and production started for soil application and fertigation.

The Institute is playing a vital role in integrated nutrient management and integrated disease & pest management through applications of VSI's liquid bio-fertilizers and liquid bio-control agents to increase the yield of sugarcane, controlling different diseases & pests and maintaining soil health & plant health. These products save chemical fertilizers and also improve soil fertility, reduce environmental pollution and increases sugarcane yield to the extent of 10%.

The Institute is successful in developing special decomposing culture for decomposition of paddy straw. Burning of paddy straw in field causes pollution in environment. But, after decomposition of paddy straw by this culture quality organic compost can be prepared in situ. In addition, Entomopathogenic Nematodes (EPN) has also been developed. Eco-friendly application of EPN prepared in modified liquid medium gave higher count of EPN. This EPN was infective for white grub, top borer and root borer of sugarcane.

The Institute has produced and supplied liquid bio-fungicide & liquid bio-pesticide for control of soil borne fungal diseases and pests. This product was very effective especially for the control of white grub and white fly. The Institute is also engaged in providing guidelines for setting up of liquid bio-fertilizer production units at different sugar mills in Maharashtra and other states for mass transfer of technology.

The Institute recommended "Two soil applications of Chlorantraniliprole 0.4% GR @22.5 kg/ha at the time of planting as well as 60 days after planting followed by light irrigation for effective control of early shoot borer (*Chilo infuscatellus*)".

VSI is one of the knowledge partners along-with Solidaridad Network Asia Ltd., NSL Sugars, Natem Sugars, Osmania University and WaterWatch BV (Eleaf), in a collaborative project with Solidaridad Network Asia Ltd. for increasing water use efficiency in sugarcane growing in India. The project is funded by Netherlands Enterprise Agency, a part of the Ministry of Economic Affairs, Netherlands. The trials of various technologies of increasing water use efficiency and improving sugarcane productivity were conducted during the year.

The Institute in collaboration with Bhabha Atomic Research Center (BARC) had initiated a project of the bio-stimulator development for improving sugarcane yield through inducing the abiotic and biotic stress tolerance. The multi-location field trials of this product were carried on set planted sugarcane with potato, onion, soybean and ground-nut as intercrop. These trials also gave promising results in horticultural crops and it was observed that it is beneficial in drought conditions. The Institute has formulated the proposal for its approval in Joint Agresco scheduled to be held in May 2018 at Dr. BSKKV, Dapoli.

The Institute continues to supply sugarcane breeder's seed to 27 sugar mills for further production of foundation seed on 288.8 ha. In addition, single eye budded settlings are being supplied for further production of foundation on 238 ha to 16 mills to meet the demand of the State. Breeders' seed production was taken on 40.97 ha. Total 0.912 million tissue cultured plantlets of different sugarcane varieties were produced and supplied to the sugar industry and cane growers in Maharashtra.

Under the ICAR seed project training and sugarcane quality seed, micronutrients, bio-fertilizers were supplied to tribal farmers of Ahmednagar and Nasik districts. The farmers were encouraged to adopt new techniques in cane cultivation and this endeavour resulted in increase in average yield to the extent of 20 t/ha.

The Government of India constituted an expert committee under Central Pollution Control Board (CPCB) to avoid pollution of river Ganga by sugar mills. CPCB has awarded assignment to the Institute for preparation of Adequacy Assessment Reports (AARs) of distillery ETPs in the Ganga Basin region. The Institute has completed AARs of 20 distillery ETPs in the Ganga Basin and validation of Adequacy Assessment Reports of another 5 distilleries. Water balance & ETP adequacy reports for 52 sugar mills in the Ganga basin from Uttar Pradesh, Uttarakhand and Bihar were also prepared and validation of AARs of 38 sugar mills have been completed. In addition, AARs of three distilleries of Punjab State Federation of co-operative sugar mills were completed.

The consultancy service of the Institute is aimed at reduction in process steam consumption and at the behest of the Institute fifteen sugar mills have achieved reduction in steam % cane. First time in the history of sugar industry, liquid SO_2 trial was successful at Sant Tukaram SSK for clarification of sugarcane juice.

The Institute is instrumental in providing sustainable solutions for the growth of sugar industry for transforming the sugar mills into integrated sugar complexes. It guided sugar mills for achieving enhanced mill extraction with higher capacity utilization. The Institute is successful in achieving effective plant operations with respect to energy conservation and fuel economy.

The Institute is playing a proactive role in implementation of modernization and expansion, revaluation / rehabilitation and co-generation projects in sugar mills. VSI is involved in 72 bagasse based co-generation projects. Of these, 42 were

synchronized to national grid exporting 383.33 MW surplus power. It is noteworthy that, the co-generation projects executed under the guidance of the Institute have efficiently exported the surplus power as high as 77-78 KW / ton of cane crushed.

Laboratory studies and experiments on research project entitled "Pre-clarification of molasses to improve the performance of alcoholic fermentation" funded by Principle Scientific Advisor, Government of India (PSA, GoI) were successfully completed. PSA, GoI has awarded pilot scale pre-clarification project to the Institute and it will be installed at Daund Sugar Pvt. Ltd. during 2018-19. In addition, a new project entitled "Recovery of Potash from incineration boiler ash and its utilization in agriculture" was also awarded to the Institute.

A new Indo-UK collaborative project on "Valorising waste from sugarcane industries via innovations in pre-treatment, bio-transformations and process intensification" was formulated in association with IITB, IITD & CSIR-IIP from India and Queens's University Belfast, Cranfield University and Nottingham University from UK and submitted for joint funding from DBT and Innovate-UK.

The Institute rendered technical support to various Government departments such as CPCB, SLMPC, DAM and Karnataka State Excise Departments.

The treatment of spray pond overflow prior to disposal has become mandatory since the introduction of new sugar effluent standards by MoEFCC from January 2016. Characterization and treatment studies on this effluent were carried out. In addition, treatment plant for spray pond overflow was designed.

The "Late Kisan Mahadeo alias Abasaheb Veer Award for Environmental Conservation" was introduced from this year to recognize sugar mills/ distilleries with good environmental performance. An award for the best environment officer will also be instituted from the next year.

I gratefully acknowledge the unstinted support and guidance of the visionary President, Hon. Mr. Sharad Pawar. I sincerely 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 appreciating the efforts of 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 obliged for the support of Central Government Departments, State Government Departments, Research Organizations, Agricultural Universities, Savitribai Phule Pune University and Shivaji University to VSI.

Shivajirao Deshmukh
Director General

Inauguration of the workshop "Sugarcane Development Action Plan Programme" by Hon. President, VSI

SUGARCANE DEVELOPMENT ACTION PLAN PROGRAMME

A workshop on 'Sugarcane Development Action Plan Programme' was organized by the Institute under the Chairmanship of Mr. Sharad Pawar, Hon. President of VSI. The aim of this programme was to raise the awareness about the present scenario of cane cultivation and futuristic plan of cane development to improve the sugarcane productivity and sugar recovery. Mr. Dilip Walse-Patil, Vice-President of VSI, members of the Board of Trustees and Governing Council members of VSI, Chairmen, Vice Chairmen, Managing Directors and Officers working in Agriculture department of sugar mills participated in the programme. Mr. Shivajirao Deshmukh welcomed the dignitaries on the dais and invited participants and other officials. A total of 380 representatives from 107 sugar mills participated in this programme in which, 46 Chairman, 32 Vice Chairman, 39 MDs, 82 CDOs, 89 AOs and another 172 participants related to sugar industry participated.

Mr. Walse-Patil highlighted the importance of the programme in his welcome address. Programme was inaugurated by lightening the lamp by Mr. Sharad Pawar and delivered the inaugural address in which he presented scenario of sugar industry in India, in general and in Maharashtra, in particular. He stated that, the farmers of UP achieved first position with the help of adopting modern technologies of cane cultivation and increasing the area under high sugar and high yielding varieties viz. Co 0238, Co 0239 and Co 0118. In the States like Bihar, UP, Haryana and Punjab, the cane & sugar productivity are increasing while in southern states including Maharashtra its lagging behind. In future, by 2025 the need of sugar at national level is 300 - 330 lac tonnes. Therefore, sugar mills should implement cane development schemes on sustainable basis and have action plan of the same with the help of VSI.

Technical presentations were made by VSI scientists as shown in following table. In addition, Mr. Ashok Pawar, Chairman of Raosahebdada Pawar Ghodganga SSK and Mr. Arun Lad, Chairman of Krantiagrani Dr. GD Bapu Lad SSK presented the cane development activities carried out by their sugar mills and its impact on increasing cane yield & sugar recovery.

Name of Scientist	Topic
Dr. RS Hapase, Head, Plant Breeding	Cane variety and season-wise planting & harvesting programme
Mr. SS Katake, Farm Manager	Seed change in sugarcane and settling planting
Mr. PP Shinde, Head, Agriculture Engineering	Drip irrigation for sugarcane agriculture
Dr. DB Phonde, Head, Soil Science	Soil fertility and integrated nutrient management for improving sugarcane productivity
Ms. RR More, Head, Agriculture Microbiology	Bio-compost, bio-fertilizer and bio- pesticides
Mr. BH Pawar, Head, Plant Pathology	Cane development wing and efficient extension services

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, ability to deliver to make a difference and skill to mould opinions and to act as a catalyst of the industry. These are the qualities those 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 1950-70 A.D., there was 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 AD. The Institute adopted "Sanshodhanen Samvruddhi" meaning prosperity through research as it's 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.

Organisation

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 144.

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 40 members has been formed. Three smaller groups or committees of the GC members assist the GC in its overall functioning.

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
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.).
- Research and experimental farms including nurseries and orchards (around 600 acres) along with a check dam and sugarcane breeding center Amboli (34 acres).
- State-of-the-art 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 including students.
- Students' hostel and guest-house (55,000 sq.ft.) and a new hostel (37,000 sq.ft.) with excellent facilities.
- Residential accommodation for employees (41,000 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 the 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 factories, co-generation, energy audit, pollution abatement, application of modern and sophisticated techniques in farms and in factories, appropriate software for sugar factory 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 and 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; Mahatma Phule Agriculture University, Rahuri 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 42 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 Ph.D. 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 Accreditated 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)	**Mr. Sharad G. Pawar** Former Minister for Agriculture and Food Processing Industries Govt. of India	**Chairman**
2)	**Mr. Dilip Walse-Patil** Chairman, National Federation of Co-operative Sugar Factories Ltd.	**Member**
3)	**Mr. Shankarrao G. Kolhe** Founder Chairman, Sanjivani (Takli) SSK Ltd.	**Member**
4)	**Mr. Vijaysinh S. Mohite-Patil** Former Deputy Chief Minister, Govt of Maharashtra	**Member**
5)	**Mr. Ajit A. Pawar** Former Deputy Chief Minister & Minister for Finance, Planning and Energy Govt. of Maharashtra	**Member**
6)	**Mr. Jayant R. Patil** Former Minister for Rural Development, Govt. of Maharashtra	**Member**
7)	**Mr. Balasaheb B. Thorat** Former Minister for Revenue, Khar Lands, Govt. of Maharashtra	**Member**
8)	**Dr. Indrajit Y. Mohite** Former Chairman, Yashwantrao Mohite Krishna SSK Ltd.	**Member**
9)	**Mr. Jaiprakash Dandegaonkar** Director, Purna SSK Ltd.	**Member**
10)	**Mr. Vishal P. Patil** Chairman, Vasantdada Shetkari SSK Ltd.	**Member**

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

GOVERNING COUNCIL

1)	**Mr. Sharad G. Pawar** Former Minister for Agriculture and Food Processing Industries Govt. of India	**President**
2)	**Mr. Dilip Walse-Patil** Chairman, National Federation of Co-operative Sugar Factories Ltd.	**Vice-President**
3)	**Mr. Shankarrao G. Kolhe** Founder Chairman, Sanjivani (Takli) SSK Ltd.	**Member**
4)	**Mr. Vijaysinh S. Mohite-Patil** Former Deputy Chief Minister, Govt of Maharashtra	**Member**
5)	**Mr. Ajit A. Pawar** Former Deputy Chief Minister & Minister for Finance, Planning and Energy Govt. of Maharashtra	**Member**
6)	**Mr. Jayant R. Patil** Former Minister for Rural Development, Govt. of Maharashtra	**Member**
7)	**Mr. Balasaheb B. Thorat** Former Minister for Revenue, Khar Lands, Govt. of Maharashtra	**Member**
8)	**Dr. Indrajit Y. Mohite** Former Chairman, Yashwantrao Mohite Krishna SSK Ltd.	**Member**
9)	**Mr. Jaiprakash Dandegaonkar** Director, Purna SSK Ltd.	**Member**
10)	**Mr. Vishal P. Patil** Chairman, Vasantdada Shetkari SSK Ltd.	**Member**
11)	**Dr. Patangrao P. Kadam** Founder, Sonhira SSK Ltd.	Member
12)	**Mr. Harshwardhan S. Patil** Chairman, Nira-Bhima SSK Ltd.	**Member**
13)	**Mr. Diliprao D. Deshmukh** Chairman, Vikas Ratna Vilasrao Deshmukh Manjara Shetkari SSK Ltd.	**Member**
14)	**Mr. Rajesh A. Tope** Karmveer Ankushrao Tope Samarth SSK Ltd.	**Member**
15)	**Mr. Kallappa B. Awade** Chairman, Jawahar Shetkari SSK Ltd.	**Member**
16)	**Mr. Satej D. Patil** Chairman, Pad. Dr. DY Patil SSK Ltd.	**Member**
17)	**Mr. Yashwantrao K. Gadakh-Patil** Chairman, Mula SSK Ltd.	**Member**
18)	**Mr. Arvindrao J. Gore** Chairman, Dr. Babasaheb Ambedkar SSK Ltd.	**Member**

GOVERNING COUNCIL (Contd.)

19)	**Mr. Ganpatrao S. Tidke** Chairman, Bhaurao Chavan SSK Ltd.	**Member**
20)	**Mr. Shirishkumar S. Naik** Chairman, Adiwasi SSK Ltd.	**Member**
21)	**Mr. Babanrao V. Shinde** Chairman, Vitthalrao Shinde SSK Ltd.	**Member**
22)	**Mr. Madan P. Bhosale** Chairman, Kisanveer Satara SSK Ltd.	**Member**
23)	**Mr. Ashutosh A. Kale** Chairman, KS Kale SSK Ltd.	**Member**
24)	**Mr. Narendra Murkumbi** Co-founder, Vice-chairman and MD, Renuka Sugars Ltd.	**Member**
25)	**Mr. Rohit Pawar** Baramati Agro Ltd., Unit-1	**Member**
26)	**Minister for Co-operation,** Govt. of Maharashtra	**Member**
27)	**President,** National Federation of Co-operative Sugar Factories Ltd.	**Member**
28)	**President,** Maharashtra Rajya SSK Sangh Ltd., Mumbai	**Member**
29)	**President,** National Heavy Engineering Co-operative Ltd.	**Member**
30)	**President,** Deccan Sugar Technologists' Association	**Member**
31)	**Vice-Chancellor,** Savitribai Phule Pune University, Pune	**Member**
32)	**Vice-President,** Maharashtra Council of Agriculture Education and Research	**Member**
33)	**Joint Secretary (Sugar)** Ministry of Food and Civil Supplies, Govt. of India	**Member**
34)	**Director,** National Chemical Laboratory, Pune	**Member**
35)	**Commissioner of Sugar,** Maharashtra State	**Member**
36)	**Commissioner of Agriculture,** Maharashtra State	**Member**
37)	**Director,** National Sugar Institute, Kanpur	**Member**
38)	**Director,** Technical Education, Maharashtra State	**Member**
39)	**Managing Director,** Maharashtra Rajya SSK Sangh Ltd., Mumbai	**Member**
40)	**Director General,** Vasantdada Sugar Institute	**Member**

GOVERNING COUNCIL (Contd.)

INVITEE MEMBER	
1)	**Mr. Jaysinh Mohite-Patil** Chairman, Sahakar Maharshi Shankarrao Mohite-Patil SSK Ltd.
2)	**Mr. Narendra Ghule-Patil** Director, Dnyaneshwar SSK Ltd.
3)	**Adv. Ashok Pawar** Chairman, Raosahebdada Pawar Ghodganga SSK Ltd.
4)	**Mr. Arun Lad** Chairman, Krantagrani Dr. GD Bapu Lad SSK Ltd.
5)	**The Managing Director** National Federation of Co-operative Sugar Factories Ltd.

COMMITTEES

Selection Committee	
Mr. Dilip Walse-Patil	Chairman
Mr. Shankarrao G. Kolhe	Member
Mr. Jayant R. Patil	Member
Mr. Balasaheb B. Thorat	Member
Mr. Harshwardhan S. Patil	Member
Mr. Satej D. Patil	Member
Mr. Babanrao V. Shinde	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	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
Dr. Patangrao S. Kadam	Member
Mr. Diliprao D. Deshmukh	Member
Mr. Arvindrao J. Gore	Member
Mr. Ganpatrao S. Tidke	Member
Mr. Madan P. Bhosale	Member
Mr. Rohit Pawar	Member
Director General, VSI	Member

COMMITTEES (Contd.)

Building & Purchase Committee	
Mr. Dilip Walse-Patil	Chairman
Mr. Vijaysinh S. Mohite-Patil	Member
Mr. Ajit A. Pawar	Member
Mr. Jaiprakash Dandegaonkar	Member
Mr. Vishal P. Patil	Member
Mr. Rajesh A. Tope	Member
Mr. Kallappa B. Awade	Member
Mr. Yashwantrao K. Gadakh-Patil	Member
Mr. Arvindrao J. Gore	Member
Mr. Shirishkumar S. Naik	Member
Mr. Ashutosh A. Kale	Member
Director General, VSI	Member

DG, VSI, felicititating Ms. Rajshree Pathy, Chairperson of Rajshree Sugars & Chemicals Ltd. (TN)

DG, VSI, felicititating
Ms. Reshmi Kumari, Director, Research and Policy, Govt. of Fiji

DG, VSI, felicititating Mr. Hemendra Sharma, Director (DPA-II), Ministry of External Affairs (MEA), Govt. of India

Technical Performance

TECHNICAL PERFORMANCE OF SUGAR MILLS IN MAHARASHTRA SEASON 2017-18 (October to September)

Sugar production scenario

The global sugar output in 2017-18 season was 194.07 million tonnes (raw value) as compared to previous season's production of 179.38 million tonnes (raw value). The sugar production was higher than the consumption (183.62 million tonnes raw value) that results increase in stock to consumption ratio of sugar to 41.31% from 37.73% (2016-17). The average raw sugar prices showed decreasing trend from the beginning of the sugar year. During month of April 2018, average raw sugar price per tonne decreased by US$ 53.13 (from US$ 313.71 to US$ 260.58). Similar trend was observed for white sugar, there was a decrease in price of US$ 33.25 per tonne for the same period (from US$ 373.57 to US$ 340.32). In forthcoming 2018-19 season, sugar output is expected to slightly decrease by 0.70% over 2017-18 season.

The country's opening stock of sugar at the beginning of sugar season 2017-18 was 3.94 million tonnes and the production during the season was 32.25 million tonnes (white value) which was 59.18% more than the last season (20.26 million tonnes) because of increase in sugar production of major states viz. Maharashtra (155.24%), Karnataka (75.48%), Uttar Pradesh (35.39%) and Gujarat (20.22%). There was an increase in area under sugarcane in Maharashtra (42.50%), Gujarat (8.15%) and increase in cane yield by 17.10% in Karnataka over the previous season. In Uttar Pradesh, area & cane yield was increased by 3.42% & 12% respectively over previous season with more area under the high yielding & high sugar content variety Co 0238 that improved sugar recovery percent cane.

Maharashtra produced 10.72 million tonnes (white value) of sugar during 2017-18 and it surpasses the previous high sugar production record of 10.51 million tonnes (2014-15). The Indian Sugar Mills Association (ISMA) estimates the total area under sugarcane in the country to rise by 7.8% to 5.44 million hectares in 2018-19 from 5.04 million hectares in this season, based on satellite images taken at the end of June 2018. This indicates that sugar output is likely to scale record high of 35 million tonnes in the next marketing season and country will start with carry forward stocks of around 10 million tonnes.

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 the 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 fig. 1 and 2 shows the trend of sugarcane and sugar production respectively in major states of the country for the last five seasons.

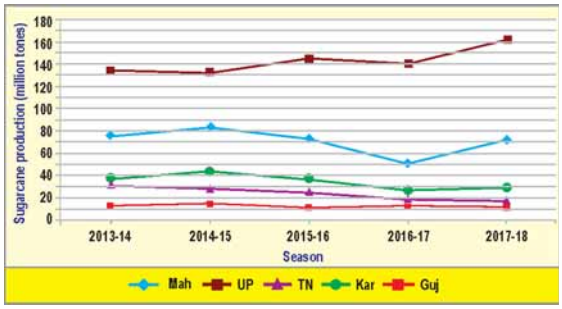

Fig.1 : Trend of sugarcane production

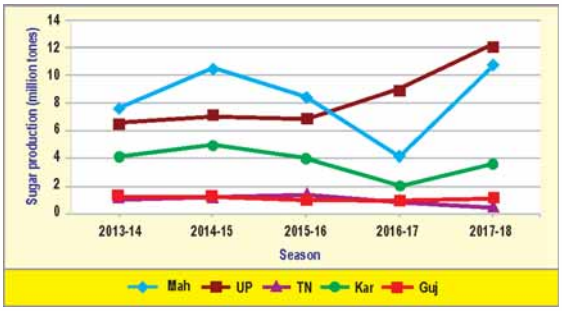

Fig.2 : Trend of sugar production

Government policies on sugar industry

The excess sugar production during current sugar season has adversely affected the market of sugar due to which the ex-mill prices of sugar declined sharply from Rs 3500-4000 per quintal to Rs 2450-2600 per quintal in the month of May, 2018. Sugar mills were unable to pay Fair and Remunerative price (FRP) of sugarcane to cane growers due to low realization from sale of sugar. It has affected financial health that resulted in

accumulation of cane price arrears to the tune of Rs 22,000 crore. Government has been taking various measures to stabilize sugar prices and to help sugar mills for clearing the cane arrears as follows.

- Scheme for financial assistance @ Rs 5.50 per quintal of cane crushed to be paid directly to sugarcane growers on account of cane arrears to offset the cost of cane amounting to around Rs 1540 crore.
- Doubled sugar import duty 50% to 100% and scrapped 20% duty on sugar exports under the Minimum Indicative Export Quota (MIEQ) scheme for 2017-18 to encourage sugar exports and fixing of mill-wise monthly sale quotas (release order mechanism system) of sugar sale. Reducing GST on ethanol to 5% from the existing 12%.
- The Central Government approved Rs 7000 core bailout package on 6th June, 2018 which include creation of buffer stock of 3.0 million tonnes for which Government will reimburse carrying cost of Rs 1175 crore towards maintenance of buffer stock; extending soft loans of Rs 4440 crore through banks to sugar mills for setting up new distilleries (Rs 2240 crore) and installation of incineration boilers (Rs 2200 crore) to augment ethanol production capacity for which Government will bear interest subvention of Rs 1332 crore.
- In order to prevent cash loss and to facilitate sugar mills to clear cane dues of cane growers, the Government fixed minimum selling price of sugar at Rs 29 per kg to support struggling sugar sector. But Sugar mills associations viz. ISMA & NFCSF demanded that Government should fix a minimum ex-mill price of sugar in the range of Rs 30-32 kg and it should be linked to the FRP for sugarcane so that sugar mills will clear the mounting cane price arrears.
- Government has also notified new National Policy on Bio-Fuels, 2018 under which sugarcane juice has been allowed for production of ethanol and fixed remunerative price of ethanol produced from C-Heavy molasses and B-Heavy molasses/sugarcane juice separately for supply under EBP during ensuing ethanol season 2018-19.

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. During current season, State made a historic record of 10.72 million tonnes of sugar production as against 4.20 million tonnes in previous season by crushing 95.35 million tonnes of cane. The sugar production increased by 39.50% as compared to average production of last four seasons. The State's average sugar recovery was 11.27% in 2017-18 season with marginal decrease of 0.05 units over previous season.

The sugar production of state is estimated to be around 11.00 million tonnes in forthcoming crushing season 2018-19 as against 10.72 million tonnes in 2017-18.

Table 1 : Technical performance of sugar mills in Maharashtra (2013-14 to 2017-18)

Particulars	Season				
	2013-14	2014-15	2015-16	2016-17	2017-18
No. of installed sugar mills	216	230	236	238	241
Installed capacity ('000 TCD)	588.60	667.40	702.60	739.70	767.20
No. of sugar mills not in operation	59	48	48	86	53
No. of sugar mills in operation	157	182	178	152	188
Gross days	132	156	124	77	143
Sugarcane crushed (million tonnes)	67.88	93.12	74.30	37.33	95.35
Sugar production (million tonnes)	7.61	10.51	8.42	4.20	10.72
Capacity utilization %	104.78	100.58	102.26	94.05	96.01
Recovery % cane	11.42	11.31	11.38	11.32	11.27
Lost hrs. % to available hrs.	12.01	10.16	9.00	10.00	9.78
Pol % cane	13.36	13.26	13.32	13.23	13.21
Share of State in country's sugar production (%)	31.06	37.12	33.55	19.53	33.24

The contribution of the state in country's sugar production is 33.24% during 2017-18. There are 241 sugar mills in the state having installed sugarcane crushing capacity of 0.77 million tonnes per day. Of these, 138 sugar mills were in co-operative sector and 103 sugar mills in private sector. Cane crushing capacities of these sugar mills vary from 500 to 12000 TCD. During 2017-18, only 188 sugar mills were in operation and remaining 53 could not start their crushing operation.

The zone-wise technical performance of sugar mills for 2016-17 and 2017-18 seasons is given in table 2.

Salient features of crushing season 2017-18

- State made a historic record of sugar production with 10.72 million tonnes which is more than 155.24% as compared to previous season's sugar production (4.20 million tonnes) by crushing 95.35 million tonnes of cane.
- The state's average sugar recovery was 11.27% slightly lower than that the previous season (11.32%).
- Shri Gurudatt Sugars Ltd, Dist. Kolhapur from south zone recorded the highest sugar recovery in the state consecutively two seasons (13.34% & 13.11%).
- In all, 87 sugar mills achieved sugar recovery of 11% cane and above.
- The average pol% cane remained same as that of the previous season (13.23). Thirty sugar mills reported pol% cane of 14 and above.
- The state's average crushing capacity utilization was 96.01% (with slight increase of 1.96 units as compared to the previous season).
- There was a increase in average RME (Mittal) and RBHR(G'rao) as compared to previous season.
- Vitthalrao Shinde SSK and Jawahar SSK reported the highest cane crushing (1.94 and 1.65 million tonnes) and the highest sugar production (0.219 and 0..212 million tonnes) respectively.

Visit of DG, VSI, to Sharayu Agro Pvt. Ltd.

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

Characteristics	2016-17				2017-18			
	South	Central	N-East	State	South	Central	N-East	State
No. of installed sugar mills	56	85	97	238	56	88	97	241
Installed capacity ('000 TCD)	214.65	299.15	225.90	739.70	223.75	317.55	225.90	767.20
No. of sugar mills not in operation	1	24	61	86	5	13	35	53
No. of sugar mills in operation	55	61	36	152	51	75	62	188
Gross days	92	70	64	77	138	146	138	143
Sugarcane crushed (million tonnes)	20.74	12.68	3.91	37.33	30.39	43.47	21.49	95.35
Sugar production (million tonnes)	2.52	1.31	0.37	4.20	3.74	4.75	2.23	10.72
Capacity utilization %	103.44	83.95	75.04	94.05	95.97	98.99	90.82	96.01
Recovery % cane	12.18	10.37	9.58	11.32	12.37	10.92	10.41	11.27
Lost hrs. % to available hrs.	5.89	10.55	19.92	10.00	7.01	7.88	14.64	9.78
Pol % cane	14.07	12.28	11.67	13.23	14.26	12.86	12.46	13.21
Fibre % cane	13.25	13.10	13.11	13.16	13.26	13.11	13.40	13.25
Sugar lost % cane	1.92	1.92	2.10	1.94	1.91	1.96	2.07	1.97
R.M.E. (Mittal)	95.44	94.98	94.15	94.99	95.62	95.15	94.73	95.15
Added water % fibre	202.47	195.27	197.24	198.60	210.30	195.33	200.36	201.17
R.B.H.R. (Gundu Rao)	90.35	89.99	89.81	90.09	90.42	90.00	90.24	90.19
R. O.E. (Mittal- Gundu Rao)	86.23	85.47	84.56	85.58	86.46	85.64	85.48	85.82
Molasses % cane	4.08	4.33	4.76	4.23	4.05	4.32	4.70	4.32

Services

HUMAN RESOURCE DEVELOPMENT

Human resource development (HRD) is a series of organized activities, conducted within a specified time and designed to produce behavioral changes. HRD develops the key competencies that enable individuals in organizations to perform current and future jobs through planned learning activities.

Rapid growth of modern technology is the most significant source and obligatory factor and it should be adopted and implemented for effective function and principal procurement of industry. Highly resourceful experts from the Institute consistently striving to discover growing innovative scientific, 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 to flourish their growth.

Training is an important activity in HRD. It is an investment in personnel, as the persons working in any organization are of utmost importance for success in all endeavors. The Institute has designed a number of courses / training programmes to cater to the need of the sugar and allied industry for varying duration, covering wide range of disciplines to enable a trainee to imaginatively understand the value and utility of modern technologies to achieve desired results. The Institute has established state-of-art laboratories to offer world class practical training to students of different disciplines. These laboratories have latest equipment for research, thereby students get not only experience of such sophisticated instruments but they are trained to handle the live issues in the laboratories under effective supervision of experts. Excellent hostel facility is available for national and international students.

The courses conducted are classified as under

- Regular
- Short Term
- Special
- Customized for Foreign Students
- For Sugarcane Farmers (men and women)

The Institute is recognized as a research institute by renowned Universities from the state like Savitribai Phule Pune University, Pune; Mahatma Phule Agriculture University, Rahuri and Shivaji University, Kolhapur for PhD degree. Scientists from this Institute have been recognized as guides for PhD students of these Universities.

The Institute also conducts two master degree courses affiliated to Savitribai Phule Pune University viz. MSc (Environmental Sciences) and MSc (Wine, Brewing & Alcohol Technology)

The various courses conducted by the Institute aim at improving skill, qualification and technical proficiency of the personnel employed by sugar & allied industry. Students across the country and abroad enroll for various courses conducted by the Institute.

Regular courses

The Institute conducts regular courses of various durations ranging from six months to two & half years. The list of the regular courses, their duration and the number of students enrolled in each course is given in the table 1.

Mr. Pandurang Shitole, renowned expert in the field of organic farming delivering a lecture

DG, VSI, felicitating Dr. Tapas Bhattacharya, Vice Chancellor, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Table 1 : Courses offered and students enrolled

Course title	Duration (Years)	Number of students		
		Maharashtra	Other States	Total
(I) POST GRADUATE DIPLOMA				
Sugar Technology	2 1/2	09	04	13
Industrial Fermentation & Alcohol Technology	1 1/2	48	18	66
Sugar Engineering Diploma	1 1/2	09	07	16
Sugar Instrumentation Technology	1 1/2	01	01	02
(II) MASTERS DEGREE (affiliated to Savitribai Phule Pune University)				
MSc Environmental Sciences	2	14	00	14
MSc Wine, Brewing and Alcohol Technology	2	19	05	24
(III) CERTIFICATE COURSES (AVSI)				
Sugar Engineering	1 off season	08	05	13
Sugar Manufacturing	1 off season	16	03	19
Sugar Boiling	1/2	08	09	17
Total		**132**	**52**	**184**

The year of commencement of the course and total number of students passed out (Table 2) and the number of foreign students passed out since inception of the Institute (Table 3).

Table 2 : Courses and number of students since inception

Programme	Year of commencement	Students
Sugar Technology	1981	1520
Sugar Engineering Certificate	1981	485
Sugarcane Development	1982	132
Sugar Instrumentation Technology	1984	349
Sugar Engineering Diploma	1984	375
Industrial Fermentation & Alcohol Technology	1985	1977
Microprocessor & Computer Controlled System for sugar & allied Industries	1986	52
Environmental Sciences	1992	497
Pulp and Paper Technology	1992	82
Sugar Boiling Certificate	1992	1341
Sugar Industrial Management	1992	12
Industrial Safety	1992	04
Juice Supervision Certificate	2000	149
Sugar Manufacturing Certificate	2005	449
Wine, Brewing & Alcohol Technology	2011	145
ETP Operation & Maintenance	2013	13

Table 3 : Number of foreign students since inception

Name of country	Students
Sudan	69
Nepal	38
Uganda	16
Kenya	09
Ethiopia	08
Tanzania	07
Bhutan	03
Sri Lanka	02

Short term courses

In addition to regular courses, the Institute also offers short term courses to fulfill the specific needs of sugar industry. The list of such courses organized is given in table 4.

Sponsored training programmes

The Institute conducted the following sponsored training programmes (Table 5).

Table 4 : Short term training programmes

Duration	Topic	No. of Participants	Details of Participants
	A) Industrial Training		
Jun.12 - 16, 2017	Juice clarification and evaporation	49	Juice supervisors from sugar mills
	Pan boiling and centrifugation	76	Pan attendants and centrifugal mate
	Boiler attendant	20	Boiler attendants from sugar mills
	Mill foreman	25	Mill foreman from sugar mills
	Co-generation	10	Sugar engineers from sugar mill
	Fermentation and distillation	19	Fermentation and distillation operative
	techniques in distillery		in distillery
	Techniques in analytical instrumentation	07	Lab. chemists and manufacturing chemists from sugar mills
	Repairs and maintenance of sugar factory instruments	25	Instrumentation mechanics, electricians from sugar mills
	Pollution control and environmental management in sugar mills and distilleries	08	Sugar mill environment officers, chemists and other related staff
Jun.19 - 23, 2017	ETP operation & maintenance	19	ETP operators from sugar mills
	Total (A)	**258**	
	B) Farmers' Training		
	Batch - I		
Jun.20 - 24, 2017	Oos Sheti Dnyanlaxmi	96	Women farmers from regional areas of sugar mills in Maharashtra
Jun.27 - Jul.1, 2017	Oos Sheti Dnyanyag	183	Farmers from regional areas of sugar mills in Maharashtra
Jul.4 - 8, 2017	Oos Sheti Dnyanyag	189	
Jul.11 - 15, 2017	Oos Sheti Dnyanyag	194	
	Batch - II		
Nov.13 - 17, 2017	Oos Sheti Dnyanlaxmi	146	Women farmers from regional areas of sugar mills in Maharashtra
Nov.21 - 25, 2017	Oos Sheti Dnyanyag	223	Farmers from regional areas of sugar mills in Maharashtra
Nov.28 - Dec 2, 2017	Oos Sheti Dnyanyag	212	
Dec.5 - 9, 2017	Oos Sheti Dnyanyag	190	
	Total (B)	**1433**	
	Total (A + B)	**1691**	

Table 5 : Sponsored training programmes

Date/Period	Topic	Sponsor	Number of partici-pants	Details of participants
Jun. 15-16, Aug. 29-30, Oct. 25-26, 2017	Increasing water use efficiency in sugarcane	Solidaridad, India NSL Sugars Ltd. Koppa Unit, Karnataka	133	Extension officers working in NSL Sugars Ltd., Koppa Unit, Karnataka
Aug. 22-23, Sep. 5-6, 2017	Increasing water use efficiency in sugarcane	Solidaridad, India NSL Sugars Ltd., Telangana	93	Extension officers working in NSL Sugars Ltd., Telangana
Oct. 1, 2017	Sugarcane seed multiplication and production technology	Indian Council of Agricultural Research (ICAR)	113	Agril Assistants and seed nursery farmers from 30 sugar mills
Dec. 12-13, 2017	Modern Technologies in Sugarcane Agriculture	ATMA, Nashik;ATMA, Tasgaon	50	Sugarcane growers from Nasik District and Tasgaon Tahsil of Sangli District
Dec. 15-16, 2017	Modern Sugarcane cultivation	Divisional Joint Director of Agriculture, Latur and Aurangabad under National Food Security Mission (NFSM). ICAR - Seed project (tribal sub plan)	63	Officers and staff of Agril. Dept of MS.Sugarcane growers of tribal area of Kadwa SSK
Dec. 18-20, Dec. 21-23, Dec. 27-29 2017 (3 batches)	Modern Technologies in Sugarcane Agriculture	SOLIDARIDAD – South and South East Asia, New Delhi; International Finance Corporation (IFC), World Bank Group, PEPSICO and MARS	575	Sugarcane growers from operational area (Ajara, Chandgad & Gadhinglj tahsils of Kolhapur Districts of MS) of Olam Sugar, Chandgad, Kolhapur
Jan. 11-12, 2018	Modern sugarcane cultivation	Divisional Joint Director of Agriculture, Latur and Aurangabad under National Food Security Mission (NFSM) ATMA, Miraj & Tasgaon of Sangli District of MS	94	Officers and staff of Agril. Dept of MS.Sugarcane growers from Miraj & Tasgaon of Sangli District of MS
Jan. 22 - 24, 2018	Advance practices in sugarcane cultivation	ITC sponsored DSC Junnar BIAF Parner.AFARM, Srigonda	124	Progressive sugarcane growers from Ghod River command area (Junnar, Parner, Srigonda Tahsils of Pune Districts)
Jan. 29 - Feb. 2, 2018	Modern Technologies in sugarcane agriculture	Bhimashankar SSK, Pune	85	Progressive sugarcane growers from the area of Bhimashankar SSK
Jan. 29 - Feb. 3, 2018	Advanced technologies in sugarcane agriculture	Director, Lal Bahadur Shastri Ganna Kisan Sanstha , Lucknow, UP	22	Progressive sugarcane growers (20) & Officers (2) from Uttar Pradesh
Feb. 5 - 9, 2018	Modern Technologies in sugarcane agriculture	Pad. Dr. D Y Patil SSK, Kolhapur	145	Progressive sugarcane growers from the area of Pad. Dr. D Y Patil SSK
		Total	**1497**	

Customized courses for foreign students

The Institute organized special short term training programmes exclusively for the international students. The special training tremendously enhances the confidence to become a highly resourceful and determination to practice professionalism.

Countries like Ethiopia, Uganda, Kenya, Tanzania, Sudan, Vietnam, Nijeria and Fiji sponsored their students to undergo customized Short Term and Long Term Courses.

Summer training

The Institute is more concerned to offer opportunities every summer to students from different institutions to participate in short term training and project work. The institute has a sound infrastructure coupled with state-of-art laboratories and also highly professional, efficient and experienced faculties. Considering the need, requirement for the students and the industries, the summer training module is designed as the best potential source, to deliver optimum knowledge to students to elevate self-esteem and become an asset to the industry.

Around 49 students successfully completed their summer training and project assignments. The details are in the table 6.

Training on communication skill

The ability to communicate effectively with superiors, colleagues and staff is essential no matter with which industry you are associated with. Having excellent communication skills is a valuable asset that is advantageous while presentations in a class, interviews, debating a point and many ways in different situations. To be successful in any role, one needs to understand himself and others and know-how techniques to build and develop effective relationships with clients and colleagues. Therefore, the Institute has introduced a subject of communication skills to help in effective writing, dialogue with customers & employees as well as skills for training.

Placement

The Institute shares the responsibilities in securing job opportunities to the students by inviting various companies for campus recruitment. The aim of Training & Placement Cell of the Institute is to place the students in competitively good companies by identifying their knowledge skills, attitude matrix, creating job profiles, identifying areas of training and methods as per the training requirement. Formulate sequence of activities to meet the training schedules for appropriate placement.

Table 6 : University-wise breakup of students

Name of the University	Students
Savitribai Phule Pune University, Pune	22
Mahatma Phule Krushi Vidyapeeth, Rahuri	10
Shivaji University, Kolhapur	6
Swami Ramanand Teerth Marathwada University, Nanded	6
Solapur University, Solapur	2
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli	2
Karunya University, Chennai	1
Total	**49**

Delegates for the seminar
'Art of brewing and operational excellence'

Certificate award ceremony to the participants of
Fiji Sugar Corporation (FSC) for the advanced course

LIBRARY

The Institutional repository for literature on sugar & allied industries is developed and maintained by the library and information section. It plays inevitable role for institutions of higher learning by preserving the research output, technical literature generated by scientists and technocrats. It helps in bringing scholarly work at one place for the benefit of researchers and technical personnel.

The primary responsibility of library is the procurement of learning resources and building systematic collection based on users' needs. The acquisition process was carried out for 48 books, 78 bound volumes of periodicals and 4 Indian standards to the library collection. Thus, the total collection of library rose to 18993. These documents include books, bound volumes of research and technical periodicals, seminar/ workshop proceedings, etc. In addition, 41 periodicals subscribed and renewed along with 350 e-journals and websites were made available for the users.

In order to keep the agro-industrial sugar sector update in the methodologies and technological advances related to growing and processing of sugarcane, library has provided services to a large number of users in the industry and institutions such as :

- Technical Information Services
- Document Delivery Service
- Reference service to the visitors through the internet facility
- Articles of research and technical journals were provided to the staff through LAN facility

Technical processing section

Classification, cataloguing, indexing and data entry of newly added books, including journals and Indian standards were completed using Library Management Software SLIM21.

Circulation and dissemination of information

The circulation activity is one of the key services of the library. It provides lending services and facilities for loaned items and renewal of library materials. During the year, 490 students of diploma and post graduate courses along-with the technical staff and researchers were beneficiaries.

Circulation statistics

- Books circulation: 9150+
- Books/Journals issues consulted : 7200+
- Research and technical articles : 756+
- Technical papers from conference proceedings: 280+
- Indian standards made available : 24+

Special achievements in library automation

Library has drag and drop a scanned and downloaded book cover image file form a folder on their machine into the specified area of the SLIM 21 and uploaded cover image set it in SLIM 21. Uploaded book cover image helps to user for locate books with minimum time on the book racks.

Use of web OPAC

VSI library started the use of Online Public Access Catalogue (OPAC) which is indispensable information retrieval tool of the library. The students and other users make use of this facility to access library resources.

Role of library in farmers training programme for sugarcane cultivation

Scientists from agricultural division organizes various extension programmes to reach to thousands of sugarcane farmers and to make them aware of latest sugarcane cultivation techniques with the help information available in library.

Visit of team from Mauritius

Library has renewed its membership of important national and International associations related to sugar & allied industries. These includes :

- Australian Society of Sugarcane Technologists, Australia (ASSCT);
- International Society of Sugarcane Technologists (ISSCT);
- International Consortium for Sugarcane Bio-technology, Hawaii (ICSB);
- Sugar Industry Technologists Inc., New York (SIT);
- Biotech Consortium of India Limited, New Delhi (BCIL);
- Sugar Technologists Association of India, New Delhi (STAI);
- Maharashtra Economic Development Council, Mumbai (MEDC);
- Maharashtra Chamber of Commerce, Industry & Agriculture, Pune (MCCIA);
- Indian Association of Special Libraries & Information Centers, Kolkata (IASLIC).

The information in the form of newsletters, industry alerts, press news etc. received from these associations was circulated to the concerned technical and scientific staff.

New additions to the library were communicated to the users through VSI bulletin, a web journal of the Institute. The scientists and technocrats from industry and organizations are the beneficiaries.

Important publications of VSI such as Oos Sheti Dnyanyaag (Marathi and Hindi), Technical performance of sugar mills in Maharashtra, Financial performance of sugar mills in Maharashtra, Technical performance of distilleries in Maharashtra, Surplus power co-generation in sugar industry are made available to the users at a nominal price.

Technical Reports

Technical Reports

- Agricultural Sciences and Technology
- Sugar Technology
- Sugar Engineering
- Alcohol Technology and Biofuels
- Environmental Sciences
- Electronics and Computer
- Instrumentation

Agriculture Sciences and Technology

AGRICULTURAL SCIENCES AND TECHNOLOGY

Sugarcane is an important cash crop from farmers point of view and sugar industry has brought about unprecedented development in the rural area of the Maharashtra state. Sugarcane is preferred by the farmer for the obvious reason that it is a sturdy crop having few pest and diseases. It also has a better drought tolerant capacity compared to other crops. Sugarcane is having assured market and its cultivation practices are specified which have brought in an ease in its cultivation. Sugarcane also gives more return than any other crop. Moreover, many sugar mills help growers by supplying inputs such as seed, fertilizer, manure etc. With the result, wherever there is a possibility of sustainable water sufficiency for the duration of the crop, the farmer invariably prefers sugarcane. Farmers are best judges and decision makers for selecting type of crops to be grown on his own lands.

The estimated requirement of sugar in the country in 2025 will be around 30-33 million tonnes. Considering the national commitment to food security and requirement of land for food-grains, there are limitations to increase area under sugarcane in near future and the only solution lies in increasing the productivity per unit of land and enhancing the sugar recovery. The industry always suffers from cyclic phenomenon. Moreover, sugarcane being a perennial crop requires assured water. The major area of the country is dependent on Monsoon. The Monsoon is having inherent characteristics such as uncertainty, uneven distribution, variation in occurrence and most importantly dry spells of longer duration coupled with climate change. Drought is a common phenomenon. Apart from other hazards like pests and diseases, sustainable irrigation assumes greater challenge. If the sugar industry has to thrive profitably, all these issues need to be addressed squarely.

It is always desirable that there should be meaningful co-ordination between irrigation and agriculture department for the welfare of farmers. The basic mandate should be how to harness maximum rain water by arresting runoff to increase the ground water level. The agriculture scientists should tackle the issues of efficient use of available water and conservation of the moisture in the soil. The cropping pattern to be prescribed by the authorities and to be followed by a community is a debatable issue. The land holding size and the water availability with the farmer coupled with the market prospects of that crop are the cardinal points while formulating the scheme of crop pattern. Therefore, the farmer becomes the focal point for preparation and implementation of the cropping pattern.

In sugarcane, the water requirement varies with the climatic conditions soil texture, temperature, atmospheric humidity, agronomical practices, growth duration of the crop.

The sugarcane based sugar and allied industry is technically and economically most feasible and therefore diversification of sugarcane to other crops appears to be a difficult preposition. Such diversification will adversely affect not only the farming community but the livelihood of dependent technical manpower, workers, labours, small stake holders will also be affected badly.

Sugarcane agriculture in the state is facing many problems like increased cost of production, depleting natural resources, climate change, non-availability of labour, emerging pests and diseases that have affected the cane productivity. Cane growers generally use huge quantity of seed but appropriate seed programme is not being followed. Tissue culture technique can be used for rapid multiplication of newly developed varieties and rejuvenation of old varieties under cultivation. Preservation of soil fertility and improving fertilizer use efficiency with integrated approach is becoming vital for sustainable productivity. For efficient use of water, methods like paired row planting, drip irrigation and trash mulching could be of use to economize irrigation water during water scarcity periods. Shortage of labour at reasonable rate is the major concern in sugarcane cultivation. To ease the problem of paucity of labour, mechanization is the only option to carry out all the operations. Around 40 to 45% area is under ratoon crop and under proper cultivation practices of ratoon managements it has been proved that ratoon crop also gives better yields.

The department is grouped in to three divisions viz. crop improvement, crop production and crop protection. The prominence is given on need based R & D, technology transfer through various

extension means and human resource development for the personnel working for sugarcane agriculture in the sugar mills.

The crop improvement division has focused on the development of varieties suitable for sugarcane growing agro-climatic zones in the state through hybridization, mutant development and advanced tools of molecular biology and genetic engineering. It maintains the nucleus seed of cane varieties under cultivation and produces breeder seed through conventional seed production process and tissue culture technique.

The crop production division is developing best agronomical practices and scientific basis for enhancing and sustaining soil fertility and productivity. The division explores efficient fertilizer management technologies of Soil Test Crop Response (STCR) through fertigation integrated with bio-fertilizers. Humic acid extracted from lignite blended with chemical fertilizers also showed better role in nutrient availability in the soil. Focus is also laid on the assessment of soil fertility by GPS/GIS technique. More emphasis is given on R & D in the area of soil microbiology, mass production and quality control of liquid bio-fertilizers, liquid bio-control agents vermicompost. The division produces multinutrient liquid fertilizers to fulfill the demand from sugar mills & cane growers and gives analytical services of soil, water, plant, inorganic fertilizers, bio-fertilizers, compost, sugar component of drip irrigation systems.

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

Besides R & D activities, the focus of department is mainly on the transfer of latest technologies to cane growers and staff of the sugar mills through monthly workshops, seminars, field demonstrations & exhibitions and training activities.

RESEARCH AND DEVELOPMENT

CROP IMPROVEMENT

The division comprises of three sections viz. Sugarcane Breeding, Tissue Culture and Molecular Biology & Genetic Engineering which are mostly related to the development of genotypes having features of high yield and high sugar.

SUGARCANE BREEDING

The varieties are evolved to posses high cane yielding capacity with high sugar content possessing resistance to diseases & pests so as to be beneficial to both farmers and sugar mills. High sugared varieties with higher fibre content and multiratooning ability will have to be produced for meeting the projected sugar and energy requirements. In Maharashtra State, the emerging varieties will play a very important role that should have resistance to abiotic stresses like drought, salinity, water logging and high temperature. 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 the primary objectives of the breeding programme. To fulfill these objectives following long term research programmes were 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)] breeding trials for locating the most suitable varieties from the entries of the research centers of the peninsular zone.
- Sugarcane germplasm, expansion, evaluation, characterization and utilization.
- Screening of genotypes for drought and salinity tolerance.

Breeding of new sugarcane varieties

Release and pre-release of varieties

VSI 12121 (VSI 08005)

VSI 12121 (VSI 08005) a mid-late maturing sugarcane genotype was pre-released in Joint AGRESCO meeting of four Agricultural Universities (Fig 1). It has given 18.85% higher cane yield (141.24 t/ha), 23.47% higher sugar yield (CCS) (20.31 t/ha) than the mid-late maturing standard sugarcane variety Co 86032 (cane yield: 118.84 t/ha; sugar yield: 16.45 t/ha). It has good ratooning ability, less susceptible to internode borer and moderately resistance to smut, red rot & rust diseases. It is recommended for commercial cultivation *adsali*, pre-season and *suru* planting season in Maharashtra. The proposal for the release of this variety was prepared and submitted to MPKV, Rahuri.

Fig 1: Field view of genotype VSI 12121 (VSI 08005)

Elite selections from Final Varietal Trial (FVT)

Total three elite clones were tested and evaluated from 2013 batch in FVT- I Plant and presented in table 1. One genotype CoVSI 14-22 was recorded significantly superior for sugar yield over the standards CoM 0265, Co 86032, VSI 434 and CoC 671. Two clones CoVSI 14-22 and CoVSI 59-20 were found significantly superior over the standards Co 86032, VSI 434 and CoC 671 for cane yield; however, none of the genotype found significantly superior over standard CoM 0265. With respect to the sucrose percentage, two genotypes CoVSI 14-22 and CoVSI 59-20 were significantly superior over the standards Co 86032 and CoM 0265.

State level Multi-Location Trial (MLT)

State level multi-location trials were conducted at VSI, Pune; CSRS, Padegaon; RS & JRS, Kolhapur and SRS, Pravaranagar in collaboration with MPKV, Rahuri. Total six trials viz., MLT-II Plant- *Adsali*, MLT-II Plant- Pre-season and MLT-II Plant-*Suru* along with the ratoon crop of Plant I of respective seasons (*Adsali*, Pre-season and *Suru*) were conducted at VSI. Data on two plant crops and one ratoon crop is given in table 2. Total seven genotypes viz. PDN 13001, PDN 13002, PDN 13004, PDN 13007, PDN 13011, CoVSI 05058 and VSI 07001 were evaluated along with standards Co 86032, CoM 0265, VSI 434 and CoC 671 in *adsali*, pre-season and *suru* season.

In MLT- *Adsali,* none of the genotype found to be significantly superior for cane yield and sugar yield over Co 86032 and CoM 0265 (Table 2a).

In MLT- Pre-season, two genotypes PDN 13002 and PDN 13007 were found significantly superior for cane yield over the standards Co 86032, VSI 434 and CoC 671. However, none of the genotype found significantly superior for cane yield to CoM 0265. None of the genotype was found significantly superior to standards CoM 0265 and Co 86032 for sugar yield (Table 2b).

In MLT- *Suru,* only one genotype PDN 13007 was found to be significantly superior for cane and sugar yield over the standard Co 86032. None of the genotype found significantly superior for cane and sugar yield over CoM 0265 (Table 2c).

Table 1 : Performance of new sugarcane genotypes in FVT - I Plant (2013 Batch) at 12th month

Clone	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
CoVSI 59-20	21.73	155.01	19.41	14.02
CoVSI 14-22	23.02	159.69	20.03	14.42
Co 86032 (Std.)	19.26	142.36	18.79	13.53
CoM 0265 (Std.)	20.52	163.00	17.56	12.59
CoC 671 (Std.)	18.41	119.86	21.05	15.21
VSI 434 (Std.)	18.44	121.17	21.30	15.39
CD 0.05%	2.02	10.66	0.61	0.56
CV%	6.93	7.18	2.18	2.02

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

Genotypes	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
a) MLT *Adsali* (16th month)				
PDN 13001	20.37	147.18	19.84	14.20
PDN 13011	19.87	146.07	19.05	13.63
PDN 13002	18.63	150.06	17.42	12.47
PDN 13007	18.60	148.21	18.21	12.81
Co 86032 (Std.)	19.89	137.60	20.60	14.75
CoM 0265 (Std.)	22.60	160.22	19.87	14.14
CD 0.05%	2.49	18.68	0.30	0.23
CV %	7.61	8.01	0.89	0.98
b) MLT Pre-season (14th month)				
PDN 13007	17.77	134.94	18.61	13.25
PDN 13002	17.46	138.57	17.60	12.60
Co 86032 (Std.)	16.26	115.62	19.92	14.17
CoM 0265 (Std.)	19.41	141.53	19.21	13.57
CoC 671 (Std.)	15.06	95.83	21.90	15.75
VSI 434 (Std.)	15.49	98.01	21.91	15.72
CD 0.05%	2.21	14.14	1.02	0.51
CV %	7.85	6.98	1.10	1.15
c) MLT - *Suru* (12th month)				
PDN 13007	18.81	131.60	20.01	14.31
PDN 13011	17.11	121.08	20.20	14.14
PDN 13002	16.21	121.00	18.93	13.45
Co 86032 (Std.)	15.66	112.80	19.60	13.90
CoM 0265 (Std.)	17.86	134.30	18.68	13.32
CoC 671 (Std.)	16.15	102.87	21.93	15.72
VSI 434 (Std.)	16.69	104.22	22.32	16.04
CD 0.05%	1.91	13.96	0.20	0.19
CV %	6.82	7.12	0.61	0.78

Hybridization

In all 1246 clones under different groups are maintained at SBC, Amboli and evaluated for yield and quality parameters. Of these, 61.11% (761.43) genotypes were flowered and total 43 pistils & 31 pollen parents were used as parental lines in crossing program. The ratoon crop was also maintained and most of the pistil & pollen parents were utilized from the ratoon crop during the crossing programme. The sugarcane germplasm included as mentioned below.

Saccharum species	
S. officinarum	52
S. barberi	7
S. spontaneum	25
S. robustum	5
Related genera to *Saccharum*	
Erianthus species	7
Narenga porphyrocoma	1
Inter specific hybrids	110
Indian hybrids	706
Foreign hybrids	35
Genetic stock developed at VSI	298
Total	**1246**

Total 641 gm of fluff was received from SBI, Coimbatore and 4867.94 gm of fluff collected from SBC, Amboli. Details of fluff received are in table 3. The fluff will be sown in June, 2018.

Ground Nursery (GN)

Details of seedlings grown from the fluff received and sown in June, 2017 are given in table 4.

The seedlings transplanted (2016 Batch) as a Ground Nursery-II in field are in table 5. Selected seedling on the basis of millable canes/seedling, HR Brix %, cane diameter, millable height and natural incidence to pests and diseases were forwarded to Clonal trial-I given in table 6.

Table 3 : Details of fluff received from breeding centers

Locations	No. of Crosses / PC / GC	Fluff received (gm)
A. SBI, Coimbatore		
Station crosses	23	432
Poly crosses (PC's)	3	18
General collection (GC's)	4	54
B. DHG, Agali	5	137
Total (A+B)	**35**	**641**
C. SBC, Amboli		
Commercial crosses	63	1,269.62
Germplasm	15	402.58
Poly crosses (PC's)	13	2,789.05
General collection (GC's)	16	406.69
Total (C)	**98**	**4,867.94**
Grand Total (A+B+C)	**135**	**5,508.94**

First clonal and second clonal trial

Out of 68 clones (2015 batch) planted in Clonal Trial-I at VSI, ten clones were selected on the basis of erect growth habit, number of millable canes, sucrose%, cane diameter, millable height, non-flowering, leaf clasping and natural incidence of diseases and pests for commercial purpose.

Pre-final varietal trial (PFVT)

Out of seven clones (2014 batch) planted in PFVT at VSI, only one clone CoVSI 13-9 (cane yield: 160.17 t/ha; CCS: 22.59 t/ha) was found

Table 5 : Details of seedlings transplanted and selections obtained in

Location	No. of Crosses	GNII (2016 Batch)
A. SBI, Coimbatore		
Station crosses	15	8,730
Zonal crosses	07	1,332
Poly crosses (PC's)	13	2,053
General collection (GC's)	07	1,153
Total (A)	**42**	**13,268**
B. DHG, Agali	10	625
Total (A+B)	**52**	**13,893**
C. SBC, Amboli		
Commercial crosses	72	15,948
Germplasm enhancement	16	5,187
Poly crosses (PC's)	14	1,556
General collection (GC's)	16	3,150
Total (C)	**118**	**25,841**
Grand Total (A+B+C)	**170**	**39,734**

Table 4 : Details of seedlings in Ground Nursery-I and II (2017 Batch)

Locations	No. of crosses / PC / GC	GNI	GNII
A. SBI, Coimbatore			
Station crosses	20	14,287	13,696
Poly crosses (PC's)	7	1,007	930
General collection (GC's)	3	109	92
B. DHG, Agali	7	169	150
Total (A+B)	**37**	**15,572**	**14,521**
C. SBC, Amboli			
Commercial crosses	77	16,739	15,776
Germplasm	10	344	312
Polly crosses (PC's)	2	366	350
General collection (GC's)	9	1,489	1,377
Total (C)	**98**	**18,938**	**17,815**
Total (A+B+C)	**135**	**34,510**	**32,683**

Table 6 : Seedlings selected at different locations

Location	No. of seedlings	Clones advanced to clonal trial I
VSI	17,167	91
TK Warna SSK	3,911	19
Sanjivani (Takli) SSK	6,800	33
KA Tope Samarth SSK	3,900	22
Bhaurao Chavan SSK	4,011	09
Manas Agro & Allied Industries	3,945	29

significantly superior over standard Co 86032 (cane yield: 142.36 t/ha; CCS: 19.26 t/ha) for cane and sugar yield whereas same genotype was found significantly superior over standard CoM 0265 for sugar yield (20.52 t/ha). None of the clone was found significantly superior for cane yield over standard CoM 0265 (163.01 t/ha).

Propagation of nucleus seed of promising sugarcane genotypes and released varieties

Planted sufficient seed of CoC 671, Co 86032, CoM 0265, CoVSI 9805, VSI 434, CoVSI 03102 and VSI 08005 varieties after the MHAT treatment by farm section. The observations on the seed plot of varieties CoC 671, Co 86032, CoM 0265, CoVSI 9805, VSI 434, CoVSI 03102 and VSI 08005 were recorded for the assessment of genetic purity. Sufficient quantity of nucleus seed of above seven varieties was made available to the Farm section to grow breeder seed.

- **All India Co-ordinated Research Project on Sugarcane [AICRP(S)]**

As per the approved technical programme of AICRP(S) plant breeding under crop improvement, six trials were conducted. The performance of genotypes in different trials is shown in table 7.

- Initial varietal trial (IVT),
- Advanced varietal trial (AVT) plant I,
- Advanced varietal trial (AVT) plant II (Early group),
- Advanced varietal trial (AVT) plant I Ratoon (Early group),
- Advanced varietal trial (AVT) plant II (Midlate group),
- Advanced varietal trial (AVT) plant I Ratoon (Midlate group)

Table 7: Performance of sugarcane genotypes in AICRP (S) zonal varietal trials

Clones / Genotypes	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
a) Initial Varietal Trial (Crop age: 12th month)				
CoT 14366	21.66	164.88	18.32	13.14
Co 14002	21.14	153.58	19.18	13.77
Co 14023	20.96	158.19	18.44	13.26
Co 14003	20.90	167.26	17.58	12.52
CoC 671 (Std.)	17.26	107.82	22.96	16.00
Co 86032 (Std.)	17.50	124.79	19.56	14.02
CoSnk 05103 (Std.)	15.82	114.17	19.20	13.86
CD 0.05%	1.96	14.11	0.78	0.58
CV %	6.47	6.14	2.10	2.10
b) Advanced Varietal Trial- I Plant (Crop age: 12th month)				
VSI 12121	25.38	174.05	20.28	14.59
CoM 12085	21.64	148.35	20.14	14.58
Co 12012	21.11	149.54	19.57	14.11
Co 12009	21.12	144.32	20.22	14.63
CoC 671 (Std.)	19.12	124.18	21.25	15.40
Co 86032 (Std.)	19.68	139.02	19.62	14.16
CoSnk 05103 (Std.)	18.94	134.61	19.42	14.07
CD 0.05%	2.11	14.13	0.38	0.27
CV %	6.32	6.13	1.72	1.12

Table 7: Performance of sugarcane genotypes in AICRP (S) zonal varietal trials (Contd.)

Clones / Genotypes	Sugar Yield (t/ha)	Cane Yield (t/ha)	Sucrose %	CCS %
c) Advanced Varietal Trial - II Early (Crop age: 10th month)				
CoM 11082	17.29	126.18	19.26	13.70
Co 11001	15.80	124.68	17.87	12.67
Co 11004	15.74	112.76	19.57	13.96
CoC 671 (Std.)	14.51	102.09	19.87	14.22
Co 85004 (Std.)	11.19	79.58	19.66	14.06
Co 94008 (Std.)	13.06	92.85	18.13	13.57
CD 0.05%	1.80	11.50	0.44	0.87
CV%	6.35	7.33	1.32	3.62
d) Advanced Varietal Trial - I Plant Early Ratoon (Crop age: 10th month)				
Co 11001	12.81	97.52	18.40	13.13
CoM 11084	11.11	82.68	18.83	13.43
Co 11004	11.11	79.26	19.55	14.01
CoC 671 (Std.)	10.66	74.83	19.72	14.15
Co 85004 (Std.)	9.57	69.74	19.13	13.72
Co 94008 (Std.)	8.16	62.37	18.25	13.07
CD 0.05%	2.90	21.54	0.21	0.14
CV%	16.25	16.47	0.64	0.66
e) Advanced Varietal Trial - II Midlate (Crop age: 12th month)				
Co 11019	18.58	131.44	19.64	14.12
CoM 11085	16.22	120.36	18.91	13.47
CoM 11086	15.52	118.09	18.49	13.15
Co 11007	15.17	119.68	17.70	12.68
Co 86032 (Std.)	17.06	121.56	19.56	14.05
Co 99004 (Std.)	17.06	115.62	19.60	14.02
CD 0.05%	1.97	14.28	0.56	0.70
CV%	7.06	7.00	2.33	2.09
f) Advanced Varietal Trial - I Plant Midlate Ratoon (Crop age: 11th month)				
Co 11012	18.63	122.89	20.99	15.18
CoM 11085	14.55	103.13	19.65	14.11
CoM 11086	13.28	96.47	19.23	13.77
Co 86032 (Std.)	14.46	102.58	19.57	14.09
Co 99004(Std.)	12.11	84.72	19.86	14.28
CD 0.05%	2.02	15.50	0.99	0.80
CV%	9.08	9.77	2.90	3.30

Sugarcane genetic resources, collection, evaluation, characterization and utilization

Sugarcane germplasm enhancement

Under the genetic base broadening programme of sugarcane, 41 new sugarcane germplasm lines were included in the germplasm maintained at SBC, Amboli.

Germplasm evaluation

The sugarcane database recorded in the flowering sugarcane germplasm lines and other observations like flowering behavior, pollen fertility, HR Brix %, number of millable canes, stalk diameter, stalk height and number of internodes recorded in all available sugarcane germplasm at SBC, Amboli.

Germplasm utilization

Marcotting technique for the controlled crossing was utilized and 924 canes were marcotted. Total 79 bi-parental crosses in hybridization chamber were made at SBC, Amboli along-with twelve poly crosses and sixteen general collections were collected. The sugarcane germplasm developed from intergeneric hybrids between *Erianthus arundinaceus* x *Saccharum* species hybrid as well as inter specific hybrids were utilized in the crossing programme. The back cross from the flowering hybrids of *Erianthus arundinaceus* x *Saccharum* species hybrid with commercial hybrids was effected to introduce the *Erianthus* base sugarcane varieties in future. The foreign hybrids collected from SBI, Coimbatore also utilized in the hybridization programme to create the variability in the existing population.

Cytogenetics studies in distant hybrids of sugarcane

The intergeneric hybrid obtained from *Erianthus* IK 76- 99 (2n=60) x *Saccharum* (2n=110) - 9 was shifted to SBC, Amboli and it was flowered during last year. The chromosome transmission n + 2n (2n=138) was observed in mitotic study. Similarly, the meiotic study was also undertaken of this hybrid when flowered at SBC. This intergeneric hybrid showed closed bivalents at higher frequency (Fig 2a). This hybrid also showed some laggard during meiotic study (Fig 2c). With the help of this hybrid E x S-9 the backcross was performed with commercial varieties and produced seedlings for evaluation.

Utilization of inter-specific hybrids (ISH) involving different species of *Saccharum*

Interspecific hybrids were utilized in the hybridization programme at SBC, Amboli. ISH 154 was identified as a good donar parent for increasing number of millable canes and drought and salinity tolerance. The crosses involving ISH 154 made and obtained good clone from Co 91010 x ISH 154 as 175-53. This clone was shifted to SBC for back cross and used as a pistil parent in the hybridization programme. The cross combination 175-53 x Co 92001 was found good and selected 166-41 clone which is fast growing, increased number of millable canes, height and cane diameter in 7months only (Fig 3). In another *S. robustum* involving crosses 191-3 (Co 419 x ISH 57) was found superior for quality and yield with non flowering nature. These selected genotypes will be tested in the drought and saline situation to identify the genetic stock for tolerance to drought and salinity.

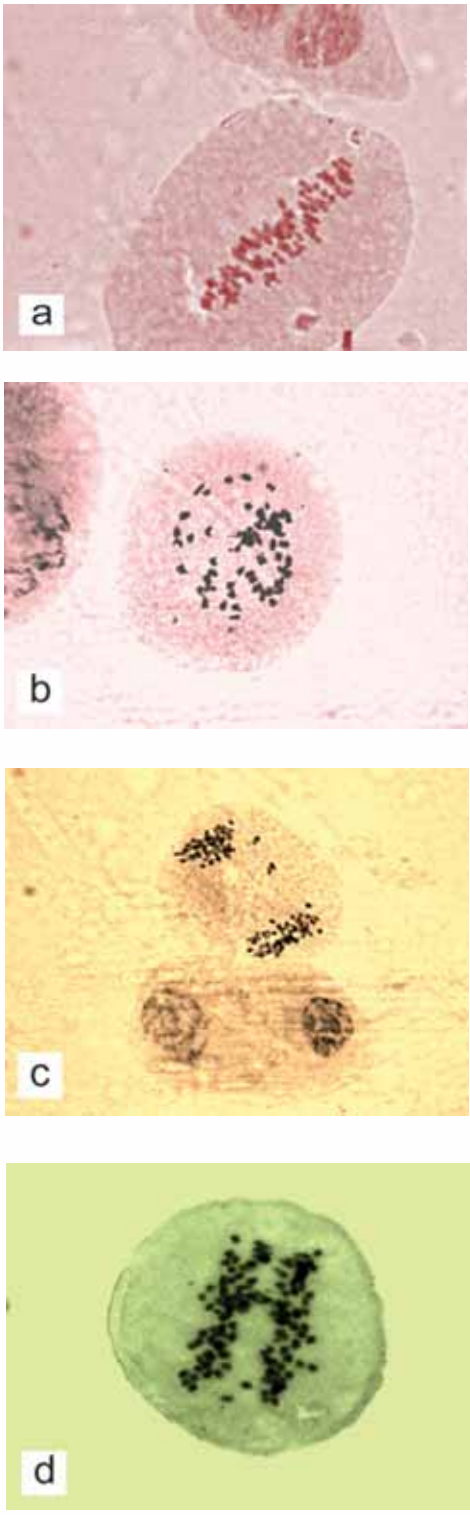

Fig 2: Meitoic stages in *Erianthus* x *Saccharum* intergeneric hybrid. a & b-Metaphase-I;c & d- Anaphase-I

Fig 3 : Clone 166-41 involving ISH 154 (Crop age: 7 months)

Utilization of *Saccharum* related genera i.e. *Erianthus* for identifying high fiber and high biomass genotypes

After confirmation of n + 2n chromosome transmission in intergeneric hybrid obtained from IK 76-99 x CoC 671, some hybrids shifted to SBC, for back cross programme. The intergeneric hybrids flowered at SBC and used massively in hybridization programme and produced back cross generation. The BC_1 from (IK 76-99 x CoC 671) - 9 x F 134 showed improvement in number of millable canes and cane diameter (Fig 4). Such hybrid will be evaluated for high fibre and biomass.

Fig 4 : Clone 143-1 obtained from BC_1 of *Erianthus* (IK 76-99) x *Saccharum* (CoC 671)-9 x F 134

- **Screening of genotypes for drought and salinity tolerance**

The trials were conducted for screening drought and salinity tolerance of six genotypes 199-2, 133-16, 28-25, 36-1, 138-4, VSI 08005 along-with Co 740, Co 86032 & CoM 0265 as standards in two plants & one ratoon crop. Of these, VSI 08005, 133-16 and 138-4 found to be drought tolerant as compared to the standards whereas, 133-16 & VSI 08005 showed salt tolerant.

TISSUE CULTURE

The section is engaged in four different objectives viz. (i) Creation of genetic variability by employing callus culture technique (ii) Sugarcane micro-propagation by employing apical meristem culture technique (iii) Banana micro-propagation and (iv) Development of bio-stimulator.

The callus culture technique is being used for creating genetic variability in sugarcane and developing elite sugarcane varieties having drought tolerance, salt tolerance and disease resistance characters. Sugarcane varieties can be developed from leaf or inflorescence calli developed on suitable medium. This technique is also used for improvement of old varieties of sugarcane. Apical meristem culture technique is being used for large scale production of true to type and disease free plantlets of different sugarcane varieties which are supplied to sugar industry and sugarcane growers of Maharashtra and adjoining states for the production of good quality planting material. It is also used for rejuvenation of old varieties of sugarcane. The planting material obtained from micro-propagated plantlets has the capability of early germination, synchronous with higher germination percent ultimately resulting higher cane and sugar production. Section is also working on banana micro-propagation and producing the plantlets of Grand Naine variety. In addition, the section is engaged in one collaborative project with BARC Mumbai for development of bio-stimulator.

Somaclonal variation

Callus culture technique was used for varietal improvement and development of new varieties of sugarcane. The somaclones were developed and selected on the basis of cane and sugar yield by field performance of last four years and were multiplied for further study at different locations in collaboration with BARC, Mumbai (Table 8).

Sugarcane micro-propagation

Micro-propagation technique is being used for production of breeders' seed and subsequently for the production of foundation and certified seed in three tier system of seed production of sugarcane. The modification and development of micro-propagation protocol for MS 10001, Co 92005, VSI 08005 and Co 0238 sugarcane varieties and development of mother cultures for further multiplication was continued.

Table 8 : Date of the promising clones compared with their parent varieties

Sr. No.	Variety / clones	Yield (MT/ha)		CCS (MT/ha)		Improvement/ morphological variation
		Normal soil	Saline soil	Normal soil	Saline soil	
Co 86032 IRR						
Parent	Co 86032	132.6	37.1	18.2	5.8	
1	TC 4160	179.7	116.6	26.2	18.2	Quality
2	TC 4199	100.6	58.0	13.6	8.5	Distinct variant
3	TC 4209	131.6	49.0	18.6	7.6	Distinct variant
4	TC 4073	92.4	-	12.7	-	Distinct variant
5	TC 4206	159.10	40.6	21.21	5.2	Distinct variant
Co 86032 IRRSS						
Parent	Co 86032	74.70	33.0	10.60	5.1	
6	TC 8733	94.72	39.2	13.26	7.0	Variant with quality
7	TC 8737	87.62	42.3	12.27	6.9	Variant with quality
8	TC 8785	98.62	26.6	14.25	4.5	Distinct variant
Co 740 IRRSS						
Parent	Co 740	109.1	37.7	13.1	5.4	
9	TC 7835	-	75.5	-	11.3	Variant with quality
10	TC 7931	-	70.5	-	10.9	Variant with quality
CoM 0265 IRRSS						
Parent	CoM 0265	96.5	51.5	12.23	8.0	
11	TC 8299	75.38	28.2	10.67	4.4	Distinct variant
12	TC 8457	112.66	32.4	15.78	4.9	Variant with quality
13	TC 8711	92.16	43.5	12.55	6.9	Variant with quality
14	TC 8721	88.35	40.7	12.47	6.5	Distinct variant
EMS selections						
15	2543(VSI 434)	172.98	-	29.77	-	High yielding & quality
16	3489(Co 86032)	143.76	-	19.32	-	Leaf and stem colour variant with quality

Note : IRR= Irradiation, IRRSS= Irradiation & salt selection, EMS= Ethyl methyl sulphonate

Total 0.912 million plantlets of different sugarcane varieties were produced and distributed to the sugar industry and cane growers of Maharashtra and adjoining states as breeders' seed for production of foundation seed and subsequently production quality certified planting material. month-wise and variety-wise plantlets produced & supplied are given in table 14 & 15 under Inputs and Analytical Services.

Banana micro-propagation

Plantlets production of Grand Naine variety of banana was continued and cultures were developed by using different modified media. Subsequently, the plantlets were produced and hardened in suitable potting mixture. In all, 8915 banana plantlets were produced and 5190 plantlets were supplied to banana growers, 275 plantlets were planted at Manjari & Amboli for research and 3000 were in green house under hardening.

Bio-stimulator development

The field trials for studying effect of irradiated bio-stimulator on sugarcane were conducted at CSRS, Padegaon and VSI. The pooled data of two plant and one ratoon was compiled (Fig. 5). It has been observed that there was an increase of 4.3 t/ha in CCS yield and 22.82 t/ha in cane yield. In addition, due to irradiated bio-stimulator sprays there was significantly superior improvements in number of millable canes, average cane weight, millable height, cane diameter, number of internodes and

juice quality which cumulatively contributed to increase cane and sugar yield (Table 9). The B:C ratio obtained was 1:1.65 which indicates that the irradiated bio-stimulator is highly economical for improved sugarcane yield and sugar production. The data has been submitted to RFRC MPKV, Rahuri for the necessary approval from AGRESCO.

Thus, the research outcome of four years multi-location trials showed that the bio-stimulator was economically good input for sugarcane yield improvement.

The silver nano particles using gamma irradiated bio-stimulator synthesized and its antimicrobial activity against sugarcane diseases viz. wilt and pineapple disease has been studied. The synergistic effect of nano composite of silver nano particle and gamma irradiated bio-stimulator was observed.

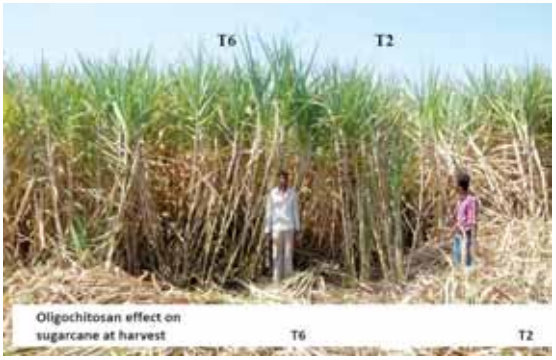

Fig 5 : Oligochitosan effect on growth performance of Co 86032

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 accreditation test laboratory for virus indexing & genetic fidelity tests of tissue culture raised plants under NCS-TCP project.

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

Sugarcane is an important salt-sensitive crop. Traditional breeding efforts are further challenged by its aneuploidy, vegetative propagation and long life cycle. Alternatively, we undertook a radiation mutagenesis approach using CoM 0265, Co 86032 and Co 740 cultivars as parent material for embryogenic callus based gamma irradiation with *in vitro* salt selection. On the basis of agronomic traits and salt tolerance, total 17 clones were selected for further evaluation and molecular characterization. Of these, 10 variant clones (eight variants from Co 86032 and two from CoM 0265) were given to IGKV, Raipur for field performance study. Further, all 17 clones used for molecular characterization using ISSR markers were in progress.

Apart from these, one mutant (4209) from sugarcane var. Co 86032 a salt-sensitive cultivar was used to study stress physiological mechanism at BARC Mumbai. In a pot study (CRD), six leaf stage plants of both genotypes were subjected to

Table 9 : Effect of irradiated bio-stimulator (@ 50ppm) on sugarcane (Variety Co 86032 - *Suru* season)

Agronomic parameter	VSI		CSRS, Padegaon	
	Control	Treated	Control	Treated
CCS (t/ha)	16.42	20.16	13.83	18.68
Yield (t/ha)	127.19	145.08	101.44	129.31
NMC ('000)	90.99	97.31	87.75	98.86
SCW (Kg)	1.39	1.49	1.13	1.31
Millable Height (cms)	255.10	278.60	191.78	245.07
Cane Diameter (cms)	2.97	3.29	3.35	3.35
No. of Internodes	22.68	25.41	17.87	21.94
Brix (%)	20.01	20.85	21.26	22.18
Sucrose (%)	18.20	19.40	19.36	20.45
CCS (%)	12.92	13.92	13.58	14.42

*Sett dipping for 30 min and foliar sprays at 30, 60 and 90 DAP

daily stress regime (50 mM salt solution, 15 days). The growth and photosynthetic features of mutant 4209 were comparable to parent. However under stress, photosynthetic assimilation, photochemical yield and electron transport rate in mutants were significantly higher by 1.2 fold, 47% and 28% respectively, relative to parent. Remarkably, the mutant exhibited significantly improved water use efficiency relative to parent, under both control (1 fold) and stress conditions (2.5 fold). The improved mutant phenotype was also associated with significantly reduced Na^+ ion accumulation (1 fold) and lower MDA levels (25%) in shoots.

Sugarcane improvement through transgenic approach for drought and salinity tolerance

Earlier study on expression of *SoMYB18* transcription factor gene suggested that, it can give protection to plant from drought and salt stress. *SoMYB18* gene transformed T3 generation nine plants were subjected to PCR analysis using gene specific and marker specific primers. About four events (Bio-86-7, Bio-86-2, Agro-86, and Agro-671) were shown positive results with expected amplification repetitively. Further, confirmation by RT-PCR for its expression and copy number by Southern blot hybridization technique was in progress.

Ectopic expression of *Glycinebetaine* accumulating genes (*betA & betB*) for enhanced water deficit stress tolerance in sugarcane is carried out in collaboration with Sugarcane Breeding Institute (SBI), Coimbatore, Tamilnadu. These genes constructs were developed by SBI, Coimbatore and given to VSI for further transformation experiments. Optimization for callus induction in sugarcane variety CoM 0265 was done taking leaf roll disc as initial explants. Hygromycine concentration optimization was done for leaf whorl discs. The effective concentration of Hygromycine was determined in the range of 20 to 25 mg/l for screening the transformed callus. This variety was found more sensitive than Co86032. Transformation of these genes (*betA & betB*) in sugarcane var. CoM 0265 was attempted by biolistic and *Agrobacterium* mediated methods. Gus, as reporter gene was used to trace the transformation protocol. Shoots were regenerated under selection pressure from three batches after transformation that are still under selection process.

Virus indexing and genetic fidelity tests of tissue culture raised plants

VSI is one of the five Accredited Test Laboratories (ATL) under the NCS-TCP management cell of the Biotechnology Consortium India Ltd.(BCIL) under Department of Biotechnology (DBT). ATL is involved in Virus/ quality (genetic fidelity) testing and certification of tissue culture raised plants by commercial tissue culture production units (TCPUs) registered with BCIL. Presently, performs virus indexing: CMV & BBrMV done by using enzyme-linked Immunosorbent assay (ELISA) and BSV & BBTV by polymerase chain reaction (PCR) techniques. Genetic fidelity was tested by using inter simple sequence repeat (ISSR) markers. Gerbera samples tested for CMV using ELISA methods. However, date palm tested for phytoplasma using nested PCR. Leaf samples of banana (13,950), gerbera (8,904) and date palms (247) were analyzed. Samples received from the total 27 TCPUs, out of which 18 TCPUs were involved in Batch certification program. In total 78 batches were certified and 150 reports & certificates of approval were generated.

CROP PRODUCTION

AGRONOMY

The section carried out research on agronomic evaluation of new promising sugarcane genotypes, use of plant growth regulators (PGRs) for enhancing yield and quality of sugarcane, water and nutrient management for sugarcane ratoon under water stress condition, evaluation of new herbicide for weed control in sugarcane. The section is also involved in training to agriculture officers, field staff of the sugar mills, sugarcane growers and teaching to post graduate students. Technical guidance and consultancy to various sugar mills for improving sugarcane productivity through advanced crop management practices especially sugarcane ratoon management under drought situation is provided.

Agronomic performance of elite sugarcane genotypes

The field trial was conducted to assess the performance of various elite sugarcane genotypes. The results of the plant crop indicated that, the early maturing genotype Co 10026 found better with max. germination (67.78%), tillering (0.90 lac/ha), single cane weight (2.13 kg), cane girth (10.66 cm), cane

yield (125.33 t/ha), CCS yield (17.74 t/ha) and B:C ratio (1:2.63) but inferior in juice quality over check variety CoC 671. The midlate genotype Co 10033 found better with tillering (0.96 lac/ha), NMC (0.89 lac/ha), cane yield (177.00 t/ha), CCS yield (22.72 t/ha), B:C ratio (1:3.45) and juice quality over the check variety Co 86032.

Use of plant growth regulators (PGRs) for enhancing yield and quality of sugarcane (Pooled results of three plant crops)

The field trial was conducted to assess the effect of plant growth regulators for enhancing yield and quality of sugarcane with planting of setts (ver. VSI 08005) after overnight soaking in 50 & 100 ppm Ethrel solution and spraying of Gibberlic acid (35 ppm) at 90, 120 and 150 DAP and compared with conventional planting. The pooled results over three plant crops indicated that, maximum germination (62.94%) at 30 DAP, tillering (1.32 lac/ha) at 120 DAP, NMC (0.81 lac/ha), cane girth (11.60 cm), cane yield (167.22 t/ha) and B:C ratio (1:3.17) was recorded when the setts were overnight soaked in 100 ppm Ethrel before planting and foliar spraying of Gibberlic acid 35 ppm at 90, 120 &150 DAP followed by cane yield of 165.23 t/ha in overnight soaking of setts in 50ppm Ethrel and spraying of GA (35 ppm).

Water and nutrient management for sugarcane ratoon under water stress condition (IInd ratoon crop)

(Multilocation trial – CSRS, Padegaon; VSI, Pune and RS JRS, Kolhapur)

The ratoon crop of variety CoM 0265 recorded higher cane yield (139.09 t/ha), CCS yield (19.72 t/ha) with an application of four irrigations than three irrigations. Application of RD NPK 50% at the time of ratooning by crow bar + 50% at the time of onset of mansoon by crow bar + 25% extra K + Calcium silicate @ 400 kg/ha at the time of ratooning by crow bar to ratoon sugarcane produced significantly higher cane yield (157.74 t/ha), CCS yield (20.65 t/ha) and B:C ratio (1: 3.03) than the other nutrient management practices.

Evaluating bio-efficacy of herbicide RJKP 1505 (2,4-D Di-methylamine salt 58% WSC) against weed flora in sugarcane (Two seasons crop).

The two season data of the bio-efficacy trial on RJKP 1505 in sugarcane revealed that RJKP 1505 dose @ 6300-7200 ml/ha has significantly reduced the population and biomass of sedges and broad leaf weeds. The effective weed control (87.0 - 90.9%) by RJKP 1505 @ 6300 - 7200 ml/ha created weed free environment that promoted the growth and cane yield and lead to improved yield parameters such as more no. of tillers, no. of internodes, milliable cane height, single cane weight and in turn resulted in significantly higher cane yield (125 t/ha) and higher B:C ratio (1:2.48) among other herbicidal treatments. Both were followed by the treatment of two hand weeding. RJKP 1505 at all the doses tested ranging from 6300 to 12600 ml/ha did not cause any phytotoxic symptoms and is safe for use in sugarcane. Further, RJKP 1505 @ 6300 and 12600 ml/ha were found to be safe to maize as follow up crop.

SOIL SCIENCE

Sugarcane agriculture is fast losing its sheen owing to declining soil health due to monocropping, soil carbon loss, imbalanced nutrient management, excess use irrigation water. In sugarcane agriculture soil fertility improvement is vital for sustainable soil productivity. Therefore, section has undertaken the research and extension activities on integrated use of organics, balanced nutrients and bio-fertilizers in sugarcane with a view to increase fertilizer use efficiency and reduces the chemical fertilizer use. Research has been carried out on soil test crop response (STCR) targeted yield approach, fertigation technique with bio-fertilizer. Soil application of humic acid shows promising results in soil nutrient availability for enhancing growth and cane yield. This section provides services of soil testing based fertilizer recommendations and technical know-how for establishing soil testing laboratory, soil fertility assessment by GPS-GIS technique, nutrient enrichment of bio-compost and overall soil fertility management. Training services in this regard are also provided. The increased demand of multi-macronutrient & multi-micronutrient liquid fertilizers for foliar application and water soluble solid microsol for fertigation & soil application in sugarcane is fulfilled by improving production.

Use of Soil Test Crop Response (STCR) technology and bio-fertilizers for sustainable soil fertility and sugarcane productivity

The judicious use of STCR technique and soil health & plant health - VSI's bio-fertilizer products

were tested for achieving cane yield target of 125 t/ha in ratoon crop in medium black soil. The data showed that the highest cane yield of 131.82 t/ha (5.4% more than the targeted yield of 125 t/ha) in ratoon crop was achieved by reducing STCR dose of NPK by 25% along with soil health and plant health bio-fertilizers (Fig. 6). However, the target (125.50 t/ha) was achieved in 50% of STCR dose with judicious use of bio-fertilizers. It indicates that fertilizer dose (NPK) can be reduced to 50% of the total dose worked out by STCR technique in conjunction with the bio-fertilizer products to achieve targeted cane yield of 125 t/ha in ratoon crop.

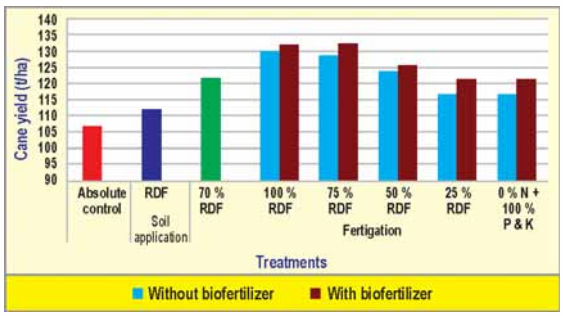

Fig 6 : Use of STCR Technology and bio-fertilizer

Effect of humic acid with chemical fertilizers on nutrient availability, uptake, yield and quality of sugarcane

The effect of soil and foliar application of humic acid was studied on two plant cane and their successive ratoon crops. The pooled results concluded that soil application of humic acid @ 10 kg/ha at the time of planting and after harvest increased cane yield by 22 t/ha and sugar yield by 3.4 t/ha and found economically beneficial (B:C ratio 4.52) as compared to control. The foliar application of humic acid also increased cane yield significantly over control, but soil application was found significantly superior over foliar application. Humic acid application increased the availability of P and K in soil (Fig. 7).

The protocol of the humic acid extraction from C grade lignite and production of potassium humate containing 12 & 15% in liquid form was developed. The field trials were conducted at VSI, Bhimashankar SSK and Datta Shetkari SSK.

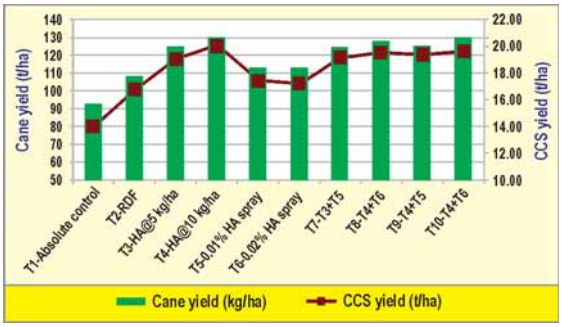

Fig 7 : Effect of humic acid on cane and sugar yield

Development of package of practices for organic sugarcane

The project of organic sugarcane was initiated in 2016-17. Total 0.75 ha area at Manjari farm is certified as per India's National programme for organic production standards (ECOCERT). Conversion period is from 2017-18 to 2019-20. Cropping sequence adopted for organic package is green manuring crop (sunhemp)-cowpea–sugarcane. Actual field trials and cane production as organic product will be started after completion of conversion period.

Integrated application of organics and inorganics in improving soil health and sugarcane productivity

The field experiment was conducted to study the integrated application of organics and inorganics in improving soil health and sugarcane productivity. The pooled results of one plant cane and its two successive ratoon crops showed that the highest cane yield 114.56 t/ha was obtained in the treatment of compost @ 10 t/ha with inorganic fertilizer based on soil test and bio-fertilizer followed by 114.54 t/ha in the treatment of compost @ 20 t/ha with inorganic fertilizers based on soil test. Significantly less cane yield response was obtained in the treatments where organics were not applied (Fig 8).

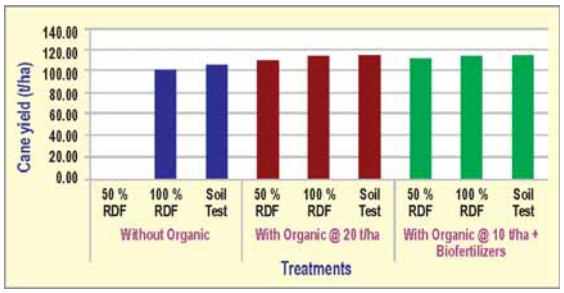

Fig 8 : Integrated application of organics and inorganics in improving soil health and sugarcane productivity

Response of SMART 24:24:0 WSF to sugarcane (*suru*)

The effect of SMART 24:24:0 water soluble fertilizers on cane yield was studied and its relative efficacy of different grades of water soluble fertilizers like 19:19:19, 12:61:0 & 13:40:13 in sugarcane plant cane and ratoon. The pooled results of one plant cane and its successive ratoon crop showed that 80% RDF applied through ferti-irrigation of SMART 24:24:0 water soluble fertilizer with sulphate of potash was found efficient source of NPK for increasing cane and sugar yield as compared to 19:19:19, 12:61:0 & 13:40:13 water soluble fertilizers.

Effect of Zytonic-M on growth, yield and quality of sugarcane

The field experiment was conducted to study the effect of zytonic-M on growth, yield and quality of sugarcane in preseason during 2016-17.The experiment was conducted on moderately alkaline, deep, medium black soil having low in nitrogen, high phosphorus and moderately high potash. The soil was calcareous in nature and sufficient in sulphur and micronutrient content. Application of 100% RDF with drenching of Zytonic M and topdressing of ZMD increased cane yield by 9.3 t/ha over only 100% RDF & found at par with 50% RDF along with drenching of Zytonic M & topdressing of ZMD. It reveals that cane yield remained at par in the treatment of only Zytonic M and ZMD may be due to the inherent soil fertility.

Effect of amorphous silicon on growth, yield and quality of sugarcane

The field experiment was conducted to study the effect of amorphous silicon on growth, yield and quality of sugarcane in *suru* season. The results showed that soil application of Si-Agro A @ 125 kg/ha with recommended dose of fertilizer increased cane yield by 13.4 t/ha and sugar yield by 2.8 t/ha. The cane yield obtained in Si- Agro R, Si-Agro D and Si- Agro S with recommended dose of fertilizer did not show any significant difference.

Economic and environmental impact assessment for UPNRM projects on sustainable sugarcane initiative (SSI) in Maharashtra

The Sustainable Sugarcane Initiative (SSI) is an innovative set of agronomic practices that involves organic manuring, raising seeds in a nursery and seedling planting, wider seed spacing and water & nutrient management through drip to increase the cane yields significantly over conventional practices. The present investigation was to study the economic and environmental impacts of sustainable sugar Initiative (SSI) project implemented in the operational area of two sugar mills viz. i) Datta Shetkari SSK and ii) KA Dr. GD Bapu Lad Kranti SSK in Maharashtra under the NABARD's umbrella programme. This project was sponsored by GIZ and NABARD. The study revealed that the SSI - an innovative set agronomic practices increased cane yield by 45.2% in plant cane and 60.2% in ratoon crop. An important component of SSI drip irrigation which saved 43.5% irrigation water and fertigation technique saved 34.9% N, 39.1% P_2O_5 and 34.7% K_2O over conventional practice of fertilizer application. Intercropping of cabbage, cauliflower, chilli, green gram, green pea, groundnut, tomato, marigold in wider space in sugarcane gave bonus amount within same quantity of irrigation water. Sugarcane found prime source of income, contributed 35 to 55% of the total household income of farming community. SSI has impacted significantly on the farm economics of all marginal to big land holding farmers.

Speech of DG, VSI in International Symposium Sucrosym 2017 at Coimbatore

AGRICULTURAL MICROBIOLOGY

The section deals with basic and applied R & D, mass production and quality control of liquid bio-fertilizers, liquid bio-control agents and vermicompost. Section also provides consultancy for establishment of liquid bio-fertilizers units for mass production, composting of agro industrial waste & its enrichment and vermicompost to the sugar mills in Maharashtra and other states. The section has established a well equipped quality control laboratory in which analysis of sugar, bio-fertilizers, vermicompost, compost and enriched compost samples were carried out.

Laboratory research

Isolation, identification & screening of efficient strains of weed pathogens and development of consortium of their toxins as a bio-weedicide controlling weeds in sugarcane

Isolation, identification and screening of weed pathogens and development of consortium of their toxins as a bio-weedicide was carried out. It was observed that endotoxins of weed pathogens were more potent than exotoxins. In toxicological studies, there was no effect on germination of wheat seeds, sugarcane seedlings, soil bacteria and earth worms. Well diffusion method for the toxicity testing of exotoxins, endotoxins and their combination showed that, there was no detrimental effect on beneficial soil microorganisms.

There were four isolates producing exo-toxins as below:

Isolate	Gram Staining	Characters
1	Negative	motile rods with thick blunt ends
2	Positive	non motile cocci
3	Positive	non-motile rods with slender blunt ends
4	Negative	motile short rods

Repetitive three tests of leaf detachment assay of bacterial exotoxins on *Parthenium* leaves, showed that after 48 hrs at 37 ºC the leaves showed symptoms like yellowing of leaves, black spots, watery lesions and scorching. Complete death of leaves was observed on third day, confirmed capability of isolates causing disease in healthy *Parthenium* leaves. In shoot cut assay of bacterial exotoxins on *Parthenium* leaves showed death of shoot within 6 hrs. Further, pot studies were in progress.

Development of bio-control agents viz. Bio-fungicide and Bio-insecticide

The section has developed liquid bio-fungicide and bio-pesticide (BVM) product. The use of bio-pesticide was demonstrated at farmer's field of Sonhira SSK and Olam Sugars, MP. Around 80-100% grub population get infected due to drenching of BVM (particularly *Beauveria* spp. and *Metarrhizium* spp) @ 3 lit. per ha and 10 to 20% infection probably due to natural disease causing micro-organisms.

The demonstration of liquid bio-pesticide (BVM) conducted at farmer's field of SMB Thorat SSK where 80-100% pest population including eggs, nymph and incipient was found. In this demonstration trial for the control of sugarcane white fly indicated that, *Aleurolobus puparia* get around 80 - 100% infected due to spraying of BVM (particularly *Beauveria* spp. *Verticillium* spp. and *Metarrhizium* spp.) @ 3 lit. per ha and 10-20% probably due to natural disease causing micro-organisms.

Isolation and identification of *symbiotic Photorhabdus bacteria* isolated from Entamopathogenic Nematode (EPN) for mass production by fermentation based technology

The isolated EPN was studied for its infectivity dose. The optimum dose for infectivity was $1x10^4$ per ml for five white grub larvae. It was revealed that the mortality of white grub larvae with this dose occur within 48 hrs.

The media was also modified for production of isolated EPN and symbiotic bacteria. In modified media, the number of EPN increased by $2 x10^6$ IJ/ml which was initially $1 x 10^4$ IJ/ml. It was concluded that the modified liquid medium was suitable for production of EPN.

Effect of application of EPN on top borer, root borer and white grub in laboratory

Eco-friendly application of EPN bio-pesticide suspension prepared in laboratory using white traps on cadavers of Rice moth, *Corcyra cephalonica* larvae ($1.2 x 10^4$ IJs/cm^2) and applied on fresh uninfected first instars larvae of white grub, *Holotrichia serrata,* second instars larvae of top borer, *Tryporrhyza excerptalis* and third instars larvae of root borer, *Emmalocera depresella* collected from sugarcane fields at Naigaon farm

of the Institute. Hourly observations up to 48 hours have indicated that all the three pest larvae gets infected with EPN suspension and it was noticed that EPN (*Heterorhabditis spp.)* and excreted bacteria (*Xenorhabdus spp.* and *Photorhabdus spp.)* developed and multiplied in the midgut of larvae. Infected host larvae killed with 15 days of treatment. It was observed that the original creamy white cadaver turned to red brown. Further studies in pot and field scale are in progress.

Evaluation of decomposition of different waste viz paddy waste by using special decomposing culture for organic compost as solid waste management

The decomposition rate of paddy straw was evaluated by using specially developed decomposing culture upto 120 days in pits. It was observed that the color of treated paddy waste turned to blackish brown and odourless smell turned to earthy odour, particle size was changed to < 0.5 cm. The chemical analysis showed that, the C:N ratio changed from 41:1 to 15:1, N content from 1.12% to 2.00%, P from 1.78% to 2.00% and K from 0.078% to 0.142%.

The microbial count at initial stage was less (Bacteria - 39 x 10^{10}, Fungi - 1 x 10^{5}, Actinomycetes - 3 x 10^{10}) but after applying special decomposing culture, count gradually increased at the peak of decomposition (Bacteria - > 3 x 10^{12}, Fungi 10x$10^{10,}$ Actinomycetes - > 3 x 10^{12}), and at the end of decomposition, the microbial counts decreased. Similar results were also observed in the fields of Ajara SSK. Therefore, it revealed that, paddy straw can be decomposed using specially designed microbial decomposing culture and that have good manure value.

Biological remediation of saline sodic soils by integrated approach through application of inorganic & organic fertilizers and microbial cultures

Four promising halophilic bacteria isolated from saline sodic soil and two bacteria were studied for their efficiency. These six strains were studied for gram staining, motility, biochemical characters, IMViC, enzyme utilization tests, optimization of salt concentration, soil incubation and pot culture. It was found that, all isolates grew optimally in 15% NaCl containing into respective medium.

In soil incubation study, after application of consortia of four isolates (20 ml /kg of soil), EC decreased from 6.25 mS to 4.96 mS and pH decreased from 7.90 to 7.46 after 9 days of incubation. Maximum total microbial count (7.22x10^{12}) was observed on 8th day. In pot culture study, against the root length (13 cm) and shoot length (19 cm) in control, highest root (18.5 cm) and shoot length (25 cm) was observed where isolate no. 4 was applied.

Field research

Effect of application of consortium of agricultural beneficial microorganisms as soil health and endophytic nitrogen fixing bacterial liquid bio-inoculant (plant health) on yield & quality of sugarcane (plant & ratoon)

Field trials indicated that drenching of *soil health* product at 30, 75 and 120 DAP @ 10 lit/ha with 0% N and 50% P_2O_5 & K_2O (70 kg of RDF) gave significantly higher cane yield 128.69 t/ha and sugar yield 19.58 t/ha as compared to control (121.32 t/ha 16.18 t/ha respectively) whereas in ratoon drenching of soil health product at 30, 75 and 120 DAP @ 10 lit/ha with 0% N and 50% P_2O_5 & K_2O gave significantly higher cane yield 98.86 t/ha and sugar yield 14.40 t/ha as compared to control (87.70 t/ha 13.00 t/ha respectively).

Effect of consortium of endophytic nitrogen fixing bacteria on yield and quality of sugarcane ratoon

Field experiment was conducted for evaluation of consortium of endophytic nitrogen fixing bacteria on third ratoon of sugarcane planted in pre-season, s*uru* and s*uru* under drip irrigation.

In 3rd ratoon of pre-season, cane yield (54.45 t/ha) and sugar yield (8.93 t/ha) was found significantly superior due to the foliar application of consortium of endophytic bacteria @ 3 lit /ha at 60 DAR in the morning hours without application of recommended dose of N over control where 100% RDN was used (50.38 t/ha and 7.88 t/ha respectively).

Similar results were obtained in 3rd ratoon of s*uru* season under flood and drip irrigation. Foliar application of endophytic nitrogen fixing bacteria @ 3 lit/ha significantly increased cane yield by 22.69% & sugar yield by 22.67% under flood irrigation and 8.07% & 12.98% under drip irrigation without application of N fertilizer.

Effect of graded levels of potash and consortium of potash mobilizing bacteria on yield and quality of sugarcane (plant & ratoon)

The cane and sugar yield of sugarcane planted in *suru* season, gave significantly higher 144.20 & 20.72 t/ha by application of consortium of potash mobilizing bacterial liquid bio-inoculant @ 2.5 lit/ha with 50% RDK compared to control (103.99 t/ha and 13.44 t/ha). Whereas in ratoon crop, the cane & sugar yield was found significant (84.05 & 12.89 t/ha) by application of consortium of potash mobilizing bacterial liquid bio-inoculant @ 2.5 lit/ha with 50% RDK as compared to control (68.38 t/ha and 10.23 t/ha).

Effect of application of consortium of Iron & Zinc microbial bio-inoculant on yield and quality of sugarcane (plant & ratoon)

The field research trial conducted to study the effect of application of consortium of iron & zinc microbial liquid bio-inoculant on yield & quality of sugarcane revealed that the yield of cane & sugar was found significantly higher (148.90 t/ha & 22.75 t/ha respectively) by application of consortium of Iron & Zinc solubilizing microbial liquid bio-inoculant @ 2.5lit/ha with 50% dose of Fe & Zinc sulphate (12.5 kg/ha & 10 kg/ha) at the time of planting as compared to control (105.14 t/ha & 17.66 t/ha). Whereas in ratoon, the cane and sugar yield was significantly higher (115.27 t/ha & 16.54 t/ha respectively) by application of consortium of iron and zinc solubilizing microbial liquid bio-inoculant @ 2.5 lit/ha with 50% iron & zinc sulphate (12.5 kg/ha & 10 kg/ha) at the time of planting as compared to control.

AGRICULTURAL ENGINEERING

The R & D activities of the section are focused on two important areas *viz.*, farm mechanization and irrigation water management. The mechanical sugarcane planter and earthing up equipment developed by the Institute have been commercialized. A whole cane mechanical sugarcane harvester developed in collaboration with Rane Agro, Pune & ICAR, New Delhi is at commercialization stage. The fertigation schedule as per crop growth stages of sugarcane under drip irrigation has a good adaptability among the cane growers. The section has NABL accredited laboratory for testing of drip irrigation system components.

Commercialization of sugarcane planter and earthing up equipment

VSI developed mechanical sugarcane planter for 0.9 m, 1.2 m, 1.5 m in single row spacing and 0.90 - 1.80 paired row spacing with more than 72% germination and 48% saving in the cost of planting in comparison with conventional manual planting. Tractor operated earthing up equipment developed by VSI is suitable for heavy earthing up operation in 1.2 m ,1.5 m single row planting and 0.75 -1.5 m paired row planting of sugarcane. Both the equipments are recommended through Joint Agresco meetings of Agricultural Universities of Maharashtra State and commercialized for wider spread of the technology at the end user level on royalty basis through Deccan Farm Equipments, Kolhapur and Rohitkrishi Indusrties Private Ltd., Chinchwad, Pune.

Evaluation of product MIDAS application through drip irrigation in sugarcane

The effect of sea weed extract viz. MIDAS application through drip irrigation was studied in sugarcane. The pooled results of plant cane and first ratoon crop revealed that the application of MIDAS @ 2.5 lit/ha each at 40, 95 DAP and 70 & 30 days before harvest recorded highest cane yield of 116.10 t/ha and highest CCS of 14.28%.

Scheduling irrigation with mulch under different sugarcane planting methods

The results of first plant cane revealed that furrow planting of 120 cm spacing with green manure (sunhemp) planting at 30 days of sugarcane planting, mulching of green manure crop at 75 days of sugarcane planting and earthing up at 110 days of sugarcane planting recorded highest cane yield of 138.68 t/ha. Among the irrigation scheduling level of 0.6, 0.8 and 1.0 IW/CPE, the irrigation scheduling at 1.0 IW/CPE recorded the highest sugarcane yield of 133.58 t/ha.

Sugarcane harvester

The fully automatic chopper and whole cane sugarcane harvesters are developed in collaboration with M/s. Rane Agro, Pune and ICAR, New Delhi. The fully automatic chopper harvester was already commercialized and whole cane sugarcane harvester is at commercialization stage.

Solidaridad project

VSI has a collaborative project with Solidaridad Network Asia Limited for increasing water use efficiency in sugarcane growing in India. VSI is one of the knowledge partner in this project. The other partners are Solidaridad Network Asia Limited, NSL Sugars Ltd., Natem Sugars Ltd., Osmania university and WaterWatch BV (Eleaf). This project is funded by Netherlands Enterprise Agency, a part of the Ministry of Economic Affairs, Netherlands. Under this project, the trials on various technologies of increasing water use efficiency and improving sugarcane productivity were conducted at VSI. The training was also imparted to the extension officers and farmers from the sugar mills.

ITC project

ITC is implementing a project on increasing water use efficiency, reducing cost of cultivation and increasing productivity of sugarcane in Ghod River Basin in Junnar & Shirur blocks of Pune district and Parner & Shrigonda blocks of Ahmednagar district. Under this project, VSI imparted training to the farmers on improved cane cultivation and water management practices. The consultancy services are also provided to ITC to conduct the demonstration trials of improved technologies of sugarcane cultivation and irrigation water management in the project area.

Drip irrigation material testing laboratory

- The drip irrigation material testing laboratory is accredited by NABL since 2005. After successful assessment by NABL, the accreditation of laboratory is renewed till September 2018.
- Total 11 drip samples were tested as per relevant Indian standards.

AGRICULTURAL ECONOMICS

The section collects, compiles and analyzes the data on cost of cultivation, impact of adoption of innovative techniques of sugarcane cultivation and season-wise & variety-wise area under sugarcane in the area of sugar mills. Assessing the data of quality seed material and damages due to natural calamities and providing the information to the Government officials for future planning. In addition, the section also gives guidance relating to statistical aspects to scientists and dissemination of information regarding sugar industry.

Trends in variety-wise area and their impact on cane yield & sugar recovery in Maharashtra

The majority of sugarcane area in the state was covered by Co 86032 and CoM 0265 during last five years (2013-14 to 2017-18). The variety CoM 0265 has covered more than 30% area in the State with an increase of 4.15% i.e. 36.02% (2017-18).There was a reduction in variety CoC 671 during 2017-18 by 0.87% and in case of Co 86032, reduction was by 2.63% as compared to previous year (Fig 9).

Fig 9 : Trends in variety-wise area under cultivation

Maximum cane yield (85 t/ha) was recorded in 2014-15; while, it was minimum (68 t/ha) in 2016-17. In year 2017-18 average sugarcane yield was increased by 12 t/ha due to favorable climatic conditions but sugar recovery decreased by 0.04 due to long duration of crushing season. Maximum sugar recovery was attained in 2013-14 (11.43%) and gradually decreased to 11.28% in 2017-18 (Fig.10).

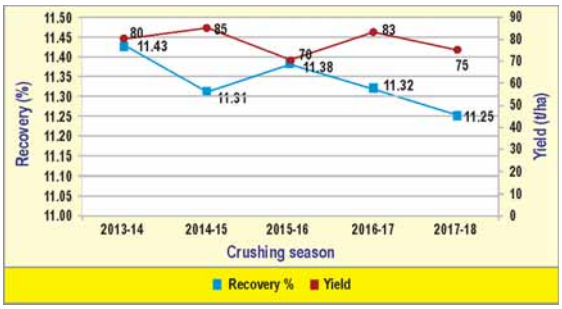

Fig 10 : Trends in average cane yield and sugar recovery

Trends in season-wise planting area in Maharashtra

Usually, the proportion for sugarcane plantation in *adsali*, pre-season, *suru* and ratoon crop is 10, 30, 20 and 40 percent respectively, while actual trend during last five years (2013-14 to 2017-18) showed variation. The variation in planting season depends on rainfall, it's distribution and price of sugarcane. The area was maximum in 2014-15 under *adsali*

(29.24%), pre-season (30.66%) and *suru* (16.93%). Whereas in 2016-17, it was *adsali* (17.27%), pre-season (9.83%), *Suru* (7.22%) ratoon area was maximum (65.68%) and minimum (27.18 %) in 2017-18. This shows that more planting was done in 2017-18 and it was minimum in 2016-17 due to shortage of rain. The area under planting in 2017-18, under pre-season, *suru* & *adsali* was increased by 20.83%, 9.71% and 7.96% respectively. While area under sugarcane ratoon decreased by 38.50% as compared to previous year.

Estimation of quality planting seed material

The data on actual seed replacement using certified seed obtained from sugar mills is shown in table 10. The analysis was carried out considering crushing capacity and cane requirement for fulfillment for the normal season.

It was observed that there was a gap of 69.68% between required and actual certified seed. The gap of 87.67% was more in North-East zone as compared to two other zones.

CROP PROTECTION

This division comprises of Entomology and Plant Pathology section and is engaged in research and extension activities related to the pests and disease incidence and plant protection measures.

ENTOMOLOGY

The section undertakes screening of varieties in AICRP(S) trials and promising genotypes that are under development in Institute's breeding programme related to major insect pests. The section conducts survey regarding incidence of pests and evaluates bio-efficacy of new insecticides against early shoot borer in sugarcane. This section also takes care of mass multiplication of potential bio-agent and their supply to sugar mills & sugarcane growers for effective and timely control of pests.

Recommendation

Two soil applications of Chlorantraniliprole 0.4% GR @22.5 kg/ha at the time of planting as well as 60 days after planting followed by light irrigation is recommended for effective control of early shoot borer (*Chilo infuscatellus*) in timely and late planted *suru* sugarcane.

Evaluation of zonal varieties/genotypes for their reaction against major insect pests Initial Varietal Trial (Early/Midlate)

Out of 40 varieties/genotypes screened, Co 14032, CoT 14367, Co 86032, Co 14004, CoN 14072 showed highly susceptible reaction to early shoot borer. All other 35 varieties/genotypes showed less susceptible reaction to internode borer and mealy bug.

Advanced Varietal Trial I Plant (Early/Midlate)

Out of twelve varieties/genotypes screened, Co 12008 and CoSnk 05103 showed less susceptible reaction to early shoot borer. All other ten varieties/genotypes showed less susceptible reaction to internode borer, mealy bug and scale insect.

Advanced Varietal Trial II Plant (Early)

Out of eight varieties/genotypes screened, CoM 11082, CoM 11084 and Co 85004 showed less susceptible reaction to early shoot borer, while other varieties/genotypes showed less susceptible reaction to internode borer and scale insect. Co 11001 and CoC 671 showed moderately susceptible to mealy bug.

Advanced Varietal Trial Ratoon (Early)

Out of eight varieties/genotypes screened Co 11004, CoM 11081 and Co 11001 showed moderately susceptible reaction to early shoot borer. All other varieties/genotypes showed less susceptible to internode borer. CoM 11082 and Co 85004 showed less susceptible reaction to mealy bug. All varieties/genotypes showed less susceptible reaction to scale insect except Co 11001 which was moderately susceptible.

Table 10 : Gap analysis of certified seed replacement

Zone	No. of mills	Certified seed area required to be replaced (ha)	Actual seed area replaced (ha)	Gap between required / actual seed area (ha)
South	7	13492	6587	6905 (51.18 %)
Central	17	46475	15805	30670 (65.99%)
North-East	7	23412	2886	20256 (87.67%)
Total	**31**	**83379**	**25278**	**58101 (69.68%)**

(Figures in parenthesis indicate % gap between certified seed requirement and actual seed replaced)

Advanced Varietal Trial II Plant (Midlate)

Out of eight varieties/genotypes screened, Co 11012 and CoM 11085 showed moderately susceptible to mealy bug. All other varieties/ genotypes showed less susceptible to early shoot borer, internode borer and scale insect.

Advanced Varietal Trial Ratoon (Midlate)

Out of eight varieties/genotypes screened, all varieties/genotype were found less susceptible to early shoot borer and internode borer. Co 86032 and Co 99004 showed less susceptible to mealy bug. CoM 11086 was found moderately susceptible to scale insect.

Survey & surveillance of sugarcane insect pests

Found severe infestation of white fly and wire warm in Ahmednagar district during July 2017 to August 2017. Severe infestation of white grub was observed in Solapur and Satara district in September 2017 and internode borer and root borer was also seen in Pune district in December 2017.

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

The percent incidence of early shoot borer was noticed maximum 16.97 in June 2017. The percent incidence of internode borer was noticed maximum 38 in November 2017. This plot was free from mealy bug and scale insect infestation.

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

The section has produced 1054.4 cc (210.88 lac) eggs of *C. cephalonica* and 834 cards (166.8 lac parasites) of *Trichogramma chilonis* parasites and supplied 475 Tricho cards for the control of sugarcane borer on 31.67 ha.

Formulation and validation of IPM Module of sugarcane insect pests

The cumulative percent incidence of early shoot borer was 0.53 in IPM block, while 5.44 in farmers practice block. At harvest plant population per ha was numerically high 70714 in IPM Block and it was 64615 in farmers practice block. At harvest sugarcane yield per ha was numerically high 173.81 in farmers practice block and it was 141.35 in IPM Block.

Field evaluation of IPM Technology against early shoot borer in sugarcane

The cumulative incidence of early shoot borer was low 2.83% in IPM block while in control it was 7.80%. Sugarcane yield was high 183.32 t/ha in IPM block while in control it was 147.87 t/ha.

Evaluation of varieties/ genotypes for their reaction against major insect pests
Final Varietal Trial II Plant

All ten varieties/genotypes screened showed less susceptible to early shoot borer, internode borer and mealy bug.

Multi Location Trial II Plant *Adsali*

Out of fifteen varieties/genotypes screened, VSI 10012 and CoVSI 11009 showed highly susceptible to scale insect, while all varieties/genotypes screened showed less susceptible to internode borer and mealy bug.

Multi Location Trial II Plant Pre-season

Out of sixteen varieties/genotypes screened, VSI 08005 showed moderately susceptible to internode borer, CoVSI 11004 and CoVSI 11001 showed moderately susceptible to mealy bug. All varieties/ genotypes showed less susceptible to early shoot borer.

Multi Location Trial II Plant *Suru*

Out of eighteen varieties/genotypes screened, VSI 434 was highly susceptible to early shoot borer, PDN 13011 and VSI 08005 were moderately susceptible to mealy bug. All varieties/genotypes showed less susceptible to internode borer.

Pre-final Varietal Trial (2014) and Final Varietal Trial (2013)

All eighteen varieties/genotypes screened were less susceptible to early shoot borer, internode borer and mealy bug.

Sponsored project

Field evaluation of Celite 610 against borers and sucking pest in sugarcane

For the control of borers and sucking pest in sugarcane, 1) Celite 610 @ 12.5 kg/ha + chemical control, 2) Chemical control + Biocontrol and 3) Celite 610 @ 12.5 kg/ha + Biological control treatments found effective.

PLANT PATHOLOGY

The section carries out research on sugarcane diseases related to survey, identification, causes, epidemiology and control measures. 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 infestation conditions. Extension services including farmers & officers training program and consultancy services to sugar mills & other Institutes including NGO's are provided.

Evaluation of varieties / genotypes under zonal testing for resistance to smut disease

Under AICRP(S), 60 genotypes including two standard checks (Co740 and Co7219) were screened against smut disease under artificial condition for evaluating their resistance. Out of 60, 26 genotypes were found resistant, three moderately resistant, 25 moderately susceptible, five susceptible and one genotype was found highly susceptible.

Natural occurrence of yellow leaf disease of sugarcane

Yellow leaf disease (YLD) incited by yellow leaf virus may pose serious threat to sugarcane cultivation. AICRP(S) has initiated the research work about this disease with regards to screening of sugarcane genotypes and management. At VSI, fourteen genotypes were observed at 8th, 10th and 12th month age to observe the natural incidence of YLD. The varieties are classified as per the severity grades mentioned in technical programme of AICRP(S). Out of fourteen genotypes, two *viz.,* CoVSI9805 and MS10001 were observed free from the disease, eight genotypes were moderately resistant; while, four moderately susceptible to YLD.

Methodology for screening sugarcane genotypes for resistance to brown rust (caused by *Puccinia melanocephala*)

Two artificial inoculation methods *viz.,* Clip inoculation in leaf whorl and Leaf whorl inoculation were compared for their feasibility to affect foliage by brown rust. After one month of artificial inoculation by these two methods and recorded the number of pustules on affected leaves. Number of rust pustules on inoculated leaves was higher (23.4/sq.inch) under leaf whorl inoculation method. In clip inoculation, the average number of rust pustules was 13.2/sq.inch. Therefore, leaf whorl inoculation method is far superior to clip inoculation method and hence, may be employed for the screening of sugarcane genotypes for resistance to brown rust.

Survey of sugarcane diseases in Maharashtra

- The incidence of smut has been increased in central Maharashtra and Vidarbha in last year due to prevalence of drought condition in last two crop seasons (2015-16 and 2016-17). The incidence was more in ratoon crops of Co 86032.
- Grassy shoot disease was increasing in all commercially cultivated sugarcane varieties. The incidence was more in ratoon crops of CoM 0265, Co 86032 and Co 419.
- The incidence of foliar diseases on sugarcane *viz.,* rust, pokkah boeng, yellow leaf, brown spot and eye spot was increasing.
- Chlorosis, top rot and knife cut symptoms were exhibited on sugarcane affected by pokkah boeng disease (Fig 11). Due to late heavy rain coupled with hot & humid climate during Sep.-Oct. 2017, severe incidence of pokkah boeng was observed in *Adsali* of 2017-18 planting season resulted in severe cane sprouting. This was due to suppression of apical dominance in sugarcane after disease incidence. All the affected mother shoots were stunted due to pokkah boeng owing to the shortening of internodes.
- Rust was severe in Western Maharashtra. The brown rust spore feeder insect i.e. *Mycodiplosis coimbatorensis* was also noticed on infected sugarcane leaves in Pune, Ahmednagar, Kolhapur and Satara districts (Fig 12).
- The incidence of brown spot disease is decreasing, while; the incidence of YLD was increasing in the state (Kolhapur, Sangli, Satara, Pune, Ahmednagar and Solapur districts) and it was noticed on CoM 0265 and Co 86032 varieties to the extent of 20% and this is the matter of great concern. The midrib yellowing, yellow discoloration, purple or pinkish purple discoloration was also seen on the leaf midrib and lamina of affected crop. The incidence of eye spot, mosaic and pineapple was observed in sugarcane in sparse. Pineapple disease was

observed in sugarcane cultivated in black cotton soils under heavy irrigated condition. The practice of sett transplanting in sugarcane is increasing and therefore the disease incidence is being eliminated in such plots.

Fig 11 : Sugarcane Crop (CoC671) infected by pokkah boeng caused by *Fusarium moniliforme* (Top rot stage)

Fig. 12 : Sugarcane Crop (CoC671) infected by brown rust caused by *Puccinia melanocephala* Syd. & P. Syd 1907

Screening, epidemiology and management of pokkah boeng in sugarcane

Screening: Fourteen varieties were observed throughout the crop season for the pokkah boeng occurrence under natural condition. Out of fourteen, eight varieties *viz.*, Co86032, Co419, CoVSI0405, Co85004, CoVSI0309, CoM0265, CoVSI03102 and Co94012 were remain free from the disease, while; six varieties *viz.,* CoVSI9805, VSI434, CoC671, MS10001, CoVSI2000-01 and VSI08005 were found susceptible. Maximum disease incidence was observed in first fortnight of July 2017 in CoVSI 9805, MS 10001 and VSI 434 varieties.

Epidemiology: The initiation of pokkah boeng noticed in second week of June 2017. Last year, this area received pre-monsoon rains in 1st fortnight of April 2016 (Meteorological week – 19th). During disease initiation period, the minimum and maximum temperature was 22.62 °C and 38.70 °C respectively and humidity ranged from 20.71% to 97.31%. Maximum pokkah boeng disease incidence was observed during 27th to 34th meteorological weeks, while; the incidence was reduced after 35th meteorological week.

Management: Carbendazim and mancozeb were tested along with control in five treatments. Both the fungicides were found effective to control pokkah boeng effectively, when these two fungicides were sprayed thrice at an interval of 15 days after 15th May onwards. However, mancozeb at 0.3% found more effective than the carbendazim, which controls the disease up to 75.22%.

Management of yellow leaf disease through meristem culture

AICRP(S) has initiated the research work on 'Management of yellow leaf disease (YLD) of sugarcane through meristem culture'. At VSI, tissue culture plantlets of two varieties *viz.*, Co 86032 and VSI 08005 were produced and hardened as per the standard procedure. These plantlets were transplanted in the field for the production of breeder's seed and were observed throughout the year for the natural incidence of YLD. During the production of breeder's seed, the crop remained free from YLD. The sugarcane setts obtained from breeder's seed plot were planted further for production of foundation seed in the field and monitored for YLD.

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

Thirty- five genotypes and clones developed at VSI, standard check varieties (Co 740 and Co 7219) and genotypes which showed resistant in last year were screened artificially for their resistance to smut. Out of 35 genotypes/clones screened under artificial disease condition, nineteen genotypes were found resistant, two genotypes moderately resistant, ten genotypes moderately susceptible, two susceptible, while two were found highly susceptible.

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

Under AICRP(S), plant breeding section of VSI tested 61 genotypes including five standard checks in six trials for assessing the performance at VSI. Bi-monthly observations on natural incidence of diseases on sugarcane were recorded. Observations revealed that, all varieties are free from smut under natural condition. However, grassy shoot was found on 23 genotypes, pokkah boeng on 20 genotypes, rust on nine genotypes, mosaic on 25 genotypes and YLD on eleven genotypes. Seventeen genotypes were free from all the diseases under natural condition. YLD was found in severe form on Co 86032, Co 85004 and Co 94008 (Fig 13).

Fig. 13 : Sugarcane Crop (Variety: Co86032) infected by Yellow Leaf Disease caused by Yellow leaf virus.

Occurrence of major diseases on promising sugarcane genotypes at VSI

Sugarcane genotypes under five trials *viz.*, FVT Plant II, Multilocation Trial II Plant- *Adsali*, Multilocation Trial II Plant - Pre-season, Multilocation Trial II Plant - *Suru* and PFVT (2014) & FVT (2013) conducted by Plant Breeding section at VSI were observed for various naturally occurring diseases in the area. Observations revealed that the presence of grassy shoot on fifteen genotypes, pokkah boeng on thirteen genotypes, mosaic and YLD found on six genotypes. However, 22 genotypes were observed free from the natural incidence of diseases.

FARM DEVELOPMENT AND MANAGEMENT

The Institute has six farms at different locations in the state. Of which, on two farms at Manjari field experiments and trials of Agriculture Sciences and Technology division carried out. The breeders' seed production programme of released, pre-released sugarcane varieties and promising genotype of sugarcane is undertaken at Naigaon, Manjari and Lonarwadi farms on 40.97 ha for distribution of disease free breeders' seed to sugar mills and identified sugarcane growers for further multiplication of foundation seed. The Amboli farm is exclusively devoted for the maintenance of sugarcane germplasm and development of new elite varieties through hybridization. The utilization of area for different purposes on these farms is in table 11.

Land development

Land leveling and soil filling was made on one ha land of Manjari farm and was brought under cultivation. Irrigation storage tank water proofing work was taken in hand during the year. The works of two farm ponds having capacity of twenty million liters each at Lonarwadi farm have been completed. The construction of farm office, Labors rooms, implements' shade and godown work of Lonarwadi farm is in progress. In addition, 18.40 ha land was brought under drip irrigation system.

Land leveling and soil filling on uncultivable land admeasuring 0.5 ha at Amboli was carried out and land was brought under cultivation.

Nucleus seed production

Nucleus seed of ruling sugarcane varieties was preserved on 0.43 ha. Seed cane obtained from the nucleus seed crop was subjected to heat treatment (MHAT at 54^0C for 2.5 hr at 95-99% RH).Total 0.228 million two budded setts of nucleus seed were produced and used for breeders' seed production programme at Institute's farm. The nucleus seed production is in table 12.

Production of breeder's seed

Sugarcane being a vegetative propagated crop, most of the diseases are transmitted through setts in sugarcane, which in turn adversely affects the cane productivity. 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 identified cane growers for production of foundation and certified seed. This seed multiplication chain is expected to increase sugarcane productivity by 15 to 20%. Breeder's seed production programme was taken on an area of 40.97 ha under National Food security Mission, ICAR seed project and from institute's fund. Total 57.76 lakh two eye budded setts were supplied to 27 sugar mills in Maharashtra and 0.175 million setts to 6 mills in other states. Besides, 0.780 million two eye budded setts and 0.147 million seedlings were used at Institute's farms for planting of research trials and seed plots. The seed distributed during the year is in table 16 under inputs and analytical services.

The section has also distributed 2.743 million one eye bud seedlings to 16 mills in the State and 0.102 million to 3 mills in other states as breeders' seed given in table 17 under inputs and analytical services.

Demonstration plots of sugarcane production technologies were conducted on 2.98 ha area at Institute's Manjari farm. The rotational crops like cowpea, sunhemp were taken on 34.76 and 2 ha in kharif and rabi respectively. The onion was cultivated on 0.08 ha under Directorate of Onion and Garlic Research Centre, Rajgurunagar, Pune (ICAR) for production of quality seed of elite onion lines in isolation.

New form pond at Lonarwadi farm

Green manuring at Lonarwadi farm

Table 11: Area under sugarcane and rotational crops at different farms

Particulars	Crop area (ha)					
	Manjari	Vasantdada	Naigaon	Amboli	Lonarwadi	Total
Plant cane experiments/ Germplasm maintenance	2.42	11.23	0	1.80	0	15.45
Ratoon cane experiments	0.68	1.11	0	2.00	14.07	17.86
Nucleus seed	0.43	0	0	0	0	0.43
Breeder seed production	2.97	0.60	20.44	1.90	15.06	40.97
Live Demonstration	2.98	0	0	0	0	2.98
Green mannuring and Kharif crops	0.96	9.61	17.20	1.00	7.90	36.67
Rabi crops Jawar, gram, maize and onion	0.02	0.33	0.03	0	6.83	7.21
Total	**10.46**	**22.88**	**37.67**	**6.70**	**43.86**	**121.57**

Table 12: Variety-wise nucleus seed production

Varieties	CoC671	Co86032	CoM 0265	CoVSI 9805	Co VSI 03102	VSI 434	MS 10001	Co VSI 08005	Total
No. of setts	6500	84202	16570	1000	9000	8000	8500	95000	228772

Production of single bud settling

EXTENSION AND ADVISORY SERVICES

- Survey of sugarcane fields, discussions with cane growers and suggestions regarding possibilities to use ETP water for irrigation in the operational area of three units of Rana Sugars, Dist. Moradabad and Rampur, Uttar Pradesh.
- Survey of sugarcane crop availability for revival of sick sugar mills and report submitted to Commissioner of Sugar Maharashtra state.

Consultancy

Establishment of soil testing laboratory
- Tirupati SSK, Bagaha, Bihar
- Agasti SSK
- Pandurang SSK
- Ambalika Sugar

Establishment of liquid bio-fertilizer production unit
- Vishwasrao Naik SSK
- Bhimashankar SSK
- YM Krishna SSK

Cane development activity to member sugar mills
- SMSM Patil SSK

Bio-composting and its enrichment
- Ramdev Sugars Pvt. Ltd., Thaini, Hoshangabad, MP

SDF monitoring and impact assessment

VSI is one of the monitoring agencies appointed by SDF, Ministry of Food and Consumer Affairs, Government of India for assessing the proper utilization of SDF loan and its impact. Impact assessment reports for three mills were sent to SDF.

- Madhucon Sugar and Power Industries, Telangana
- SM Kagal Taluka SSK, Maharashtra.

Breeder's seed plot

- Sitaram Maharaj Sakhar Karkhana, Maharashtra.

Monthly workshops on cane development

The Institute has initiated the intensive programme of monthly one day workshop on important need based themes of sugarcane development for agriculture officers, cane development officers and all the technical officers working in soil testing, bio-fertilizer production and seed nursery management in sugar mills. This activity has been started from July 2013 preferably on fourth Saturday of each month. The workshop themes were given in table 13.

The participants from sugar mills excitedly participated in workshops held on various themes of cane development. This activity is useful for planning and accelerating the development activities in the area of sugar mills.

Dr. Sunanda Patil, Nematologist, NIPHM, Hyderabad interacted participants of EPN Based Bio-control of White Grub in Sugarcane

Recommendations finalized in the working group

Sugarcane varieties in Maharashtra, their planning and harvesting

- Every sugar mill should have well planned varietal planting planning and harvesting programme.
- The mills should take help of VSI to prepare planting and harvesting programme.
- The mills should test the new varieties in area of operation before their inclusion in planting programme.

EPN based bio-control of white grub in sugarcane

- Maintenance of EPF and EPN along with organic fertilizers in soil is mandatory to control pests in sugarcane.
- For controlling white grubs, application of liquid EPF@ 2 lit/acre in 200 lit. of water by drenching is recommended.

Soil organic carbon management and its importance

- Sugar mills have to establish their own soil testing laboratory at mill and those mills who have already established the laboratories they should improve analytical techniques and its application at field level.
- Green manuring practice is to be implemented in precise way on farmer's fields for increasing organic carbon in soils.
- Trash mulching should be followed in ratoon crops, trash burning should be strictly banned. Farmers should be encouraged for *in situ* trash mulching and its decomposition with use of appropriate microbial culture, as it helps to reduce the loss of water from soil through evaporation, minimizes weed intensity and improves physical, biological and chemical properties of soil by recycling of organic matter.
- The bio-composting unit needs to be implemented on large scale for increasing utilization of bio-compost for increasing sugarcane productivity and sustainability.
- Crop rotation with leguminous crops, intercropping in sugarcane and following practices needs to be adopted in larger way in sugarcane growing areas.

Inter culturing operations for better sugarcane productivity

- Inter culturing operations should be carried out properly at proper time with appropriate implements and machinery.
- Wide row and paired row system of sugarcane planting with mechanized inter culturing increase sugarcane productivity and profitability.
- Selection of appropriate herbicide, recommended dosage, spray water volume, time of application and soil moisture are key points for weed control in sugarcane crop management.

Fertigation techniques in sugarcane

- Fertigation should be a mandatory part of drip program for sugarcane in the mill operational area.
- Sugar mill should have trained manpower for successful implementation of the drip and fertigation program in sugarcane crop.
- The prompt after sale service should be provided to the cultivators by the drip manufacturing companies for achieving the better results of drip irrigation in sugarcane agriculture.

Management of important diseases and pests in sugarcane

- Regular survey on periodical basis should be carried out for knowing the occurrence and

Table 13 : Monthly workshops

Date	Theme	No. of participants	No. of sugar mills
Apr. 22, 2017	Sugarcane varieties in Maharashtra, their planning and harvesting	105	45
May 27, 2017	EPN based bio-control of white grub in sugarcane	73	28
Sep. 23, 2017	Soil organic carbon management and its importance	96	46
Oct. 28, 2017	Inter culturing operations for better sugarcane productivity	27	18
Jan. 27, 2018	Fertigation techniques in sugarcane	62	31
Feb. 24, 2018	Management of important diseases and pests in sugarcane	64	30
Mar. 24, 2018	Review of cane development activities in sugar mills	51	31

spread of the diseases and insect pests on sugarcane crop in the mill operational area.

- A new disease on sugarcane *i.e.* YLD was observed in Maharashtra and to check the spread of the disease the agriculture department in sugar mills should monitor the disease in their area, specifically and report to VSI.
- Field demonstrations on IPM of major pests of sugarcane should be conducted and arranged the visits of farmers to the demonstration plots.
- The field demonstration for control of white grub and white fly by using Entomo - Pathogenic Fungi (*Beuveria/Verticillium/Metarrhizium*) should be arranged.
- It is suggested to avoid the spraying / dusting of insecticides for the control of sugarcane wooly aphid.
- To supply good quality disease and pest free seed material of sugarcane, sugar mill should implement three tier seed nursery program. The breeder seed in the form of tissue culture plantlets/ settlings/ setts should be taken for the raising of foundation seed.
- The maximum mills should take part in promotional scheme of award for cane development in the sugar mills of Maharashtra launched by VSI.

Review of cane development activities in sugar mills

- The Agriculture Officers from each sugar mills should grasp the technology and transfer in the farmers field. They should be made self sufficient to the sugar mills in cane production and work hard for doubling the farmers income.
- For chalking out the cane development programmes the main emphasis should be given on sugarcane seed, productivity in ratoon crop and intercropping in sugarcane.
- The sugar mills should follow the proper procedure for selection of participating farmers and collection of their database for the Oos Bhushan Award before submission.
- Those mills participated in VSI's Promotional Award Scheme, the creation / strengthening of separate Cane Development wing is mandatory before the initiation of this scheme.
- The participating mills for VSI's promotional award scheme, should keep all the database computerized for easy monitoring

INPUTS AND ANALYTICAL SERVICES

Production and supply

Production and supply of tissue cultured plantlets for seed production

Tissue culture section produced 0.912 million micro-propagated plantlets of different sugarcane varieties. Of these, 0.777 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 in table 14 and 15 respectively.

Multi-micronutrient and Multi-macronutrient liquid fertilizer production

The Institute produced and supplied to the State Govt. notified grade micronutrient fertilizer namely multi-micronutrient (grade-2), multi-macronutrient (NPK 8:8:8) and microsol (grade-1 solid soluble micronutrient mixture). Around 67500 lit. multi-micronutrient and 65615 lit. multi-macronutrient liquid fertilizers were supplied to sugar mills and individual farmers in Maharashtra. In addition, there is a production of 12500 kg the microsol during the year.

Visit of team of Indian Institute Seed Science, Kushmaur, Mau (UP) at live demonstration plot of VSI

DG, VSI participating in the 5th TTC Annual International Sugarcane Conference at Phan Thiet city, Binh Thuan Province, Vietnam

Table 14: Production of micro-propagated plantlets of sugarcane

Month	Sugarcane varities							Total
	Co 86032	CoC 671	VSI 92005	VSI 08005	MS 10001	Co 86002	Co 0238	
April 2017	20540	1200	-	19540	3260	21555	-	**66095**
May	18700	1000	-	18290	7700	12830	-	**58520**
June	10460	1350	-	21740	9640	9610	-	**52800**
July	16330	-	-	23710	9140	12030	-	**61210**
August	17548	-	-	18690	9660	4830	10010	**60738**
September	11380	-	-	17680	10200	1600	17510	**58370**
October	29290	-	5660	13680	12010	-	31470	**92110**
November	29610	-	3940	7180	10400	1380	33590	**86100**
December	25580	-	2780	6460	9520	2310	20160	**66810**
January 2018	50780	-	500	5240	3070	6730	39260	**105580**
February	43770	-	4600	10840	1310	14680	25870	**101070**
March	51030	-	5330	6460	1250	7500	30960	**102530**
Total	**325018**	**3550**	**22810**	**169510**	**87160**	**95055**	**208830**	**911933**

Table 15 : Zone-wise supply of micro-propagated plantlets of sugarcane

Particulars	Sugarcane varieties								Total
	Co 86032	CoC 671	VSI 434	VSI 08005	Co 92005	MS 10001	Co 86002	Co 0238	
I) Maharashtra									
A) Mills (19)	202750	4500	-	46800	7825	21225	-	16500	299600
B) Taluka Krishi Adhikari (1)	-	-	-	2400	-	-	-	-	2400
C) Farmers (191)	36605	765	900	68205	4491	10225	-	-	121191
D) VSI *	3085	-	-	60	605	-	-	-	3750
Total (I) = A + B + C + D	**242440**	**5265**	**900**	**117465**	**12921**	**31450**	**-**	**16500**	**426941**
II) Other States									
A) Mills / Govt. Organizations (10)	52000	1300	-	45500	3500	34200	76000	128200	340700
B) Farmers (16)	7200	100	50	400	-	300	-	900	8950
Total (II) = A + B	**59200**	**1400**	**50**	**45900**	**3500**	**34500**	**76000**	**129100**	**349650**
Total = I + II	**301640**	**6665**	**950**	**163365**	**16421**	**65950**	**76000**	**145600**	**776591**

*Indicates plantlets supplied free of cost for field experiments.

Visit of AICRP(s) Monitoring team to the Institute

Table 16 : Zone-wise distribution of breeders' seed

Particulars	No. of mills	Co 86032	CoC 671	CoM 0265	CoVSI 9805	VSI 434	CoVSI 03102	MS 10001	VSI 8005	Total
A) Maharashtra										
a. South	4	202105	0	117950	4000	0	0	0	79850	403905
b. Centeral	13	1499128	36000	789353	15000	0	44500	0	1740259	4124240
c. North East										
i) Marathwada	4	199646	0	0	0	0	0	0	156400	356046
ii) Khandesh	3	139000	0	34000	0	0	0	0	471658	644658
iii) Vidarbha	3	12000	0	0	0	0	0	0	235500	247500
Total (A)	**27**	**2051879**	**36000**	**941303**	**19000**	**0**	**44500**	**0**	**2683667**	**5776349**
B) Other states										
i) Karnataka	1	40000	0	0	0	0	0	0	0	40000
ii) Chhatisgarh	1	0	0	0	0	800	0	0	0	800
iii) Tamilnadu	1	0	0	0	0	0	0	26000	44500	70500
iv) Telangana	2	0	0	0	0	0	0	0	24000	24000
v) M.Pradesh	1	0	0	0	0	0	0	0	40000	40000
Total (B)	**6**	**40000**	**0**	**0**	**0**	**800**	**0**	**26000**	**108500**	**175300**
C) VSI Farm		**261667**	**12500**	**82852**	**4952**	**14002**	**21921**	**16502**	**366307**	**780703**
Total (A+B+C)	**33**	**2353546**	**48500**	**1024155**	**23952**	**14802**	**66421**	**42502**	**3158474**	**6732352**

Table 17 : Zone-wise distribution of one eye budd seedling

Particulars	No. of mills	Co 86032	CoC 671	CoM 0265	CoVSI 9805	VSI 434	CoVSI 03102	MS 10001	VSI 8005	Total
A) Maharashtra										
a. South	3	29426	0	2400	0	8236	0	0	195860	235922
b. Centeral zone	6	56016	0	4635	47	100	0	8700	1932476	2002874
c. North East										
i) Marathwada	3	15000	0	0	0	0	0	95832	262577	387441
ii) Vidharbha	2	0	0	9576	0	0	0	0	36667	46243
iii) Khandesh	2	0	0	0	0	0	0	0	70500	70500
Total (A)	**16**	**100442**		**16611**		**8283**	**1000**	**104532**	**2498080**	**2742980**
B) Other State										
i) Gujarat	1	0	0	0	0	0	0	0	20000	20000
ii) Karnataka	1	0	0	0	0	0	0	0	81836	81836
iii) Madhya Pradesh	1	0	0	0	0	0	0	0	420	420
Total (B)	**3**	0	0	0	0	0	0	0	**102256**	**102256**
C) VSI Farm		**38504**	**16427**	**12506**	**506**	**14506**	**518**	**12909**	**52048**	**147924**
Total (A+B+C)	**19**	**138946**	**16427**	**29117**	**506**	**22789**	**1518**	**117441**	**2652384**	**2993160**

Analytical Services

Soil/Fertilizer/Chemical testing

It has been recommended that the application of fertilizers should be done on the basis of soil analysis. Total 230 soil samples received from sugar mills, farmers were analyzed for various parameters like pH, EC, organic carbon nitrogen, phosphorous, potash and micronutrient. On the basis of the results of detailed analysis the fertilizer doses were recommended. Total 618 soil samples and 318 sugarcane leaf samples of research trials were analyzed for different parameters and nutrient contents as an important part of scientific research on nutrient management.

A total 282 samples of process chemical and fertilizer received from sugar mills and private organizations were analyzed.

Liquid bio-fertilizers

The Institute produced 101299 lit. of multifarious liquid bio-fertilizers and supplied 89166 lit. to sugar mills in Maharashtra and other states. The details are in table 18.

Table 18 : Supply of liquid bio-fertilizers

Particulars	Supply (lit.)
Acetobacter	577
Azo-phospho	3474
Decomposing Culture	12488
Biopesticide	29050
Biofungicide	6758
Rhizo-phospo	69
Sulphur Oxidizing microorganisms	272
Soil health	24041
Plant health	10547
Silicate Solubilizing bacteria	86
Potash mobilizing bacteria	795
PSB	0
Iron & Zinc solubilizing microorganisms	206
Pomegranate kit (46×10)	460
Departmental	343
Total	**89166**

Vermicompost

The Institute produced 144.323 tonnes of vermicompost of which 57.830 tonnes was supplied to various the in the Institute for experimental purpose. Remaining 77.013 tonnes was supplied to sugarcane growers in Maharashtra. In addition, 105 kg earthworms of *Esienia foetida* were supplied to the farmers.

Microbial culture

Total 84 slants were supplied to sugar mills and bio-fertilizer manufacturers viz. Vishwasrao Naik SSK (3), Bhimashankar SSK (18), RB Patil SSK (16), Kisanveer Satara SSK (11), SMB Thorat SSK (2), YM Krishna SSK (9), Vighnahar SSK (7), USK Agro sciences (6), S7 Biotech (4), J/K marketing (3) and Mr. Piyush Saha (4), Kakasaheb Khonde (1).

Microbial analysis

Total 604 samples (In-house and outside) were analyzed for microbial analysis. Of which, DC (16), liquid bio-fertilizers (85), bio-control (64), mother culture (197), chemicals (18), Vermi-compost (145), outside soil samples (55) and LBF and Raw Materials (24) received from in-house, sugar mills and other parties.

Tricho cards

The Institute supplied 475 tricho cards for control of sugarcane borers on 31.67 ha.

Field equipments

Agricultural tools developed by the Institute were supplied to sugar mills and farmers.

- Conventional harvesting knives : 1
- VSI developed harvesting knives : 674
- Hand operated scoop bud cutting machines : 2
- Crow bar : 5

Sugar Technology

SUGAR TECHNOLOGY

The objective of the department is to put constant and continuous efforts to improve the technical performance of sugar mills. To achieve this, a multipronged strategy is adopted, which includes teaching & training, research & development and extension & advisory services. Sugar mills from Maharashtra, other states of India as well as abroad avail the technical consultancy services for improving their technical performance, capacity utilization, reduction in sugar losses in boiling house, production of superior quality sugar and optimum utilization of steam & power. Emphasis is also laid on conservation of water to achieve zero raw water requirement and effluent treatment technology to accomplish the discharge norms fixed by the pollution control board.

Teaching & training is an important activity through which required technical caliber is made available to the industry and to equip the available personnel with latest technologies. The department organizes training programme for the staff of sugar mills in India as well as abroad, covering different topics of sugar manufacturing process (juice extraction, clarification, evaporation, crystallization, centrifugation and packing).

Research & Development is a noteworthy activity through which attempt is made to improve the efficiency in manufacturing process with improvement in precision, productivity and quality. Consultancy services play a very important role for enhancing technical performance and guiding the sugar mills for introduction of latest technology & equipment to reduce the cost of production and enrichment of sugar quality. Detailed Project Reports (DPRs) regarding modifications, additions, alterations, modernization and expansion of the boiling house machinery are prepared.

The laboratory of the department is accredited by the National Accreditation Board for testing and calibration Laboratories (NABL), New Delhi. Sugar mills are using the analytical services of this laboratory to ascertain the quality of their product and by-products.

Tailor made courses are organized in the Institute or on site. International training programme was conducted for Fiji Sugar Corporation, Fiji Islands. As requested, an advanced training programme was designed, for a period of three semesters which was executed and successfully completed. The certificate awarding ceremony was attended by Chief Operating Officer of Fiji Sugar Corporation and expressed satisfaction regarding the infrastructure and facilities available in the Institute, teaching methodology which is a combination of classroom lectures followed by technical visit to the modern sugar mills for practical exposure. The participants of the training programme departed with delight and self-confidence to bring out a radical change in the operation of their sugar plants in Fiji Islands.

The Government of India constituted a committee under Central Pollution Control Board (CPCB) to avoid pollution of river Ganga by sugar mills. The department assessed the ETP adequacy and water management of sugar mills allotted in Ganga basin and suggested remedial measures to achieve the norms fixed by CPCB.

RESEARCH AND DEVELOPMENT

A study on shelf life of white sugar with respect to storage at varying relative humidity and temperature

The project was started in Aug. 2016. Results of 1st set were completed in Dec. 2016. Thereafter, the project is on hold as the modification in stability chamber and digital display problem rectification was in progress by the supplier.

Reduction in emission of SO_2 from sugar mills

During the year, the trials of sugar production by single sulphitation were executed successfully in Kumbhi Kasari SSK. The sulphur burner used for syrup sulphitation was totally stopped and sugar was produced by single sulphitation process only. The physical appearance of single sulphited sugar was observed similar to traditionally produced double sulphited sugar.

Sugar produced by double sulphitation and single sulphitation was analyzed in the Institute's laboratory. The results indicated that the colour difference between single sulphitation and double sulphitation was negligible (Table 1). Hence, if clear juice colour is in the range of 7000 to 8000 IU, single sulphitation is advisable.

Table 1: Results of double sulphitation and single sulphitation

Particulars	Double Sulphitation	Single Sulphitation
M - 30 sugar colour in IU	74	76
S2 - 30 sugar colour in IU	79	80

To reduce emission of SO_2 from sugar mills, the gas absorption tower was designed and developed by VSI and trials are expected in April 2018.

Clarification of intermediate molasses for better keeping quality of sugar

The intermediate molasses was brought for taking trials to finalize the molasses dilution brix %, required temperature, flocculent dosage for getting better settling of non-sugars to achieve desired results of the laboratory scale trials.

Findings/conclusions of laboratory trials on process optimization

- Optimum brix % of diluted molasses observed in the range - 68 to 70 °C
- Optimum temperature for heating of molasses - 85 °C
- The optimum dosing of Flocculant (LT-27) - 6 to 8 ppm

Results of laboratory trials on B-heavy molasses

- Turbidity reduction - 25 to 26%
- Colour reduction - 5 to 10%
- Calcium oxide reduction - 5 to 6%
- Purity rise - 0.5 to 1.25 unit

Visits for R & D activities

Technologists paid visits to the sugar mills for conducting different studies (Table 2).

NABL sugar laboratory

The laboratory of the department maintains its accreditation status from last fifteen years. This laboratory is accredited as per IS/ISO/IEC 17025:2005 by "National Accreditation Board for testing and calibration Laboratories (NABL)", New Delhi. The test reports are accepted worldwide. Nineteen test parameters related to sugar quality are under the scope of this laboratory. Desktop surveillance audit of this laboratory is conducted by NABL and continued accreditation status for next year.

Details of analysis done in NABL accredited sugar laboratory

Total 375 plantation white sugar, raw sugar and final molasses samples were analyzed for different parameters. Around 256 sugar samples for ICUMSA by different methods, 71 samples for conductivity ash %, 96 samples for moisture %, 105 samples for SO_2 content, 83 samples for Pol % and 120 samples for total reducing sugar in final molasses analysis was carried out (Fig.1)

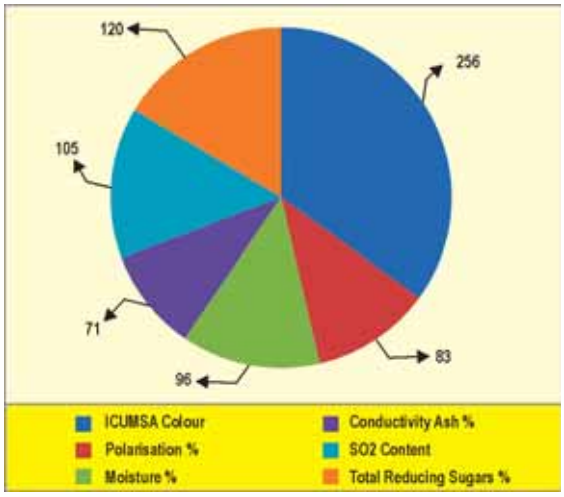

Fig.1: Analysis of samples in NABL sugar laboratory

Table 2 : R & D visits

Name of mill	Purpose
Rajgad SSK	Meeting regarding trials of liquid SO_2
Sant Tukaram SSK	To conduct plant scale application of liquid SO_2 for cane juice clarification & syrup sulphitation
Kumbhi Kasari SSK	For implementation of single sulphitation for production of plantation white sugar. Data collection for emission of SO_2 gas from juice and syrup sulphitor. Analysis of ICUMSA colour and SO_2 absorbed in juice, syrup, intermediate boiling house products and final product
Mutkeshwar Sugar Mill	Development of innovative cane carrier, heating of 2nd mill juice through DCH for enhancing of juice imbibitions on wet bagasse

EXTENSION AND ADVISORY SERVICES

Total 315 visits were paid by the technologists to sugar mills for extending consultancy services on the following 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 water requirement and minimizing effluent generation in sugar mills
- Optimization of process chemicals dosage
- Logic for automation at different stations in boiling house
- Selection of technical personnel
- ETP adequacy and water balance of sugar mills
- DPRs regarding modifications, additions, alterations, modernization and expansion of boiling house

ACHIEVEMENTS

SMSN Nagawade SSK

The mill was not achieving the rated capacity of 5000 TCD due to the problem in the evaporator set. It was suggested to modify the boiling house and vapour bleeding system. Accordingly, configuration & vapour piping sizes were calculated and recommended for implementation. With this new configuration, there is an increase in crush rate in the range of 450 to 500 TCD and reduction in steam consumption by 4% on cane, which resulted in proportionate saving of bagasse.

Kadwa SSK

Technical consultancy services were extended for renovation of old equipment in the sugar mill. It was suggested to improve the technical efficiency of the plant regarding steam consumption and sugar quality. This resulted in saving of bagasse and improvement of quality of final product. Evaporator set configuration was modified to improve the performance of the plant with the available two boilers, each with a generating capacity of 20 T/hr. As a result, the sugar mill achieved following results

- Improvement in crushing by 400 T/ day
- Reduction of steam % cane by 10 units
- Sugar colour reduced from 133 IU to 67 IU

Kumbhi Kasari SSK

During crushing season 2016-17, it was observed that the lowest clear juice colour achieved was 7605 IU, while highest was 10737 IU. It indicated that there was a large variation in values. To find out reasons of these variations, hourly % transmittance and pH of clear juice data was recorded. The behaviour of clear juice quality was monitored scientifically indicated in fig.2 & 3.

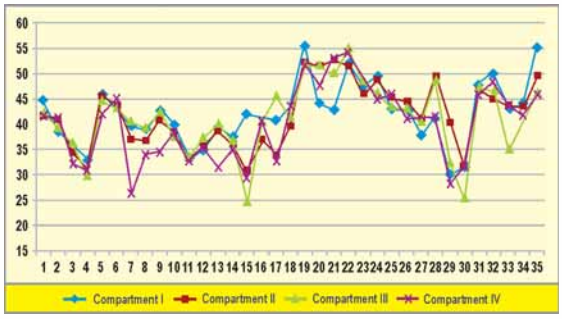

Fig 2 : Compartment wise % transmittance of clear juice on hourly basis

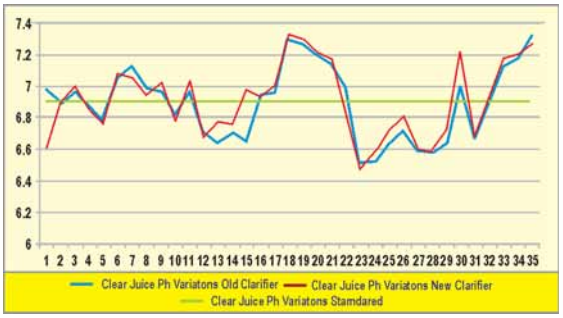

Fig 3 : Clear juice compartment wise pH variations

To reduce fluctuation in the clear juice quality, the detailed study of both existing juice clarifiers was carried out and respective modifications in juice withdrawal coils are proposed. It was also suggested to increase the capacity of sulphur burner and air compressor. Accordingly, modifications were carried out during off-season.

Due to these modifications, the mill achieved following benefits.

- No variations in clear juice pH
- Clear Juice % transmittance - in the range of 55-58%
- Clear juice turbidity - below 4 units
- Clear juice colour - 7000 to 8300 IU
- Filter cake % cane - reduced by 0.32 units
- Sugar colour - below 65 IU

Agasti SSK

Suggestions were given for replacement of some old equipment and modernize the plant in tune with the latest equipment available in the industry. This has led to improvement in the rate of crushing, reduction of steam consumption and sugar quality improvement.

The following achievements were made

- Improvement of crushing by 600 T/day
- Reduction of steam % cane by 6 units
- Sugar colour reduced from 120 IU to 65 IU

Detailed Project Reports (DPRs)

Prepared DPRs for modernization, expansion and appraisal reports of the sugar mills as given in table 3.

Visits for consultancy services

The technologists paid visits to member and non member sugar mills for consultancy services (Table 4 & 5).

Table 3 : DPR for sugar mills

Name of mill	Type of DPR
UP Rajya Chini Avam GannaVikas Nigam Ltd. a subsidiary of UP State Sugar Corporation Ltd., UP	Appraisal report on modernization-cum-expansion from 3500 to 5000 TCD with 18 MW Co-generation
Ramala Sahakari Chini Mills, UP	Appraisal report on modernization-cum-expansion from 2750 to 5000 TCD with 27 MW Co-generation
Narmada Khand Udyog Mandali, Gujarat	DPR for steam saving
Malegaon SSK	Modernization of plant for 4000 TCD and modernization-cum-expansion of sugar plant for 4000 to 7500 TCD
Agasti SSK and Kadwa SSK	Renovation / Modernization of sugar plant

Table 4 : Extension and advisory services to member sugar mills

Name of mill	Purpose
Agasti SSK	Review the progress of modernization work
Ambalika Sugar	Syrup jamming problem and to improve crushing rate
Bhima SSK	Mud problem
Datta Shetkari SSK	Technical discussion on steam economy and 3rd body vapour bleeding to 'A' pan boiling, off-season modification and boiling house machinery calculation for proposed 9000 & 10000 TCD
Dnyaneshwar SSK	To conduct mill test of sugarcane variety Co 86032 and problem of working performance of ETP due to higher organic loading rate of effluent
Dr. B Ambedkar SSK	Improvement of sugar quality and to stabilize the plant for 6000 TCD
Gangapur SSK	To assess present conditions of plant & machinery to start the crushing season 2017-18
KA Dr. GD Bapu Lad SSK	Isolation facility for Evaporator first & second effect
Kranti Sugar & Power	Modifications and rectification in existing equipment in boiling house for achieving desired crush rate in crushing season 2017-18
Malegaon SSK	The pre-bid meeting for boiling house machinery
Narmada Khand Udyog Niyamit, Gujarat	Consultancy for steam and energy conservation, higher effluent generation and problem of ETP working performance
Pandurang SSK	Technical discussion for stabilizing the plant for 7200 TCD
PK Dr. NN HK Ahir SSK	Expansion of plant to 6000 TCD

Table 4 : Extension and advisory services to member sugar mills (Contd.)

Name of mill	Purpose
Sanjivani SSK, Goa	Evaporator condensate withdrawal problem
SMSN Nagawade SSK	Bolder grain production and dust formation problem. Off-season modification and vapour bleeding rearrangement and water pollution due to sugar factory effluent - NGT Case
Someshwar SSK	Modification in evaporator second body calendria for improvement in its working and discussion on expansion with co-generation for 7500 TCD
Sonhira SSK	Technical pre-bid meeting for boiling house machinery and suggestions for modernization-cum-expansion for proposed crushing of average 6500 TCD
Vikas SSK Unit - II	Discussion for achieving 3000 TCD crush rate
Vishwasrao Naik SSK	Higher water consumption and mud problem
Vitthal SSK	Modifications in clarification section equipment for achieving desired crush rate of 6500 TCD

Table 5 : Extension and advisory services provided to non-member sugar mills

Name of mill	State	Purpose
Athani Sugars, Unit II, III & IV	Maharashtra	Process colour audit and sugar colour improvement
Gangakhed Sugar & Energy	Maharashtra	For assessment of spontaneous combustion of final molasses
Jarandeshwar Sugar Mills	Maharashtra	To study the progress of evaporator work
Manas Agro, Unit I	Maharashtra	Proposed Refinery project
Shri Dutt India (Operator of Vasantdada SSK)	Maharashtra	To study the boiling house machinery for smooth running of plant and to improve crush rate
Saswad Mali Sugar Factory	Maharashtra	Reasons for low recovery
Sharad SSK, Paithan	Maharashtra	For assessment of crushing rate with existing machinery
Sharayu Agro Industries	Maharashtra	For improvement in technical efficiency
Athani Sugars, Unit I	Karnataka	Process colour audit and sugar colour improvement
Dhampur Sugar	Uttar Pradesh	Off-season modification in juice clarification and filtration system

Suggestions for improvement in overall technical performance

Total 26 sugar mills availed the services to improve their technical performance.

Sugar quality improvement

Colour is important parameter which decides the quality of sugar. Colour audit service was provided to the sugar mills. Improvement in the colour is shown in table 6.

Table 6 : Sugar colour improvement

Name of mill	Original sugar colour in IU	After improvement sugar colour in IU
Daund Sugars	90-115	70-80
Athani Sugar Unit I	120-125	58-64
Athani Sugar Unit II	83-94	55-57
Athani Sugar Unit III	95-98	55-68
Athani Sugar Unit IV	64-66	51-55
Halsiddhanath SSK	93-103	67-87
Baramati Agro, Unit I	102-106	70-89

Steam and energy conservation

Lower process steam consumption increases economic viability of co-generation plant. As a result, many sugar mills are interested in reducing the steam consumption. Total fifteen sugar mills were visited for steam and energy conservation.

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. Twenty sugar mills were visited regarding the off-season maintenance work.

Low crush rate and low sugar recovery

Technologists visited eight sugar mills to improve crushing rate. Reasons for the low recovery were studied systematically and remedial measures were suggested for improving the recovery in twenty sugar mills.

Preparation of tender technical specifications, scrutiny of design and drawing of equipment

The expansion and modernization reports are prepared by VSI. Design and drawings of equipment relating to boiling house were scrutinized. Scrutiny of the design and drawings of boiling house equipment for fifteen sugar mills was done.

Assessment of technical data for different technical efficiencies and individual awards

With the intention of encouraging the member sugar mills and instill a sense of competitiveness, awards are announced for all the important categories every year. Work relating to collection of data and presenting the same in a methodical manner for identification of the best in the specific group was done by the department.

ETP up-gradation

Effluent treatment plays an important role in the operation of the sugar mill in view of achieving norms laid down by Pollution Control Board. Technologists visited the sugar mills viz. KA Tope Samarth SSK, Dr. B Ambedkar SSK, SMSN Nagawade SSK and Sonhira SSK to prepare technical specifications for waste water management.

Water conservation and waste water management

In the present scenario of water crisis, the available water has to be conserved and avoid polluting the environment. Ten sugar mills were visited for advising them on water conservation and minimizing waste water generation.

- Ambalika Sugar
- Dnyaneshwar SSK
- Daund Sugar
- KS Kale SSK
- KS Patil SSK
- KA Tope Samarth SSK
- Sonhira SSK
- Udgiri Sugar & Power
- Vishwasrao Naik SSK
- Narmada Khand Udyog Mandali, Gujarat

Verification of water balance and ETP adequacy assessment

The Government of India constituted a committee under Central Pollution Control Board (CPCB) to avoid pollution of river Ganga by sugar mills. The department assessed the ETP adequacy and water management of sugar mills allotted in Ganga basin and suggested remedial measures to achieve the norms fixed by CPCB (Table 7).

Visit of DG, VSI at sugarcane fields of Vietnam

Table 7: Verification of water balance and ETP adequacy assessment

Name of mill	State
Shree Renuka sugars, Ltd., Haldia	West Bengal
The Kisan Sahkari Chini Mills Ltd: Gajraula-Hasanpur, Ghosi, Sultanpur, Sampurnanagar, Mahmudabad, Sathiaon, Satha, Anoopshahar, Badayun, Semikhera, Bisalpur, Tilhar, Powayan, Rudra Bilaspur, Kaimganj, Puranpur	Uttar Pradesh
Avadh Sugar & Energy Unit: Hargaon, Hata, Seohara, Unit-Rosa	Uttar Pradesh
Anamika Sugar Mills, Bulandshahar	Uttar Pradesh
Indian Potash Limited, Unit- Rohana Kalan, SakotiTanda, Jarwal Road	Uttar Pradesh
Titawi Sugar Complex, Titawi	Uttar Pradesh
Sarjoo Sahkari Chini Mills Ltd, Belrayan	Uttar Pradesh
Shravasti Kisan Chini Mills Ltd., Nanpara	Uttar Pradesh
Indreshwar Sugar Mills Ltd.	Maharashtra
Riga sugar Co. Ltd.Sitamarhi	Bihar
Majhaulia Sugar Industries Pvt. Ltd. Majhaulia	Bihar
Tirupati Sugars Ltd. Bagaha	Bihar
Vishnu Sugar Mills Ltd. Gopalganj	Bihar

Educational tours

The department organized visits to Datta Shetkari SSK, Sharayu Sugar, Sonhira SSK and Swaraj Agro India to guide the trainees of Fiji Sugar Corporation, Fiji.

Selection of suitable candidate for technical posts in sugar institute and sugar mills

Sugar Technologists were member in the interview board for the selection of suitable candidate for senior technical posts in different organizations and sugar mills (Table 8).

Educational activity

The department is conducting regular short term and need based training programmes. The details are given in HRD section.

International training programme

The department conducted international training programmes for Fiji Sugar Corporation, Fiji at VSI from Oct. 16 to Dec. 22, 2017.

Table 8: Selection for technical posts

Organization	Technical posts
Datta Shetkari SSK	Manufacturing Chemist and various posts in boiling house
SMSN Nagawade SSK	Chief Chemist and ETP In-charge
KA Tope Samarth SSK	Managing Director, Chief Chemist and Distillery Manager
Chhatrapati SSK, Bhavaninagar	Chief Chemist and other posts in manufacturing section
Malegaon SSK	Sr. Manufacturing Chemist and various posts in boiling house
Kadwa SSK	Chief Chemist
Krishna SSK, Athani, Karnataka	ETP Manager
Vitthal SSK	Supervisory posts in clarification and boiling house
UPSC, New Delhi	Interviews for NSI, Kanpur

Sugar Engineering

SUGAR ENGINEERING

The department is a core center to strengthen the sugar industry with technological resources with a mandate to nourish, ensure and enhance an efficient globally competitive and sustainable growth of sugarcane and its allied industries; thereby plays responsible role in the socio-economic development of the country and endeavors to ensure long-term viability of sugar industry. The prime objective of this department is to augment the economic eminence by rendering technically appropriate and economically feasible advice and to give guidelines to sugar mills enable to move towards improved overall performance. The department is instrumental in leading and providing specialized engineering solutions across the globe in the field of sugar and allied industries.

The department is involved in multifarious activities like: Teaching and training, preparation of Detailed Project Reports (DPRs), providing extension and advisory services, ensuring timely implementation of project, applied Research & Development (R & D), conducting workshops and seminars, analytical work of sugar industry to augment the performance. Consultancy services encompassing the activities like improvement in preparatory index, primary extraction, reduced mill extraction and reduction in bagasse pol and moisture, overall improvement of the cane juice extraction are provided by the department. Emphasis is also given to have higher capacity utilization, saving in steam and power consumption. These factors contribute to the economic viability of sugar mill.

The department offers wide range of diversified services to the sugar mills under one roof and keep up with technological advancement and continuously update the mills in the field of sugar engineering through conventional and modern technologies from juice extraction to sugar manufacturing, co-generation systems, resolving technical problems, troubleshooting, steam and power balancing, energy conservation and automation. The department has committed to deliver the techno-economically feasible options to sugar mills. New applied R & D projects are undertaken to assess the worthiness of the latest technologies.

The department was involved in implementing 72 co-generation projects having installed capacity of 1246.50 MW with exportable power of 770.59 MW (61.82%). The present status of co-generation projects is shown in Table 1.

The co-generation plants which exports electrical power above 30 MUs during season 2017-18 are given in fig 1.

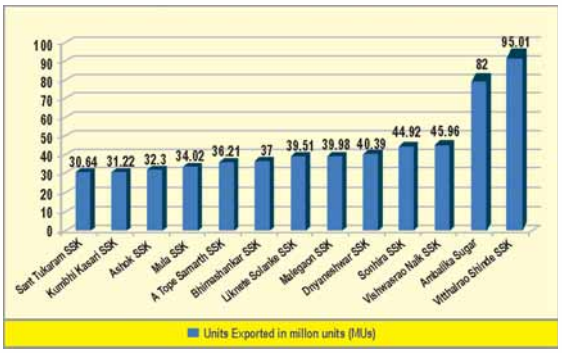

Fig 1: Major exporters of electrical power above 30 MUs during the year

The department gives paramount importance to modernization for improving capacity utilization, plant performance, energy conservation and plant electrification in the detailed project reports on co-generation. The full-fledged support and technical guidance is provided while selecting the appropriate type of equipment, inspection of plant and machinery, erection and commissioning of cogeneration projects along-with modernization.

During the year, as per the guidelines of Commissioner of Sugar, Pune, the technical team visited twenty sick sugar mills, which are under closure for a long time and studied the possibility to start the sugar mills. Detailed revival reports including the financial requirements to start the mills were prepared and submitted to the Govt. of Maharashtra.

Table 1 : The present status of co-generation projects

Status of project	No.	Installed Capacity (MW)	Exportable Power (MW)
Completed (C)	46	765.00	453.96
Under Execution (UE)	26	481.50	316.63
Total	**72**	**1246.50**	**770.59**

Teaching and Training

The department is engaged in academic activities for engineering oriented regular, short term, specialized training courses for sugar engineering, sugar technologists and distillery staff (Alcohol technology and Bio-fuel) with well-defined emphasis to suit the industry requirements.

The Institute conducts sugar engineering diploma and sugar engineering certificate courses on regular basis. Apart from class room education, to instill confidence in students, case studies are also discussed to enable them to work independently in the mills. The department also organizes short term courses for boiler and turbine attendants, mill foreman, cogeneration operators & supervisors to familiarize themselves with the operation & maintenance.

Besides, to develop the skills of the staff in operation & maintenance of co-generation, a tailor made workshop-cum-seminar programme was designed. In addition, a short term training programme on "Bagasse based co-generation" was also conducted. International training programme was conducted for Fiji delegates of Fiji Sugar Corporation at VSI.

RESEARCH AND DEVELOPMENT

R & D is a continual ongoing activity. The department undertakes cost-effective R & D projects useful to the Indian sugar industry to enhance its viability, competitiveness and sustainability. The department is committed to deliver the techno-economically feasible options to sugar mills. New applied R & D projects are undertaken to enhance the dissemination of the knowledge on latest new technologies for improving processing and energy efficiency.

Mill trash plate profile modification suitable for maximum juice extraction

By modification of trash plate profile and by increasing heat clearance moisture % bagasse will reduce subsequently increasing GCV of bagasse, boiler efficiency and steam to fuel ratio (Fig 2).

Results observed

- With proposed modification, there will be reduction of moisture about 1% (from 50% to 49%) on bagasse
- GCV of bagasse improves from 2275 to 2321 Kcal/kg and ratio S/B (with HP heater) from 2.42 to 2.5 and without HP Heater 2.2 to 2.25
- Improves boiler efficiency from 70 to 70.89%

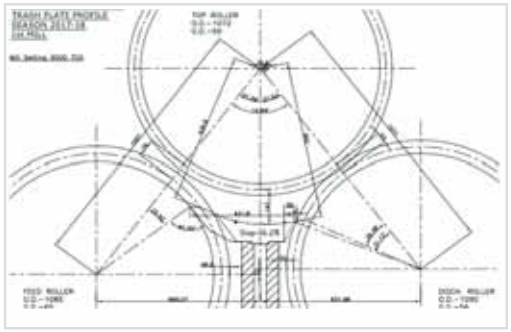

Fig 2 : Trash plate modification to increase heel clearance

Development of innovative cane carrier (heating of 2nd mill juice through DCH for enhancing of juice imbibition's effect on the mill wet bagasse)

By converting existing rake type carrier into diffuser carrier in milling tandem will increase the primary mill extraction (Fig 3).

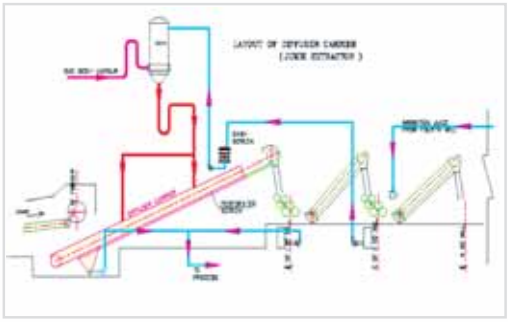

Fig 3 : schematic diagram of diffuser carrier

Results

- Improves imbibition affectivity
- Improves first mill extraction
- Saving of maintenance cost

Low speed milling technology in sugar industry

To study the conventional high speed vs. low speed milling technology in different sugar mills relating to milling performance. Conventionally, mills are operated at surface speed of 12 to 16 meter/ minute. The study conducted for different mills speed in sugar mills during 2016-17 and 2017-18. The results of R & D work were found encouraging for low speed milling technology.

EXTENSION AND ADVISORY SERVICES

The department has played a proactive role in enhancing performance of the sugar mills by rendering timely and technically most suitable advice as a part of extension services during operational season and off-season maintenance period. The outstanding improvements in the performance of the sugar mills outlined below are primarily attributed to the guidance of the dedicated and committed technical expert team of the department. During the year, 576 visits were paid by the department to sugar mills and co-generation plants for extending consultancy and extension services on various specified issues arisen 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

Ashok SSK

The management desired to improve the crushing rate along with plant performance. Hence, by balancing the plant at minimum investment as per the VSI guidance, mill improved crushing rate from 2356 to 3936 TCD. The capacity utilization improved from 76.6 to 133%. RME improved from 95.06 to 96.46%. Ultimately, the recovery % cane improved from 9.25 to 10.66.

Dr. Balasaheb Ambedkar SSK

The mill was facing the problem of shear pins breakage of coupling while synchronizing 10 MW TG set to grid. VSI Engineers checked the general associated reasons for cause like malfunctioning of governor on load, and / or AVR or Problem in switch-yard CT& PT Connection, but all were intact and in correct position. On further investigation of auxiliary equipment, it was noticed that BUS PT is having much lower resistance than required. Therefore, it was replaced with suitable one and synchronized with TG to TG, TG to Grid, solo operation. At present, both old and new 10 MW TG sets are running satisfactory.

Halsidhanath SSK, Karnataka

The management wanted to sort-out the problem of frequent tripping of fibrizers (2 x 1000 KW) on overload which was instrumental in hampering the crushing rate. The existing setting parameters of the motor protection relay & its time durations with respect to motor characteristic curves were checked and rectified. TG set was tripping on grid failure and was not running on island mode. The interlock between grid breaker and export breaker was not functioning properly. Thereafter, the trouble of tripping was eliminated.

Kadwa SSK

The management was interested to enhance their existing crushing rate by 200 TCD by addition of minimum equipment. It was observed that during the previous crushing season, stoppages of sugar mill were more at cane kicker due to jamming of harvested sugarcane pieces. The tilting table was shifted to appropriate location and flow of chopped cane is stabilized on cane carrier resulting no jamming of sugarcane at kicker throughout the season. Further, one evaporator body (1600 sqm) and one pan (60 T) with receiving crystallizer was installed. The existing vapour bleeding system of evaporator set was re-arranged. After implementation of above modifications, the sugar mill achieved an increased crushing by 300 TCD as compared to previous season.

Kanoria Sugars & General Manufacturing Company Ltd., UP

The management was interested to assess the machinery to improve recovery and plant performance. After implementing the recommendations, the management confirmed that the overall recovery % cane was improved by 0.75.

Kukadi SSK

The mill was facing tripping problem in 12 MW TG set due to earth fault which was hampering the crushing season. After re-setting all relays and further testing, it was noticed that the rotor was failed. The rotor was sent to the manufacturer for further analysis. The reports revealed that the rotor was failed due to sudden jerk from 132 KV MSETCL grid line and then rotor rewinding was

carried out. Meanwhile, adjustments were made in the setting values of earth fault relay, –ve (negative) phase sequence relay and other relays, so that same problem will not occur in future. TG set was taken into service with rewound rotor and above adjustments. It was working smoothly with full load of 12 MW.

Malegaon SSK

The management wanted to carry out modernization of existing plant. Accordingly, station-wise additions at mill and pan section were made as per the modernization/ balancing report. The mill improved the performance of the plant with desired crushing rate of 5000 TCD in 2017-18 (excluding stoppages) with peak crushing of 6000 TCD, with improved RME 96.5% (Deer), Pol % bagasse 1.8 and moisture % bagasse 47 to 48.

Mula SSK

It was informed that a heavy flash was occurring at the stator end of 14 MW generator was occurring. It was noticed that it occurred due to improper connections of stator end and insulation. The required material of the damaged portion was fabricated at mill and secured proper connection with insulation. Then, it was taken into service after complete checking of all required operations. The 14 MW TG set was running smoothly at full load in the season.

Shree Valsad SKUM, Gujarat

Considering the cane availability, the management wanted to reduce crushing capacity from 5000 to 2500 TCD by adjusting the internals of connecting equipment mill size (4 mill tandem of 40" x 80"). The plant performance was not encouraging at this crush rate. The different mill tests were conducted by plotting brix curves, analyzing the juice distribution, individual mill efficiency & extraction, effectiveness of imbibition and mill sanitation (ERQV) enable to reduce the undetermined losses. Fibrizer turbine speed was increased besides the adjustment of fibrizer opening. Consequently, Preparatory Index (PI) increased from 68 to 76. Imbibition water application point was shifted towards the 3rd mill discharge side where the compressed bagasse was coming out from discharge (before formation of air pockets) for better water absorption with penetration into the mill bagasse mat. With the above adjustments, primary mill extraction was increased from 64.19 to 71.68 and mill extraction from 94.23 to 95.46 besides reduction in moisture % bagasse from 51.50 to 48.80.

Sonhira SSK

The milling tandem has 1st mill and last mill of 42" x 84" size two roller mills and mill no. 2, 3 and 4 are of 33"x 66" size conventional mills with TRF. For improving the crushing rate, there was a bottleneck of increasing the mill speed of 33" x 66" size mills. Hence, the gear internals of the gearbox were changed to increase the roller speed from 4.90 to 5.92 rpm. Due to this modification, the crushing rate was improved from 5500 to 6500 TCD at 13% fibre.

Vikas SSK (Unit II)

It was informed by the management that the mill was facing a problem of fluctuation in crushing rate, ultimately affecting the mill and plant performance. Suggestions for improvement were given after conducting mill tests. Fibrizer openings were adjusted which resulted in improvement of PI from 72 to 81. Further, mills were reset according to the test results. Subsequently, crushing rate was improved from 2200 to 2800 TCD besides the improvement in Primary Mill Extraction (PE) from 62.24 to 66.17 and mill extraction (ME) from 93.28 to 94.83.

Co-generation proposals

The department actively involved in preparation of co-generation DPRs and tender documents for boilers, TG sets and peripheral equipment, electrical interfacing equipment in co-generation projects. In addition, erection & commissioning of following co-generation projects were monitored and status of co-generation project proposals with power export is specified in table 2 & 3.

Visit to Shinnippon Ltd., Japan for inspection of Turbine

Table 2 : Details of co-generation project proposal

Name of mill	TCD	Co-gen. Cap. (MW)	Boiler Cap. (TPH) / Pressure (ata) / Temp. (°C)	TG Cap. (MW) / Type BP/ DEC	Status / Remarks
Kukadi SSK	2500	15.0	85/87/515	15 / DEC	Project commissioned
Sharad SSK	3500	13	80/45 / 485 (Existing)	13/BP	Project commissioned
Mula SSK	5000	30	80/67/485 (Existing) 85/87/515 (New)	16/DEC (Old) 14/BP (New)	Plant commissioned Power export during Season - 20 MW Off-season - 7 MW
Rena SSK	2500	12	(40+40)/ 45/485	12 BP	Project commissioned Power export during Season - 6.5 MW
SMSN Nagawade SSK	5000	27	140/87/515	12/BP 15/DEC	Project under execution Power export during Season - 19 MW Off-season – 10 MW
Jagmitra Sugar Mills	3500	15	90/73/520	15/DEC	DPR prepared and submitted Power export during Season - 9.18 MW Off-season - 12.73 MW
Venkteshwara Power Project	12000	56	80 & 70 /66/510 (Existing) 190/87/535 (New)	8/BP & 15/DEC 36/ DEC	DPR prepared and submitted Power export during Season - 38.85 MW Off-season - 7.05 MW
Swami Samarth Sugar and Power	3500	14	80/87/515	14 BP	Project under execution
Tuljai Sugars	3500	12	70/87/515	12 BP	Project under execution
Diligence Sugar	2500	12	80/87/515	12 BP	Project under execution

Table 3 : Status of actual export of power of prominent sugar mills through co-generation projects executed by VSI

Name of mill	Installed capacity (MW)	Year of commissioning	Units exported (MUs)	
			During 2017-18	Since commissioning
Co-operative (A)				
Jawahar Shetkari SSK	27	1994-95	27.35	582.99
Mula SSK	16	2006-07	34.09	257.44
Rajarambapu Patil SSK (Wategaon unit)	12	2006-07	21.01	265.17
Dnyaneshwar SSK	12	2007-08	40.39	265.49
Vitthalrao Shinde SSK	40	2007-08	95.10	434.34
Malegaon SSK	21	2009-10	39.98	410.89
Sanjivani (Takli) SSK	12	2009-10	16.85	100.98
Sonhira SSK	22	2010-11	44.92	321.63
Vikas SSK	18	2010-11	27.73	131.45
KA Tope Samarth SSK, Unit I	18	2011-12	36.21	234.89
SM Kagal Taluka SSK	12	2011-12	18.18	112.62
Vighnahar SSK	18	2012-13	35.14	202.60
Vishwasrao Naik SSK	15	2012-13	45.96	192.22
Bhimashankar SSK	19	2013 -14	37.00	317.66
Lok. S. Solanke SSK	22	2013-14	39.51	122.97
Kumbhi Kasari SSK	19.5	2013-14	31.22	137.52
Kukadi SSK	12	2013-14	16.35	70.39
Ashok SSK	15	2013-14	32.30	137.69
Nira Bhima SSK	18	2014-15	28.14	96.62
Sant Tukaram SSK	14.32	2016-17	30.64	58.15
Sharad SSK	12	2016-17	12.04	20.04
Total (A)			**712.11**	**4475.75**
Private (B)				
Dwarkadhish Sugar Mill	13	2010-11	31.69	129.56
Ambalika Sugar	15	2012-13	82.00	268.20
Bhairavnath, Unit-IV	12	2014-15	28.22	43.20
Total (B)			**141.91**	**440.96**
Total (A+B)			**854.02**	**4916.71**

Detailed Project Reports (DPR)

DPRs for co-generation proposals of the sugar mills were prepared and submitted (Table 4).

Table 4 : Details of DPRs

Name of mill	TCD	Co-gen. Cap. (MW)	Boiler Cap. (TPH) / Pressure (ata) / Temp. (°C)	TG Cap. (MW) / Type BP/ DEC	Status / Remarks
Diligence Sugar	2500	12	80 / 87 / 515	12 / BP	Project under execution
Jagmitra Sugar Mills	3500	15	90/73/520 (New)	15/ DEC	DPR submitted
Swami Samarth Sugar and Power	3500	14	80 / 87 / 515	14 / BP	Project under execution
Tuljai Sugars	3500	12	70 / 87 / 515	12 / BP	Project under execution
Venkteshwara Power Project, Karnataka	12000	36	190/87/535	36/ DEC	DPR submitted

Topping cycle ratio certification

Department has scrutinized the topping cycle documents and issued certificates to following sugar mills

- Ajinkyatara SSK
- Ashok SSK
- Dnyaneshwar SSK
- Jawahar Shetkari SSK
- Kisanveer Satara SSK
- Kukadi SSK
- Sharad SSK
- Dudhganga Vedganga SSK
- Gurudatta Sugars

Modernization proposals

Modernization proposals were prepared for the following sugar mills with the aim of reducing steam and captive power consumption for enhancing the exportable power from co-generation plants. Also emphasis is given for improving the technical performance and enhancing the capacity utilization. The details of machinery specifications are given separately under tender technical specifications and scrutiny of design and drawing of equipment.

- Agasti SSK - Modernization for 2500 TCD
- Kadwa SSK - Renovation DPR 1600 TCD
- Malegaon SSK - Modernization for 4000 TCD

Expansion proposals

Prepared DPR for expansion of sugar plant of the following sugar mills.

- Narmada SKUM, Gujarat - Expansion from 4000 to 5000 TCD
- Malegaon SSK - Expansion from 4000 to 7000 TCD
- Prasad Sugar & Allied Agro Products Ltd. - Expansion from 2500 to 4000 TCD

New sugar mill projects

- Khatav Man Taluka Sugar Mill - 2500 TCD sugar plant with 12 MW co-generation
- Jagmitra Sugar Mills Ltd. - 3500 TCD sugar plant with 15 MW co-generation
- Nandi SSKN - 5000 TCD sugar plant with 37 MW co-generation
- Shiur Sakhar Karkhana Pvt. Ltd., - 2500 TCD plantation white sugar production

Report on revival of sick sugar mills

The technical team of VSI visited to the twenty sick sugar mills and prepared the revival reports (Table 5) along estimated cost to restart the mill as per the guide lines of Commissioner of Sugar, Pune. Besides the above report of revival of sugar mills, the other reports prepared are specified (Table 6).

Table 5 : Revival report of sick sugar mills in Maharashtra

Name of mill	Name of mill
Ambajogai SSK	Balaji SSK
Bhausaheb Birajdar SSK	Banganga SSK
Dr. V V Patil SSK, Kej	Gajanan SSK
Gangapur SSK	Jai Bhavani SSK
Jai Jawan Jai Kisan SSK	K K Wagh SSK
Late Bapurao Deshmukh SSK	Mahesh SSK, Kada Sakhar
Nasik SSK	Niphad SSK
Sangola SSK	Shetkari Killari SSK
Shivajirao Patil Nilangekar SSK	Tasgaon SSK
Terna Shetkari SSK	Yashwant SSK

Table 6 : Other reports

Name of mill	Details
Ajinkyatara SSK	Valuation of 18 MW co-gen. plant
Loknete Sunderraoji Solanke SSK	Restructuring of SDF loan for revival
Ambaji Trading Company (M/s. Belganga)	Revival report
Gangapur SSK	Valuation of 1800 TCD sugar plant
UP State Sugar Corporation Ltd., Unit Pipraich, UP	New sugar plant for 3500 TCD expandable to 5000 TCD along-with 18 MW co-generation
UP Co-op. Sugar Factories Federation Ltd., Lucknow, Ramala Sugar Mill, Bagpat	2750 to 5000 TCD (Expandable up to 7500 TCD) with 25 MW co-generation

Report on revival for Punjab State Sugar Federation

Basic revival reports for modernization and rehabilitation prepared for six sugar mills viz. Budhewal, Morinda, Nawanshahr, Nakodar, Fazilka and Ajanala.

Consultancy to non-member sugar mills

The department provided consultancy to non-member sugar mills for improving the technical performance (Table 7).

Interviews conducted for selection of technical personnel

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

- Ashok SSK
- Krishna SSKN, Athani, Karnataka
- SMSN Nagawade SSK
- Vitthal SSK

Preparation of tender technical specifications for plant and machinery

Tender technical specifications of machinery and equipment were prepared for following mills

KS Kale SSK

- 15 TPH (Spent wash) Incineration Boiler (45 ata / 400 °C)
- 1.5 MW TG set
- 10 TPH DM Plant
- Coal and ash handling system
- EOT Crane and Cooling Tower

KA Dr. GD Bapu Lad SSK

- 22 TPH Incineration Boiler
- 2 MW TG set
- 10 TPH DM Plant
- Coal and ash handling system
- EOT Crane and Cooling Tower

SM Kagal Taluka SSK

- Spent wash incineration boiler of 16 TPH @ 46 ata/ 390 °C with all accessories
- Matching Turbo - Alternator 1.5 MW
- DM Plant
- Coal and ash handling system
- EOT Crane and Cooling Tower

Nandi SSKN, Karnataka

- Expansion of sugar plant 5000 TCD expandable to 7500 TCD on EPC basis
- 37 MW complete co-generation plant on EPC basis
- 220 TPH Boiler
- 37 MW TG set
- 50 m^3/hr DM plant
- Cooling tower
- Bagasse and ash handling system
- Mill house and boiling house

Dwarkadish Sakhar Karkhana

- Multi fuel boiler of 12 TPH @ 46 ata/490°C with all accessories
- Matching Turbo - Alternator 1 MW

Scrutiny of design and drawing of equipments

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

Nandi SSKN, Karnataka

- Co-generation plant layout
- PID's for 220 TPH / 87 ata / 515 °C boiler and 37 MW DEC type TG set
- Surface condenser
- Steam jet air ejector system
- Oil coolers
- 37 MW overall SLD
- 37 MW Alternator data sheet, GA and curve drawings
- AVR panel drawings
- CT, PT, NGR sizing calculations

Table 7 : Consultancy provided to non-member sugar mills

Name of mill	State	Details
Sharad SSK, Paithan	Maharashtra	Review/assess the off-season work to start the mill in Jan. 2018
Shree Valsad SKUM	Gujarat	Improving the overall performance
Tirupati Sugar	Bihar	Capacity assessment work

SM Kagal Taluka SSK

- Spent wash Incineration boiler of 16 TPH @ 46 ata/ 390 °C GA drawing with all accessories

Chhatrapati SSK

- 220 KV CT, PT, Isolator and breaker
- Auto Slip Regulator (ASR) drawings of fibrizer
- DSLC, MSLC panel drawings

Inspection of machinery and equipments

Inspection of machinery and equipment for following mills was carried out.

Chhatrapati SSK, Bhavaninagar

- Planetary gearboxes (20) for different drives
- Pressurized ventilation system
- HT VCB panel
- Mill, boiler and sugar VFD
- 555 KW mill motor
- 375 KW leveler motor
- PCC, APFC and various MCCs
- 20 MVA 11/220 KV generator transformer

Bhima (Takali) SSK

- HT VCB panel
- ASR panel for fibrizer motor
- VFD and MCCs of mill station

Visit of VSI Team at Thanh Thanh Cong Sugars (TTCS) Vietnam

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 guides the alcohol industry for achieving maximum productivity, efficiency and yield from various feedstock, improving quality of various finished products and achieving Zero Liquid Discharge (ZLD). The department acts as a consultant/inspection agency for ongoing and proposed molasses and non-molasses based distilleries and effluent treatment projects. In addition, technical inputs and guidance to various Government and non-Government agencies are provided. A compilation on "Technical performance of VSI member distilleries in Maharashtra" affiliated to sugar mills of the state is published every year.

The department conducts MSc (Wine, Brewing and Alcohol Technology) course affiliated to the Savitribai Phule Pune University, Pune and a post-graduate diploma in Industrial Fermentation and Alcohol Technology (DIFAT). In addition, need based short-term courses in the areas of Alcohol Technology and Effluent Treatment Technologies are conducted. The department provides guidance to PhD, MTech and MSc students from various universities. The students were recruited in various breweries, distilleries, wineries and bottling units across India.

The department has received accreditation from National Accreditation Board for Testing and Calibration Laboratories (NABL), Department of Science and Technology, Govt. of India.

The department has prepared Effluent Treatment Plant (ETP) Adequacy Assessment Reports and Assessment Validation Reports for distilleries located in Ganga basin (including Uttar Pradesh, Bihar, West Bengal and Uttarakhand) as per the directions given by the Central Pollution Control Board (CPCB). It is now mandatory for Ganga basin as well as all distilleries in the country to achieve ZLD as per Corporate Responsibility for Environment Protection (CREP) norms. In addition, revival reports of sick distilleries attached to the co-operative sugar mills in Maharashtra were also prepared as per direction of the Commissioner of Sugar, MS.

The department has also prepared a report on "Technical cum adequacy assessment report on status of distillery units in co-operative sector in Punjab State" as required by the Punjab State Federation of Co-operative Sugar Mills Ltd., Chandigarh.

RESEARCH AND DEVELOPMENT

- **Pre-clarification of molasses to improve the performance of alcoholic fermentation**

The investigation of various pre-treatment methods showed that carbonation along with heating was found to be promising and economical method for pre-clarification of molasses. Process parameters such as brix of molasses, temperature, time of heating along with dosage of polyelectrolyte were optimized for carbonation process.

Bench scale pre-clarification experiments

Fermentation experiments of pre-clarified molasses were conducted to determine the effect of ionic reduction on 10 lit. draft tube reactor assembly. It was found that at 40° brix, sparging CO_2 with flowrate of 30 LPM for 30 min at 80°C and polyelectrolyte dosage of 5 ppm achieved highest ionic reduction. Total cationic reduction of around 36.09% was obtained using optimized carbonation method. The increase in fermentation performance can be clearly co-related to decrease in ionic content of molasses broth and inhibition of microbial flora due to heating of molasses. The pre-clarification method developed resulted in enhancement of fermentation efficiency by around 2.0 - 2.5% with increase in yield from 266.63 to 274.54 lit./T.

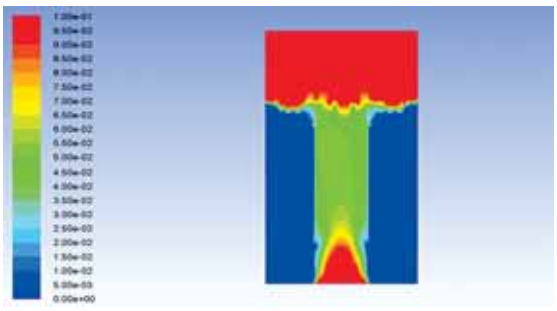

Fig. 1 : Contours of gas volume fraction over the cross section plane of the laboratory airlift reactor

Computational Fluid Dynamics (CFD) analysis of the draft tube reactor was also conducted at the Institute of Chemical Technology (ICT), Mumbai. CFD simulation was carried out to understand the flow patterns in the reactor. The data generated is being used to design the draft tube carbonation reactor for pilot scale plant. Fig. 1 shows the contours of gas volume fraction in the laboratory airlift reactor. It can be concluded that only central zone of the reactor showed sufficient gas mixing and negligible mixing around the wall of the reactor which means that significant area of the reactor was not utilized. Therefore, the flow inside the reactor has to be streamlined and all the sharp corners and step baffles which hinder the circulation must be avoided in pilot scale reactor design. Least number of column internals will have to be used.

Vectors of liquid velocity coloured by the velocity magnitude over the cross section plane of the laboratory airlift reactor are shown in fig 2. The structure of the draft tube has certain influences on the gas holdup and distribution. The CFD report indicates the possibility of improvements of the draft tube structure increasing the gas residence time, which can lead to a more even distribution of the gas phase in the riser area and prevent the plug flow in the down comer area.

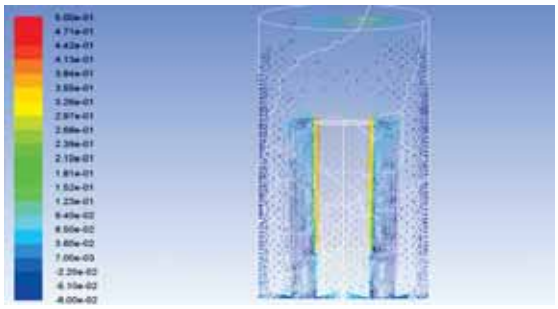

Fig. 2 : Vectors of liquid velocity coloured by the velocity magnitude over the cross section plane of the laboratory airlift reactor

Based on the results, office of Principal Adviser to GoI has sanctioned a new research project to validate the results at pilot scale.

The objectives of pilot scale pre-clarification project are:

- Further design improvement at pilot scale plant for proposed pre-clarification technology employing CFD analysis.
- Installation of skid mounted pilot scale plant at Daund Sugar (distillery unit).
- Operation of pilot scale plant and performance evaluation.
- To investigate the effectiveness of proposed pre-clarification technology on fermentation efficiency and downstream effluent treatment system.
- To evaluate merits & demerits and cost benefits of proposed pre-clarification method on the pilot scale plant.
- To carry out SWOT analysis of proposed pre-clarification technology and to prepare a business plan based on results obtained from pilot scale plant.

- **Cellulosic ethanol production through syngas route**

In previous studies flask level experiments were conducted for syngas fermentation comprising of 55% CO, 20% H_2, 10% CO_2 and 15% Ar. In current study, bench scale experiments were conducted at 3 lit. scale in fermenter of 10 lit. capacity using *C. ragsdalei* (DSM15248).

Design of bench scale fermenter for syngas fermentation trials

An accurate and reliable technique would be essential to adjust the fermentation parameters (such as agitation speed, gas flow rate and liquid flow rate) in order to meet the cells kinetic requirement. The increase in gas flow rate beyond cells kinetic requirements would decrease gas uptake efficiency, while increasing agitation speed and liquid flow rate would have detrimental effects on the cell viability and costs associated with power consumption in large-scale reactors.

To study these parameters, a bench scale fermenter for gas fermentation was designed. The image of in-house designed fermenter is shown in fig.3. The designed fermenter had L:D ratio of 3:1 and was used for maximum mass transfer in gas fermentation for enhancing metabolite production. The fermenter has gas inlet port with flow meter and outlet port for gas purging. The fermenter also has sample port for sample withdrawal and agitation speed controller.

Fig. 3: Bench scale fermentation set up for syngas fermentation experiments

Bench scale fed batch syngas fermentation trials

Fermentation on bench scale was carried out for 7 days at 400 rpm agitation and operating pressure at 0.5 bar gauge at 37 °C using *C. ragsdalei* (DSM15248) with 3 Lit working volume. Syngas purging was carried out for 12 hr at 0.5 LPM followed by 12 hr of gas hold up.

The cell density was determined by estimating absorbance at 600 nm. Ethanol was estimated using gas chromatography system coupled with flame ionization detector (FID). H_2 was used as carrier with flow rate of 5 ml/min. The temperature of GC oven was raised by 5 ^{O}C/min from 50 ^{o}C until it reached to 230 ^{O}C. The concentration of ethanol was determined using external standard. The results obtained are shown in table 1.

Table 1 : Bench scale syngas fermentation

Time (Days)	Ethanol concentration (g/L)	OD @ 600 nm
0	0.01	0.5
1	1.4	0.9
2	2.4	0.9
3	1.3	1.2
4	1.5	1.6
5	1.6	1.4
6	0.6	2.1

It was observed that there was a gradual increase in cell density, while maximum ethanol was obtained on day 2. The decrease in ethanol concentration after two days may be attributed to its utilisation by the fermenting microorganism for growth and/or maintenance activities. Further studies with genome shuffled strains and process optimisation have been planned.

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

Effect of enzyme loading on sugar liberation and ethanol production

Sugarcane bagasse (SCB) of cultivar Co 86032 was used for analyzing structural components such as cellulose, hemi-cellulose and lignin content. SCB pre-treatment enzymatic hydrolysis and detoxification was carried out using protocol developed at VSI. The details of sugar release and hydrolysis efficiency are shown in fig. 4.

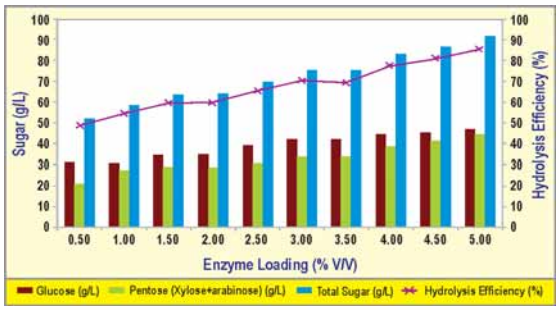

Fig. 4 : Effect of enzyme loading on release of sugars during enzymatic hydrolysis

With increase in enzyme loading, enhancement in liberation of sugar was observed. Maximum total sugars of 91.3 gm/L with hydrolysis efficiency of 85.3% was obtained at 5% (v/v) dosage of enzymes. Glucose liberation indicated saturation after 4% (v/v) of enzyme dosage while pentose (xylose + arabinose) showed gradual increase with increase in enzyme dosage.

Nutrient supplemented SCB hydrolysates were inoculated with 5% (v/v) Scheffersomyces stipitis (NCIM 3498) and 5% (v/v) of S. cerevisiae (VSI1011) containing app. 3.5×10^8 cells/ml and incubated at 32 ^{O}C at 120 rpm. Samples were withdrawn for determination of total sugars and ethanol concentration after every 12 hours. Fig. 5 represents ethanol production profiles of hydrolysates obtained with different enzyme loading.

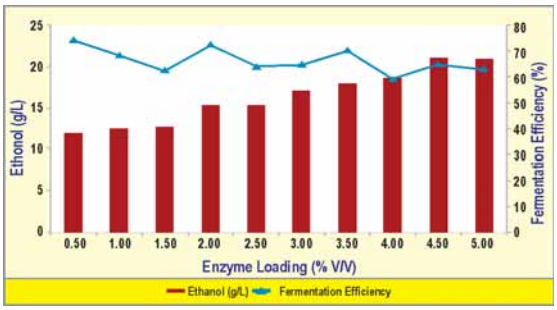

Fig. 5 : Fermentation profiles of hydrolysates obtained from different enzyme loading

It was observed that with increase in total sugars, there was enhancement in final ethanol obtained in fermenting broth. However, there was gradual decrease in the fermentation efficiency. After 4% (v/v) of enzyme dosage there was no further significant increase in ethanol production.

Bench scale experimental results

Based on results obtained on shake flask level, experiments were conducted on 3 lit. scale in Eppendorf NBS fermenter. The fermentation parameters were maintained similar to that of shake flask level. The comparison of fermenter and shake flask level experiments are shown in fig. 6.

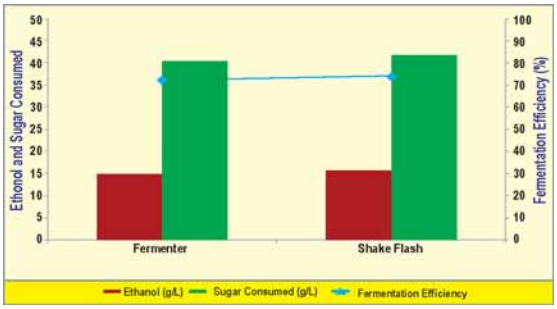

Fig. 6 : Comparison of fermenter and flask scale fermentation data

It can be concluded that the results obtained on shake flask (100 ml) are scalable to bench scale level (3 Lit). Further optimization of the process parameters such as pre-treatment conditions, enzyme dosing, fermentation parameters (pH, temperature and feeding rates) on 3 Lit level are in progress.

- **Recovery of Potash from incineration boiler ash and its utilization in agriculture**

Office of the Principal Scientific Adviser to GoI has sponsored this project for one year. The objectives are:

- To develop accurate methods of analysis of potash and other ingredients from boiler ash & pre-clarification sludge.
- Development & optimization of chemical process technology for recovery of potash & other nutrient salts from incineration boiler ash and pre-clarification sludge on bench scale.
- Extensive studies on water & organic acid leaching of ash and optimization of process parameters.
- To investigate & work out the material balance of inorganics and organic matter of incineration boiler ash before & after recovery of potash and other salts.
- To evaluate the cost benefit analysis against various potash recovery processes and monetary benefits of ash leaching process.
- Selection of most techno-economic feasible method for further scale up.

Standardization of analytical methods on estimation of cations and anions was in progress. Various methods have been described for potassium recovery such as water & acid leaching, electrostatic separation, carbonation & froth floatation etc. Of these, water and acid leaching method has suggested to be the most desired for potash recovery. Preliminary work on recovery of potash using water leaching was in progress.

Development of bio-digester for treatment of concentrated (up to 30% solids) spent wash

Work at VSI

Anaerobic digestion experiments were carried out on acclimatization of methanogenic bacterial cultures for high brix spent wash using lab scale bio-digesters. After acclimatization and stabilization of the digester, it was fed with concentrated spent wash having 30° brix. The pH of the feed spent wash was not maintained. Using spent wash having 30% solids and COD of 242000 - 245000 mg/lit., it was possible to achieve 60-62% COD reduction and maximum bio-gas generation.

Work at Shree Renuka Sugars, Athani

In first phase of operation of pilot digester, the work was disturbed because of high COD load of 9.37 kg/M^3/day.

Second phase of trial

The pilot digester was re-inoculated and restarted using acclimatized consortium of microorganisms. The digester was also charged with 2850 Lit. of cow dung slurry which was completed within 8 days. The analytical data is presented in table 2.

Digester pH of 7.2 - 7.5 indicates that the development of acetogenic and acidogenic microorganisms were at the optimum level. After 60 days, the volatile fatty acids concentration in the digester was 2828 ppm. As the digester got stabilized, it slowly decreased to 1140 ppm after 120 days. The ratio of volatile fatty acidity and alkalinity was more (0.18) at the beginning while it decreased to 0.07 in around 120 days. After 80 days, the digester got stabilized with consistent COD removal of above 66% indicating successful acclimatization of mesophilic methanogens to the concentrated spent wash. The graphical representation of digester feed and outlet COD is shown in fig. 7.

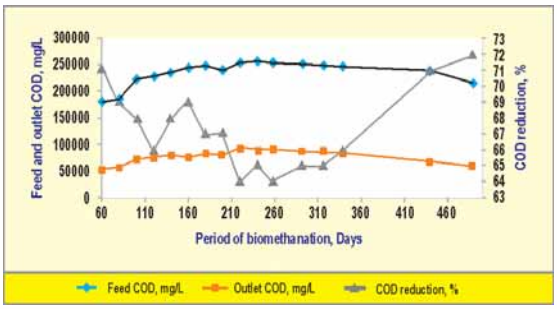

Fig. 7 : Graphical presentation of digester feed and outlet COD

This study successfully demonstrates anaerobic digester performance for 495 days by feeding high brix spent wash (25° brix) with COD reduction of 65% and average bio-gas generation of 24.32 M^3/ day. Commercial scale trials of this advanced bio-methanation technology will be conducted at Renuka Sugars (Athani Unit) in coming season.

EXTENSION AND ADVSIORY SERVICES

Detailed Project Reports (DPRs) and tender documents

DPRs and tender documents for new distilleries, modernization of existing units and ETPs completed are given in table 3.

Table 2: Analytical data of pilot digester-second phase

Days	Flow rate (L/day)	Feed °Brix	Feed COD, (mg/L)	Loading rate, (M^3/Day)	RT Days	Outlet °Brix	Outlet COD, (mg/L)	COD reduction (%)	Gas generation/ Kg of COD reduced	Actual Gas generation, (M^3/Day)
60	488	15	180000	6.27	28.68	7.3	52000	71	31.18	26.65
80	482	19	184000	6.33	29.04	8.3	57000	69	30.59	23.52
100	480	23	222000	7.61	29.16	8.7	72000	68	36.23	22.62
120	483	24	228000	7.86	28.98	8.8	76500	66	36.34	26.53
140	484	25	235000	7.58	30.99	8.9	80000	68	38.67	21.97
160	482	25	244000	7.84	31.12	9.0	76000	69	40.57	26.75
180	483	25	248000	7.98	31.05	9.1	82000	67	40.12	25.68
200	482	25	240000	7.84	31.12	9.2	80000	67	39.39	26.82
220	486	25	254000	8.22	30.86	9.3	92000	64	39.50	26.37
240	483	25	256000	8.24	31.05	9.4	89000	65	40.18	25.47
258	485	25	254000	8.21	30.92	9.3	92000	64	39.42	25.40
292	484	25	252000	8.13	30.99	9.0	87000	65	39.63	26.10
316	483	25	248000	7.98	31.05	9.0	88000	65	38.92	25.35
339	480	25	247000	7.90	31.25	10.0	85000	66	39.12	25.99
440	480	25	238000	7.37	31.25	9.0	68000	71	40.55	21.22
489	465	25	215000	6.65	32.25	9.0	60000	72	35.99	23.40

Table 3: DPRs and tender documents

Name of distillery	DPRs-Plant capacity and configuration
Malegon SSK	60 KLPD distillery plant modernization
Sanjivani (Takli) SSK	90 KLPD distillery effluent treatment system up-gradation
Dwarkadhish Sakhar Karkhana	30 KLPD distillery plant with effluent treatment system (Bio-gas, spent wash evaporation plant, bio-composting and CPU)
Spent wash evaporation plant, incineration system and CPU	
Vitthalrao Shinde SSK	45 KLPD grain based distillery plant and revised DPR for 80 KLPD MSDH plant and effluent treatment system for 120 KLPD distillery
Bhaurao Chavan SSK	Revised DPR for expansion from 30 to 60 KLPD with effluent treatment system
Prasad Sugar and Allied Agro Products	30 KLPD distillery plant with effluent treatment system
Sharad SSK	Revised 30 KLPD distillery plant with effluent treatment system
UP State Sugar Corporation, Pipraich,	60 KLPD distillery plant dual feed & effluent treatment system
Vishwasrao Naik SSK	30 KLPD distillery effluent treatment system
Bhoramdev SSUKM, Chattisgarh	40 KLPD distillery plant with effluent treatment system
KA Tope Samarth SSK	Modernization of 30 KLPD distillery plant with effluent treatment system
Tender Documents	
KS Kale SSK	Reverse Osmosis (RO) plant
Malegaon SSK	Modernization of 60 KLPD distillery plant and CPU
Vitthalrao Shinde SSK	80 KLPD MSDH plant, standalone spent wash evaporation plant and CPU
KA Tope Samarth SSK	30 KLPD ethanol plant modernization
Sanjivani (Takli) SSK	Spent wash evaporation plant and CPU
Dwarkadhish Sakhar Karkhana	30 KLPD distillery and effluent treatment system (Bio-gas, spent wash evaporation plant, bio-composting and CPU)
SMSN Nagwade SSK	Spent wash evaporation plant and CPU
Ashok SSK	20 KLPD ethanol plant
SM Kagal Taluka SSK	30 KLPD distillery and effluent treatment system (Spent wash evaporation plant and CPU)
Dnyaneshwar SSK	Bio-gas, spent wash evaporation plant and CPU

Visit of Ms. Rajshree Pathy, Chairperson of Rajshree Sugars and Chemicals Ltd., Coimbatore (TN) to the Institute.

Visit of Sugar Commissioner, MS and Vice Chancellor, SPPU, Pune to the Institute.

Preparation of adequacy assessment reports for distillery ETPs in Ganga Basin

CPCB has taken initiative to assess the effluent treatment plant (ETP) performance and achieving the prescribed norms by sugar mills and distilleries in the Ganga basin. In the meetings, it was decided that around 46 distilleries including yeast manufacturing plants, breweries and bottling plants will get ETP adequacy assessment reports and upgradation plan prepared from any of the reputed institutions like IITs, Vasantdada Sugar Institute (VSI) or National Sugar Institute (NSI).

Of these, 31 units were allotted to VSI and 15 to NSI. VSI team paid visits to 20 distilleries for collecting information. Remaining 11 units are either closed or have not responded to VSI or CPCB directions. The team inspected the fermentation, distillation and ETP sections of each distillery unit. In addition, discussion regarding various issues related to distillery, performance of ETPs and operational problems were carried out. The adequacy assessment reports of distillery ETP's have been prepared and submitted to concerned distilleries (Table 4).

During the visit, it was found that, many distillery units were not in operation. Hence, CPCB directed VSI to validate the performance of ETPs during operation of the distilleries and submit the ETP Adequacy Assessment Validation Reports and status of compliance of suggestions/recommendations made in the Adequacy Assessment Reports of distillery ETPs. Therefore, VSI team again paid visits to the distilleries to validate the performance of distilleries and downstream ETPs. Based on the actual performance of distilleries & ETPs, the validated Adequacy Assessment Reports were prepared & submitted for five distilleries from UP viz. Jain Distillery; Mohit Petrochemicals Pvt. Ltd.; Radico Khaitan Limited; Superior Industries Ltd. (Distillery Div.) and Avadh Sugar & Energy Ltd., Distillery Unit, Seohara, Bijnor.

Preparation of ETP adequacy assessment reports for distilleries in Maharashtra

CPCB has given directions to some distilleries in Maharashtra to get the ETP Adequacy Assessment Reports prepared from VSI. Four distilleries, i.e. SMB Thorat SSK, RP Ghodganga SSK, Lok. S Solanke SSK and Ajinkyatara SSK

Table 4 : List of distilleries, breweries and bottling units

Name of distillery	Capacity (KLPD)
Avadh Sugar and Energy Ltd., Distillery Unit, Seohara, Bijnor (UP)	100
Avadh Sugar and Energy Ltd., Distillery Unit, Hargaon, (UP)	100
Uttam Sugar Mills Limited, Barkatpur, Dist. Bijnore (UP)	75
New Swadeshi Sugar Mills, Distillery Division, (Bihar)	60
Riga Sugar Company Ltd., (Bihar)	50
Sona Sati Organics Pvt. Ltd., (Bihar)	45
Jain Distillery, (UP)	40
Mohit Petrochemicals Pvt. Ltd., (UP)	40
Modi Distillery, (UP)	22.5
Unnao Distilleries & Breweries Ltd., (UP)	15
Radico Khaitan Ltd., (UP)	100 - Grain based & 200 molasses based
India Glycols Ltd., (Uttarakhand)	425
Superior Industries Ltd. (Distillery Div.), (UP)	45
AB Mauri India Pvt. Ltd., Kalyani (West Bengal)	12 TPD yeast production
United Breweries Ltd., Kalyani (West Bengal)	10,000 cases /day
Saraya Distillery, Sardar Nagar, (UP)	110
Sir Shadilal Distillery & Chemicals Works, (UP)	100
Doon Valley Distillers, (Uttarakhand)	13
United Spirits Ltd., Meerut, (UP)	IMFL 10,000 cases/day
United Spirits Ltd., Rosa, (UP)	IMFL 10,000 cases/day

have received such directions. VSI team visited SMB Thorat SSK and RP Ghodganga SSK for inspection and collection of necessary information. The reports were prepared and submitted to concerned distilleries.

Revival reports of sick distilleries attached to co-op. sugar mills in Maharashtra

The Government of Maharashtra (GoM) has taken initiatives for revival of sick co-operative sugar mills and distilleries in Maharashtra in coming season 2018-19. The Commissioner of Sugar, MS assigned the work of preparation of revival reports of 40 sick sugar mills in the state to VSI. The concerned sugar mills & distilleries were visited and assessed for existing condition of plant & machinery, availability of sugarcane in area of operation, availability of molasses, financial condition, expenses required to restart the sugar and distillery unit etc. The department paid visits to seven distillery units viz. Gangapur SSK, KK Wagh SSK, Jai Bhavani SSK, Ambajogai SSK, Niphad SSK, Terna SSK, Yashwant SSK, Theur and prepared their detailed revival reports. The reports were presented and submitted to the Commissioner of Sugar, MS.

Technical cum adequacy assessment report on status of distillery units in co-operative sector in Punjab

The Punjab State Federation of Co-operative Sugar Mills Ltd., Chandigarh assigned the work for preparation of technical cum adequacy assessment report on status of distillery units in co-operative sector in Punjab State to VSI. Our team visited these distillery units viz. 1) The Gurudaspur Co-operative Sugar Mills Ltd., Paniar- Gurudaspur, 2) The Nakodar Co-operative Sugar Mills Ltd., Nakodar and 3) The Nawanshahr Co-operative Sugar Mills Ltd., Nawanshahr.

The distillery plants were assessed for operational feasibility i.e. existing condition of the plant & machinery, availability of raw material (molasses and PMC), availability of utilities (water, steam, power etc.), effluent treatment system installed for disposal of spent wash to achieve ZLD, various Government clearances/licenses required (State excise license, Ministry of Environment, Forest & Climate Change clearance, consent to operate etc.). The report has been submitted to the Punjab State Federation of Co-operative Sugar Mills Ltd., Chandigarh.

Technical meetings and evaluation of technical offers

The staff of the department attended pre-bid, technical sub-committee and State Level Machinery Purchase Committee (SLMPC) meetings at MRSSK Sangh, Mumbai and Pune for the distilleries viz. Bhaurao Chavan SSK, Malegaon SSK, Dnyaneshwar SSK, SMSN Nagawade SSK. Technical offers received from different suppliers were critically evaluated and comparative statements were prepared and submitted to the concerned distilleries/SLMPC.

Recommendation of proposals

VSI's technical recommendations are required for setting-up of new distilleries, new Effluent Treatment Plants (ETPs) and for modernization/ modification of distilleries and ETPs. The details of recommendations given are mentioned in the table 5.

Inspection of plant & machinery and consultancy services

During project execution, Layout, GA, Civil & Structure drawings, PFDs, P & IDs were checked and approved. Consultancy services were provided to fifteen distilleries for spent wash evaporation, incineration boiler, bio-gas, standalone spent wash evaporation plant and CPU.

Design and costing of plant & machinery

Design and costing of plant & machineries carried out for distilleries viz. Bhoramdev SSUKM, Chattisgarh, Daund Sugar, Gangapur SSK and Ajinkyatara SSK.

Table 5 : Recommendations for new distilleries, ETPs, expansion and modernization

Name of distillery	Details of proposale
KS Patil SSK	Additional Pre-fermenter (60 M^3) and fermenter (280 M^3), one re-boiler for analyzer column, spent wash evaporation plant and CPU
Madhucon Sugar and Power Industries, Telangana	Preparation of audit report and and recommendation for 65 KLPD distillery process with respect to yield, manpower study and optimization of distillery plant including incineration boiler and turbine

Visits

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

Yeast culture bank

Based on the feedback received from the distilleries, it was found that the performance of yeast cultures provided by VSI (VSI-1011) and (VSI 1003) was very good. Ashok SSK and Purna SSK have used the VSI 1003 cultures and achieved improvement in performance (Table 6).

Total 23 yeast culture slants were provided to the seventeen member and non-member distilleries during the year.

Supply of propagated ale yeast culture to Brewcraft India Pvt. Ltd., Pune (Doolally), Independence Brewing Company, Pune and Effingut Brewing Company, Pune was continued in the reporting year. The results of the yeast

Table 6: Performance of VSI cultures in molasses fermentation

Particulars	Ashok SSK using VSI 1003 culture since last 5 months	Ashok SSK before use of VSI culture	Purna SSK using VSI 1003 culture since last 14 months	Purna SSK before use of VSI culture
Average alcohol % (v/v) in fermented wash	8.00 - 8.50	6.50	8.50 - 8.80	7.50 - 8.00
Highest alcohol production (lit/day)	38000	35000	42600	40000
Average alcohol production (lit/day)	35000	30000	39634	36053

Table 7 : Details of samples analyzed by various analytical methods

Name of sample	Number of samples analyzed by		
	Chemical	GC, GC-MS, HPLC and PMI	Atomic Absorption
Country liquor samples from State Excise Dept., Maharashtra	5195	03	–
IMFL samples from State Excise Dept., Maharashtra	261	–	–
Molasses samples from State Excise Dept., Maharashtra	572	–	–
Molasses from distilleries and sugar mills	36	03	–
Rectified spirit	51	48	04
Extra Neutral Alcohol	61	73	05
Impure spirit	05	10	–
Fuel ethanol	22	24	18
IMFL	07	10	–
Excise Grain samples	331	–	–
Excise Denaturant and Bitterant	244	–	–
Molasses – Microbial analysis	09	–	–
Fermentability of molasses	06	–	–
Sugar candy	—	02	–
Cassava	—	02	–
Water condensate	05	–	–
Material testing with PMI machine	–	14,296	–
Total	**6805**	**14471**	**27**

brewing cultures of VSI are very encouraging and these microbreweries are now able to maintain consistent quality of their ale beer. The department has also supplied Lactobacillus culture for production of sour beer to microbreweries.

Analytical services

Details of various samples analyzed by chemical, Gas Chromatography (GC) and GC-MS methods are mentioned in table 7.

Details of various samples analyzed under NABL by chemical and Gas Chromatography (GC) are mentioned in table 8.

Table 8 : Details of samples analyzed under NABL

Name of sample	Number of samples analyzed by	
	Chemical	GC
Rectified spirit	02	--
Extra Neutral Alcohol	09	06
Anhydrous ethanol	04	--
IMFL	76	18
Total	**91**	**24**

Calibration work

In total, 491 hydrometers and thermometers: Sykes hydrometers (295), Specific gravity hydrometer (27), Brix hydrometer (31), Alcohol meters (14) and thermometers (124) were calibrated.

Improving performance of distillery units

Services rendered to distilleries in improving performance and addressing process problems are briefed below.

Magadh Sugar and Energy, Bihar

Sugar mill approached VSI to investigate reasons of low yield of alcohol. VSI team suggested to make appropriate changes in yeast propagation system and improvement in fed-batch fermentation process by changing filling practices of fermenters and extending fermentation time.

The analyzer column vent condenser vapour bottle vent line was wrongly connected to the outlet vapour line of first condenser. Due to this, the vacuum was getting disturbed frequently resulting in huge alcohol losses in vacuum pump sealing water. Significant alcohol loss (around 2.63% v/v) from vacuum pump sealing water and alcohol loss in spent lees was around 1.08 % v/v was noticed. Therefore, suggested to connect it to the outlet vapour line of vent condenser before the manual control valve. After implementation, the plant performance improved substantially.

Someshwar SSK

The sugar mill approached VSI for improving fermentation process and yield of alcohol. Yeast propagation, fed-batch fermentation and distillation processes were inspected and samples from pre-fermenters and fermenters were checked for microbial contamination. Various samples were also analyzed for alcohol losses in distillation.

Bacterial contamination was observed in both the pre-fermenters despite addition of 75 ppm of sodium meta bi-sulphite (SMBS) in pre-fermenter. Advised to add 5 ppm of industrial grade tetracycline in place of SMBS in pre-fermenters and continue addition of 90 ppm of SMBS in the fermenters as practiced. It was observed that, after 8-9 hours of initial dilute molasses feeding, when molasses was directly added and fermenter was filled up to working volume, fermentation process temperature was increasing and remained in the range of 35-37 ^{o}C and occasionally reached above 38 ^{o}C for 3-4 hours resulting in drastic reduction in vitality of yeast biomass. Therefore, advised to install separate cooling tower for fermentation to maintain the fermentation process temperature in the ideal range of 33-34 ^{o}C.

It was also noticed that, only two-week old molasses from current season was used by the distillery. Hence, advised to keep at least two months' requirement of molasses for operation of distillery during the next season. In addition, sugar mill was advised to install MEE plant (for concentration of bio-methanated spent wash from 5-6% to 30% total solids) for reduction in spent wash volume and CPU for treatment and recycle of process condensate to make the distillery CREP compliant.

PK Dr NN HK Ahir SSK

a) Improvement in fermentation process

The distillery was facing problem of low alcohol concentration in fermented wash of about 6.5% (v/v) and high sludge content in molasses i.e. 22-25%. It was observed that fermentation process

was operated in fed batch mode and propagated yeast culture was reused for 6-7 fermentation cycles. It was advised to use fresh propagated yeast culture for each fermenter. The problem was resolved and alcohol % in fermented wash was increased from 6.5 to 8.1% (v/v). The data of trials conducted on site given in table 9.

b) Trouble shooting of evaporation plant

Distillery was facing problem in concentration of bio-methanated spent wash through evaporation plant which was not working as per performance guarantee norms (Feed capacity 350 M^3/day, concentrated product 58 M^3/day and process condensate 292 M^3/day). Details of observations and remedial measures taken are mentioned below.

i) Plant was operated at feed of 12.5 M^3/hr with 10% raw spent wash and 90% BMSW. After 10 hrs of plant stabilization, the results are given in table 10.
ii) Both forced circulation evaporators were working satisfactorily (concentrating feed from 11.3° to 23° brix) but falling film evaporators were only concentrating feed spent wash from 9.4° to 11.3° brix. Hence, it was decided to improve performance of falling film evaporators.
iii) There was malfunctioning of thermocouple due to which there was a mismatch in PLC dashboard readings and actual readings.
iv) It was suggested to modify the existing flash vessel capacity.

As a result, the evaporation duty improved from 59 to 71%. Further modification of the MEE plant (addition of pre-heaters and increasing the capacity of degasser) has been suggested to achieve 100% evaporation duty.

Dhampur Sugar Mills

The distillery was facing problem of low alcohol concentration in fermented wash of about 6.0 - 6.5% (v/v). Bacterial contamination was observed in lab culture and it was carried forward up to fermenter stage. Fresh yeast culture was prepared and yeast propagation training was given to the distillery staff. The observations of microbial count of molasses samples are given in table 11.

Table 9: Molasses fermentation experiment results

Fermenter number	Particulars	Parameters	Parameters	
			Before suggestion	After suggestion
F1	Designed to achieve 9% (v/v) alcohol using new propagated yeast culture	Sp. Gravity	1.055 - 1.058	1.054
		pH	4.12	4.40
		Residual Sugar, (%)	1.56	2.43
F3	Continuous aeration	Alcohol (%), v/v	7.16	8.12
		Sp. Gravity	1.060	1.054
		pH	4.20	4.21
		Residual Sugar, (%)	2.50	1.85
		Alcohol (%), v/v	6.51	7.34
F4	Continuous aeration with booster dose of yeast culture to the fermenter	Sp. Gravity	1.063	1.046
		pH	4.20	4.20
		Residual Sugar, (%)	2.34	1.47
		Alcohol (%), v/v	6.50	7.03

Table 10: Evaporation plant performance

Particulars	pH	Brix	Specific Gravity
Feed	7.29	9.4	1.038
Evaporator body No. 3	8.03	11.3	1.045
Product	6.60	23.0	1.095
Feed rate	12.5 M^3/hr		
Product	5.10 M^3/hr		
Process condensate	7.40 M^3/hr		
Evaporation duty	59		

Table 11: Microbial count of molasses samples

Molasses Sample Name	Type of organisms (CFU/gm)					
	Mesophillic bacteria	Wild yeast	Thermophillic bacteria	Yeast and molds	Slime forming bacteria	Total count
T - 1	4.30×10^3	1.00×10^1	1.20×10^2	2.40×10^2	5.60×10^5	5.64×10^5
T - 2	7.51×10^4	2.00×10^1	4.00×10^2	2.00×10^1	2.30×10^3	7.74×10^4
T - 3	4.00×10^3	3.00×10^1	5.85×10^4	3.00×10^1	5.00×10^1	6.26×10^4
T - 4	1.00×10^1	1.40×10^2	NIL	3.00×10^1	1.19×10^3	2.34×10^3
T – 5	1.12×10^3	1.21×10^3	NIL	NIL	1.18×10^3	3.51×10^3
T - 6	1.10×10^1	4.01×10^3	NIL	NIL	1.28×10^3	5.30×10^3

From table 11, it can be concluded that, the molasses in tank nos. T - 1, T- 2 and T- 3 were severely contaminated by thermophilic and slime forming bacteria. The mill was advised to use veterinary grade penicillin for control of bacterial contamination after sterilization and maintain proper cooling of fermenters. It was also suggested to keep molasses storage pits surrounding area clean and hygienic.

Dnyaneshwar SSK

VSI team analyzed spent wash samples for alcohol content. Alcohol loss in spent wash was found in the range of 1.5 to 2.0% (v/v). There was a fluctuation in steam supply to distillation (pressure ranging from 2.5 to 4.8 kg/cm^2 and temperature ranging from 125 to 250 ^{o}C) which was affecting the operating parameters of distillation columns.

During distillation it was observed that, the rectifier feed temperature was 80 - 82 ^{o}C instead of 105 - 110 ^{o}C due to leakage from gasket of purifier column feed PHE. It was suggested to stabilize analyzer column by adjusting bottom liquid level, steam flow rate to rectifier column and maintain analyzer column bottom temperature at around 81^{o}C. After 24 hrs of stabilization of analyzer column, the spent wash alcohol losses were gradually reduced. As a result, the plant was running at a capacity of 50-55 KLPD.

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. The department has provided technical guidance to Commissioner of Sugar, SLMPC, Karkhana purchase committees, Distillers' association of Maharashtra, Karnataka State Excise Department, Geographical Indications Registry (Intellectual Property Office) etc.

Our contribution in the Standing Technical Committee meeting of Karnataka State Excise Department has resulted in formulation of new rules for: 1) Losses during maturation of malt alcohol, 2) Fortification of wines, 3) Yield calculation in beer manufacturing and 4) Use of malts and adjuncts in microbreweries.

The Commissioner of State Excise, Maharashtra, had raised the issue of gain of molasses reported by sugar mills during the sugar production under M-1 license. To sort out this issue, a meeting was organized by the MRSSK Sangh in presence of Chief Secretary, Home Department, GoM; Commissioner of State Excise; Commissioner of Sugar; representatives of MPKV and MD of MRSSK Sangh. VSI team explained the possible scientific reasons for gain of molasses by sugar mills. As suggested in the meeting a brief report was prepared and submitted it to the Chief Secretary, Home Department, GoM.

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 financial Year 2015-16 and 2016-17". Seventy-four distilleries were functional during 2016-17. The data on technical performance of distilleries for the previous five years is presented in table 12.

Table 12: Technical performance of VSI member distilleries in Maharashtra

Parameter	Year				
	2012-13	2013-14	2014-15	2015-16	2016-17
Production capacity (Million lit./300 days) considering all distilleries	790.5	780.0	801.0	810.0	945.0
Production capacity (Million lit./300 days) Based on received information	622.5	589.5	589.5	624.0	654.0
Number of distilleries whose information was compiled	49	46	47	46	46
Average net working days	181.49	177.00	186.00	186.00	130.00
Molasses consumed (Million tonnes)	1.400	1.416	1.535	1.518	1.195
Alcohol produced (Million lit.)	380.66	380.74	416.80	413.73	327.19
Average Fermentation Efficiency (%)	89.72	89.72	89.59	89.71	89.72
Average Distillation Efficiency (%)	98.54	98.52	98.51	98.58	98.63
Recovery of Alcohol (Lit/T of molasses)	271.71	268.82	271.50	272.55	273.88
Capacity utilization (%)	60.28	64.59	64.92	65.83	52.94

Recognition

It is a matter of pride for the Institute that Dr. SV Patil, Head and Technical Adviser, Department of Alcohol Technology & Biofuels, recognizing his valuable contribution in the alcohol industry, CPCB appointed Dr. Patil as Chairman of the Expert Committee constituted to formulate the Action Plan/ Charter for up-gradation of manufacturing process technology, Zero Liquid Discharge (ZLD) system and adaptation of this practices for effective implementation of ZLD by distilleries identified as discharging effluents in to river Ganga main stream and its tributaries.

Presentation by Mr. SR Soni, Vice President, India Glycol Ltd., Kashipur

Academic

The department is involved in conducting autonomous DIFAT course and MSc (Wine, Brewing and Alcohol Technology) course affiliated to the Savitribai Phule Pune University, Pune.

A training programme entitled, "Fermentation and Distillation processes for distillery operators" was organized.

Environmental Sciences

ENVIRONMENTAL SCIENCES

The significance of ensuring sustainability in a rapidly developing world has been realized and accepted by the industry all over the world. The sugar industry too is facing the challenge of addressing economic, environmental and social issues. The department of Environmental Sciences assists the sugar and allied industry in addressing these environmental issues through research, consultancy, teaching and training. The research efforts are focused on finding sustainable solutions to environmental problems in this sector including treatment on waste and its 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 has been reaccredited by NABET for carrying out EIA studies and by NABL as per ISO 17025:2005 for chemical, mechanical and biological testing with a scope of around 60 parameters. The department also strives for capacity building of students and professionals in the area of environment through MSc and PhD programs in Environmental Sciences, short term training programs for industry personnel and sponsored programs from Central Pollution Control Board (CPCB).

RESEARCH AND DEVELOPMENT

Characterization and treatment of spray pond overflow

Spray pond overflow is a large source of wastewater in the sugar mill and is often released or used for irrigation without any measurable treatment. The Ministry of Environment Forests and Climate Change (MoEFCC) through a notification in January 2016 restricted the generation of spray pond overflow to 100 litres per ton of cane crushed. It was also essential to meet the discharge norms for quality of treated effluent as per the notification. Spray pond overflow is a mildly polluted wastewater and there is a variation in its characteristics. Not much work has been done on its treatment. Laboratory scale experiments were carried out for treatment of spray pond overflow through: a) two stage biological treatment and b) using chitosan as a flocculating agent. The results of the characterization and treatments are given in table 1.

It can be concluded that two stage biological treatment can treat spray pond over flow effectively to meet the standards prescribed by the CPCB. Treatment with chitosan was less effective however, it may be used as a pretreatment. Experiments will be carried out to check its effectiveness in combination with biological treatment.

Characterization and treatment of combined mildly polluted effluents from sugar industry

Wastewater in a sugar mill is generated from different sources. Some of these streams are more polluted while other less polluted. The mildly polluted wastewater streams include spray pond/ injection channel overflow, boiler blow down, RO reject water, excess condensate. Composite samples of all these effluents were collected over a period of 24 hours and were combined together. Analysis of the combined effluent was carried out. The combined effluent was then treated through: a) two stage biological treatment and b) using chitosan as a flocculating agent. The results of the analysis and treatment are given in table 2.

Table 1: Results of spray pond overflow treatment

Parameter	Value	Reduction after treatment	
		Two stage biological treatment (%)	Treatment with chitosan @ pH 4 (%)
COD (mg/L)	880 - 1800	93 - 97	55 - 60
TDS (mg/L)	2960 - 3620	15 - 27	15 - 20
TSS (mg/L)	380 - 760	70 - 75	85 - 90
Hardness (mg/L)	3600 - 4400	60 - 70	30 - 40
Calcium (mg/L)	3589 - 4300	55 - 60	25 - 30
Magnesium (mg/L)	9.72 - 34.5	40 - 60	20 - 25
Sulphate (mg/L)	778 - 800	5 - 10	5 - 10

Table 2: Results of treatment combined mildly polluted sugar mill effluents

Parameter	Value	Reduction after treatment	
		Two stage biological treatment (%)	Treatment with chitosan @ pH 4 (%)
COD (mg/L)	336 - 496	86 - 96	60 - 70
TDS (mg/L)	980 - 1400	12.2 - 28.5	20 - 25
TSS (mg/L)	160 - 360	72 - 87.5	70 - 85
Chlorides (mg/L)	68.9 - 89.9	80 - 85	5 - 10
Hardness (mg/L)	820 - 1340	10 - 20	20 - 30
Calcium (mg/L)	778 - 1300	10 - 12	15 - 25
Magnesium (mg/L)	9.7 - 17.0	70 - 85	10 - 15
Sulphate (mg/L)	426 - 690	15 - 40	-

The results indicated the effectiveness of two stage biological treatment as compared to treatment with chitosan. However, it may be worthwhile to explore a combination of these two to reduce the cost of treatment.

Photocatalyst mediated treatment of molasses based distillery spent wash

The said research was initiated in January 2017 to reduce chemical oxygen demand (COD) and colour of bio-methanated or raw spent wash using photo-catalyst with the aim to reclaim the water. The photo-catalysts for the research were prepared and provided by experts from BR Gholap College, Pune.

Based on the observations of previous experiment, this year the focus was on reducing the dark brown colour of the spent wash. For this purpose, bio-methanated spent wash (BMSW) was passed through an in-house developed filtration media as a pre-treatment and then subjected to photocatalytic treatment in combination with hydrogen peroxide (H_2O_2) and chitosan. Photocatalytic treatment of 150 ml BMSW in combination with 10 ml H_2O_2 for four hours resulted in a COD reduction of 74%. Another colour precipitating agent chitosan was used in the next experiment. COD reduction of 36% was observed in four hours when 3 ml chitosan was used with 50 ml of BMSW. However, when chitosan was used in combination with photocatalyst, the reduction in COD was about 42% in the same time. In all these experiments, there was no visible change in the colour of BMSW observed. Therefore, research efforts will now be concentrated on colour removal in order to reclaim the water.

EXTENSION AND ADVISORY SERVICES

Environmental Clearance (Environmental Impact Assessment)

Environmental Impact Assessment (EIA) is the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of development proposals prior to establishment. It is a decision making tool which helps in planning projects with minimum environmental consequences. EIA reports are the basis of accord of Environmental Clearance (EC) to industrial/ infrastructure projects in India by MoEFCC. The department offers its consultancy services for such work which includes guidance for selection of project site as per existing guidelines; monitoring of environmental baseline, preparation of Environmental Impact Assessment (EIA) reports; guidance for compliance of conditions stipulated by regulatory authorities. The department is accredited by National Accreditation Board for Education and Training (NABET) of Quality Council of India (QCI) for carrying of EIA studies and preparing EIA reports in sugar, distillery and co-generation (thermal power) sectors. The department has been accredited since 2011 and it has been assessed for second reaccreditation by NABET in March 2018. MoEFCC accepts EIA reports only from accredited consultants.

The work performed under EIA consultancy services is summarized in table 3.

Table 3 : EIA consultancy - Summary

Name of mill	Project	Highlights	Status /Remark
Ankur Biochem	EC for expansion of grain based distillery from 60 to 200 KLPD	Final hearing for the accord of EC was held. The Expert Appraisal Committee (EAC) recommended the project for EC.	Final EC order awaited
Prasad Sugar and Allied Agro Products	EC for new 21 MW co-generation project and 30 KLPD molasses based distillery unit	EIA has been done for co-generation project and distillery project has been kept on hold. Public hearing documents of the project were submitted to State Expert Appraisal Committee (SEAC). First hearing for the accord of EC was held.	Work in progress on resolving queries raised by SEAC
KS Kale SSK	EC for new 16 MW co-generation project	The project was kept on hold by the client. Hence, EIA report writing work was suspended till further decision.	Report writing will resume after receipt of consent from client
Kukadi SSK	EC for new 60 KLPD molasses based distillery, expansion of sugar unit to 5000 TCD and co-generation to 27 MW	EIA has been done only for co-generation and distillery project has been kept on hold. Public hearing of expansion of sugar and co-generation project was held. The project was presented to SEAC and is recommended for EC.	Project submitted to State EIA Authority (SEIAA) for the accord of EC
Pad. Dr. VV Patil SSK	EC for expansion of sugar unit to 6000 TCD	Environmental monitoring work was carried out. SEAC approved terms of reference for preparation of EIA report.	EIA report preparation in progress
Dwarkadhish Sakhar Karkhana	EC for New 30 KLPD molasses based distillery project	EAC approved terms of reference for preparation of EIA. EIA report was prepared and submitted for public hearing and was held.	Public hearing documents are awaited for further process
KA Dr. GD Bapu Lad SSK	EC for expansion of sugar unit from 5000 to 8500 TCD and co-generation from 19.7 to 36 MW	EIA report was prepared as per approved ToRs after site visit by experts. The project was presented to EAC and was recommended for EC.	EC has been issued by MoEFCC
Bhoramdeo SKUM, Chhattisgarh	EC for new 30 KLPD molasses based distillery project	Experts visited the site and environmental monitoring work was carried out. Application was prepared and sent to client. The client has kept the project on hold.	Work will resume after receipt of consent from client
Shreenath Mhaskoba Sakhar Karkhana	EC for expansion of sugar unit from 2500 to 6000 TCD and distillery from 30 to 55 KLPD	Application for EC was made and ToRs were granted online. Experts visited the site and environmental monitoring was carried.	EIA report preparation in progress
Malegaon SSK	EC for expansion of sugar unit from 4000 to 8250 and co-generation from 21 to 35 MW	Preliminary information and data of project was compiled. Environmental monitoring was in progress.	Application for EC
Kumbhi Kasari SSK	EC for expansion of sugar unit from 5000 to 8000TCD, co-generation from 19.5 to 30 MW and distillery from 30 to 60 KLPD	Preliminary information and data of project was compiled. Environmental monitoring was in progress.	Application for EC prepared

Compliance of environmental clearance

Environmental clearance (EC) is issued to industries with general and specific conditions, compliance to which is mandatory. Compliance reports are to be submitted by the industry to concerned regional offices of MoEFCC for certification after site visit. The department also offers its services for preparation of such compliance reports for sugar and distillery industry. Following is the status of work done by the department in this regard.

Sugar ETP

Malegaon SSK

The department prepared a DPR to upgrade existing ETP. Mill implemented the work as per the DPR which helped to improve performance and achieve the disposal norms for treated effluent. The preparation of DPR of condensate polishing unit (CPU) to treat excess sugar condensate was in progress.

Dwarkadhish Sakhar Karkhana

The technical specifications for the up-gradation of ETP by considering existing civil and electromechanical equipment were prepared. The existing equalization tank was converted to anaerobic filter by installing media and a new equalization tank was constructed with neutralization tank. Diffused aeration system in aeration tank and chlorination followed by filtration for tertiary treatment were installed as per the specifications given by the department. The upgraded system is working efficiently and has achieved desired standards prescribed in consent to operate issued by MPCB. Mill is utilizing treated effluent for irrigation of own farm with good results.

Siddhi Sugar and Allied Industries

The technical specifications for up-gradation of existing ETP to treat effluent generated at 4000 TCD capacity were prepared. Specifications were prepared by considering existing unit and machinery. Mill implemented partial modification by constructing intermediate neutralization tank and primary clarifier. This modification helped to improve the performance of existing ETP. Other modifications will be implemented before next season to achieve the desired standards.

Bhimashankar SSK

The technical specifications for civil and electromechanical machinery in the modification of existing ETP to treat effluent generated from 4500 - 5000 TCD were prepared. Mill constructed and installed all machinery as per the specifications. Existing treated effluent storage tank was utilized for anaerobic treatment, the capacity of blower & diffuser has been increased and construction of neutralization tank and primary clarifier of adequate capacity has been completed. Mill has achieved standard of treated effluent as prescribed in consent to operate issued by MPCB after modification and plant was working satisfactorily.

Chattrapati SSK, Bhavaninagar

The DPR to treat sugar mill effluent for 850 to 1000 cubic meter per day was prepared. The mill constructed and partially erected ETP as recommended in DPR.

Parag Agro Foods & Allied Products

This is a new private sugar unit having crushing capacity of 3500 - 4000 TCD. The department prepared technical specifications for new ETP to treat effluent of 450 - 500 cubic meter per day.

The United Provinces Sugar Company Limited (UPSCL), UP

The UPSCL is located in Kushinagar district of Uttar Pradesh and has crushing capacity of 5000 TCD. The mill was discharging its spray pond/ injection channel over flow wastewater directly.

Table 4 : Environmental Compliance Report - Summary

Name of mill	EC compliance	Highlights	Status
The Saswad Mali Sugar Factory	Molasses and grain based distillery units	Compliance report prepared	Report submitted to MoEFCC regional office Nagpur
Udagiri Sugar and Power	Molasses based distillery	Site visit to check compliance	Report ready for submission to MoEFCC regional office Nagpur

The Central Pollution Control Board (CPCB) has stringently enforced treatment of the said wastewater up to desired level before discharge particularly for mills in the Ganga Basin. The work for treatment plant for this injection channel overflow was assigned to the department. Accordingly, a technical team visited the site and collected necessary data from mill. DPR for a treatment plant for 500 - 550 m^3/day of injection channel overflow was prepared. Mill has constructed and erected civil & electromechanical work. Commissioning of the plant was done and it is operating successfully with treated effluent as per discharge norms.

KA Dr. GD Bapu Lad SSK

The industry plans to increase the crushing capacity of existing sugar unit from 5000 to 8500 TCD. Mill has received consent to operate for their existing unit in which MPCB has made it mandatory to install CPU to recycle the treated condensate. The team visited the site and collected necessary data for preparation of DPR. Tentative layout for proposed CPU to treat the excess condensate up to 1800 - 2000 m^3/day by considering proposed expansion has been given to the mill and further work was in progress.

KS Patil SSK

The mill has expanded crushing capacity of 5000 to 8000 TCD due to which existing ETP is under capacity and technically unfit to treat the effluent. The team visited the site and tried to understand the existing scheme and operational problems of ETP. It was suggested to go for two-stage biological treatment and upgrade the existing primary treatment to increase the efficiency of the plant. The mill assigned the work of DPR for ETP modification by considering existing civil unit and machinery. The proposed modification and upgradation will treat the effluent of 1000 -1200 m^3/day. The mill has also assigned the monitoring of condensate characteristics and suggestions for excess condensate. Accordingly, various samples of condensate and spray pond over flow were collected for analysis.

Nira Bhima SSK

The mill was facing problem of excess condensate, boiler blow down, RO reject and spray pond over flow wastewater discharge and it required to treat minor polluted wastewater either combined or separately for recycle or reutilization. The team visited the site to quantify the various wastewater sources and recommended to analyze said wastewater. The suggestions for appropriate treatment technology will be given after relevant laboratory data is compiled.

Indreshwar Sugar Mills

The mill has crushing capacity of 3500 TCD and wants to install a CPU to utilize treated condensate in distillery unit. A technical team discussed and collected appropriate information required for water balance which was prepared and submitted to the mill. It was suggested to analyze the characteristic of the second body condensate and combined condensate to decide the CPU either for second body or for combined condensate.

Water balance and ETP adequacy assessment

The CPCB directed all sugar mills in the Ganga Basin to get third party assessment of their water/ mass balance and ETP adequacy to comply with the standards for effluent disposal notified through GSR 35(E), MoEFCC, January 14, 2016. Accordingly, the department was assigned 20 mills from Uttar Pradesh, Bihar and Uttarakhand. Two technical teams visited these mills, collected data and prepared the reports of water balance and ETP adequacy. The objectives of the reports were:

- Preparation of water balance by estimating the water usage for each unit process in manufacturing, fresh water intake, reuse, recycling, losses and generation of effluent.
- Assessment of adequacy of existing ETP by checking the individual unit processes for size and capacity of electromechanical units.

This work was conducted in off-season when mills were not working. Hence, in the second stage, CPCB directed the mills to get the reports validated during the crushing season when the mills were in operation. The objective of the validation was to verify the actual implementation of the suggestions/ recommendations made in the first report. Details of the work carried out by the department and its current status is given in the table 5.

Environmental Statement Report (ESR) and Hazardous waste management (HWM) returns

The department carried out environmental audit and hazardous waste audit at various sugar mills

Table 5 : Status of work on water balance and ETP adequacy assessment

Name of mill	Work Status	
	Adequacy Report	Validation Report
Uttar Pradesh		
United Provinces Sugar Company Ltd.,Seorahi	Completed	Visit completed, report being prepared
Modi Sugar Mills, Modinagar	Completed	Completed
SBEC Sugar Ltd., Malakpur	Completed	Visit completed, report being prepared
Ramala Sahakari Chini Mill Ltd., Ramala	Completed	-
Kisan Sahakari Chini Mill, Nanauta	Completed	-
Ganga Kisan Sahakari Chini Mill Ltd., Morna	Completed	Draft report sent
Kisan Sahakari Chini Mill Ltd., Sneh Road Najibabad	Completed	Visit completed, data awaited
Kisan Sahakari Chini Mill Ltd., Sarsawa	Completed	-
The Baghpat Co-operative Sugar Mill	Completed	-
Rana Sugar Ltd., Belwara	Completed	Visit completed, report being prepared
Rana Sugar Ltd., Karimganj, Shahabad	Completed	Draft report sent
Shree Ajudhia Sugar Mills, Raja ka Sahaspur, Bilari	Completed	Draft report sent
Indian Potash Ltd, Sugar Unit-Khadda	Completed	Visit completed, data awaited
Indian Potash Ltd, Sugar Unit-Siswa Bazar	Completed	Visit completed, data awaited
Uttarakhand		
Dhanshri Agro Products Pvt. Ltd, Haridwar	Completed	Draft report sent
Doiwala sugar company ltd. Doiwala	Completed	Draft report sent
Kisan Sahkari Chini Mill Ltd. Sitarganj	Completed	Mill closed
Bihar		
Magadh Sugar and Energy Ltd. Unit -Hasanpur Sugar Mills	Completed	Draft report sent
Magadh Sugar and Energy Ltd. Unit: Bharat Sugar Mills, Sidhwalia	Completed	Draft report sent
Magadh Sugar & Energy Ltd. Unit-New Swadeshi Sugar Mills, Narkatiaganj	Completed	Draft report sent

and distilleries. The results in the form of ESR and HWM were submitted online to the MPCB. The department prepared ESR and HWM for Sant Tukaram SSK and Ashok SSK.

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. This laboratory was reaccredited for two years starting from Dec. 2016 and documents were submitted for desktop surveillance assessment in January 2018.

In the reporting year, environmental monitoring was carried out at two sugar mills i.e. Sant Tukaram SSK (thrice) and Ashok SSK (once). In addition, environmental monitoring for EIA study was carried out for Pad. Dr. VV Patil SSK, Dwarkadhish Sakhar Karkhana, Kumbhi Kasari SSK, Shreenath Mhaskoba Sakhar Karkhana, Someshwar SSK and Malegaon SSK.

Visit to Abeda Inamdar College, Pune

The laboratory analyzed samples from sugar mills, farmers, housing complexes and other industries. The details of samples analyzed are given in table 6.

Table 6 : Details of samples analyzed

Type of sample	Number
Water and wastewater	222
Compost and solid waste	56
Soil	21
Ambient Air	456
Stack Emission	7
Noise monitoring locations	28
Total	**790**

Formulation of norms for environmental awards and assessment of technical data

Recognizing the growing importance of environmental conservation in developing a sustainable sugar industry and the stringent enforcement of environmental legislation, the Institute has decided to honor sugar mills/ complexes which are doing quality work in environmental conservation by conferring "Late Kisan Mahadeo alias Abasaheb Veer Award for the Best Environmental Conservation" from the crushing season 2016-17. This award has been sponsored by Kisanveer Satara SSK and is in the form of a trophy, citation and a cash prize of Rs. One Lakh. The department co-ordinated the work for formulating the norms for this award and later carried out assessment of the applications received from various mills to identify the best work in environmental conservation

It was also decided to give an award for Best Environmental Officer/ Manager/ Chemist from the forthcoming year. The work for formulating the norms for this award was also carried out.

Selection for suitable candidates for the environmental officer in sugar mills

Staff from the department were members of the interview panel for the selection of environmental officers in mills viz. SMSN Nagawade SSK, Sant Tukaram SSK, Malegaon SSK.

Academic

The department is already active in the academic arena with MSc and PhD courses in Environmental Sciences. A short term/ refresher course for environmental professionals from sugar industry is also conducted in the month of June every year. This year another short term course for ETP operators was added to the list. This was conducted in Marathi to make the operators understand the issues and subject matter in a easier manner. This was appreciated by the sugar mills which sent their ETP operators for training.

Inauguration of the workshop
'Environmental Challenges in the Sugar Industry and the Way Forward'

Electronics and Computer

ELECTRONICS AND COMPUTER

The department is engaged in academics, research & development. The department has designed and developed VSIsugarERP software for sugar and allied industries. The guidance is provided to the sugar mills for hardware and software specifications for VSIsugarERP software. The department is involved in teaching and training of different courses to the students from the Institute. The software for regular activities in VSI viz. finance, accounts, payroll, stores and soil science are developed and maintained. The LAN with 260 nodes and four servers established in the Institute are looked after.

RESEARCH AND DEVELOPMENT

Weather station system developed in VSI

The microcontroller based low cost weather station developed in VSI is functioning satisfactory. The modified system sends data through SMS daily to the user. This information is very useful to understand the prevailing weather conditions.

Two weather stations designed in VSI for Environmental Sciences department wherein the stored weather data on per hour basis for the entire day is captured in USB storage system (Fig. 1). This information is proving useful to the department for their assignments in Environmental Clearance and Environment Impact Assessment. In addition, the department of Environmental Sciences also requires air dispersion study and micro meteorological data from weather station.

Weather stations were installed

- VSI, Amboli Farm
- VSI, Manjari (BK.)
- Renuka Sugar, Unit- IV, Athani
- Renuka Sugar, Unit- V, Havalga
- Bhoramdeo SSUKM, Kawardha, Chhatisgarh
- Kumbhi Kasari SSK, Kolhapur

VSIsugarERP Software

VSI has developed and implemented quality software for sugar and allied industry, known as VSIsugarERP. It was developed in VB/VB.net software language, Oracle database and crystal reports. Presently, 23 modules of this software are being used by 85 sugar mills and allied industries. VSIsugarERP helps sugar mills in improving their management in - finance, cane, purchase, inventory, quality, sales, human resource.

Features of VSIsugarERP

- The cost is around 50% less than commercial software available in the market
- It supports multilingual facilities like Marathi, Kannad, Hindi and Gujarati. The software is user friendly to operate and easy to customize
- It helps sugar mill for transparent and systematic work flow, standardization of reports to minimize paper work and MIS reports are available on single click
- This software is a bundle of 23 modules which is implemented in 85 sugar mills of Maharashtra, Karnataka, Goa, Gujarat and abroad (Uganda)

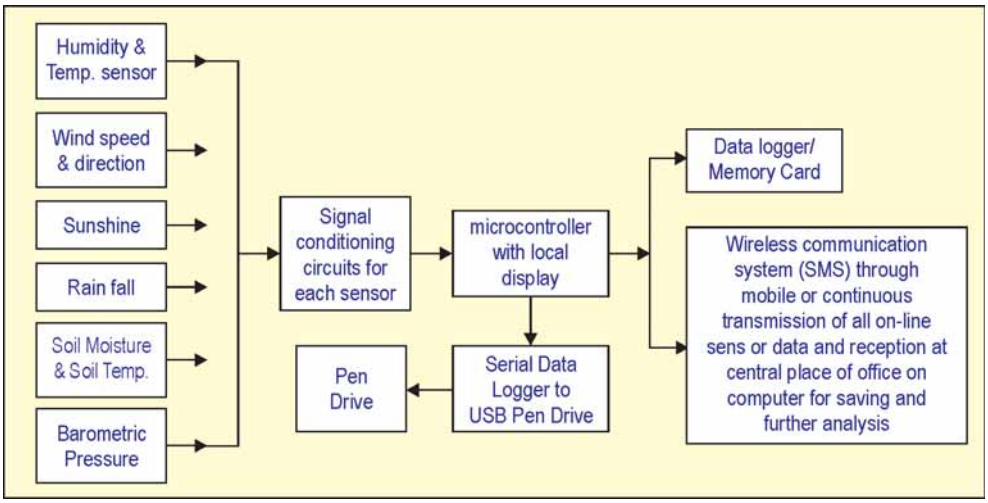

Fig. 1 : Block diagram of weather station

- It is designed using RDBMS database which avoids duplication of work
- 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 at any moment, raw-material (cane) available in cane-yard at any moment, weigh-bridge status
- Centralized database with security features
- Reliable, prompt and assured after-sales service to the entire satisfaction of users
- Better Management & full utilization of existing resources
- User friendly interface and flexible
- Better analysis and planning capabilities
- Use of latest technology
- Reports, graphs and charts gives higher performance visibility.
- Capability to integrate all the modules whether installed as a whole or module-wise

During reporting year modules installed at different locations are given in table 1

Sugarcane management

A cane plantation record from the operational area of the sugar mill covering various villages is being managed through this module. This module enables to maintain complete record related to plantation programme, registration, harvesting programme based on planting date coupled with maturity of cane. The module is capable of generating different types of reports related to the harvesting. The system is tamper proof and user friendly. Precise harvesting program is being generated to help in effective implementation to reduce cut to crush time to increase sugar recovery.

Weigh bridge

Through weigh bridge module, automatic cane weight is being recorded without any intervention. This module was designed with new MIS reports due to which management gets information at a glance and helps for planning best harvesting schedule to improve recovery. The module provides facility for field slip feeding to ensure error free entry for information relating to farmer, harvester,

Table 1 : Installation of modules

Name of mill	Modules installed
Chhatrapati SSK	Sugarcane Management, Sugarcane Development, Weigh bridge, Sugar manufacturing and chemical laboratory analysis, Sugarcane farmer billing, Harvesting and transport billing, Shares, Sugarcane deposit, Petrol pump, Weigh bridge for other products, Molasses sale, Press mud and Other sale
Sharad SSK	Sugarcane Management, Weigh bridge, Sugar manufacturing and chemical laboratory analysis, Sugarcane farmer billing, Harvesting and transport billing, Store inventory, Purchase and Store costing, Shares, Petrol pump, Weigh bridge for other products, Molasses sale, Press mud and Other sale
Utech Sugar	Sugarcane Management, Weigh bridge, Sugar manufacturing and chemical laboratory analysis, Sugarcane farmer billing, Harvesting and transport billing, Store inventory
Gokul Mauli Sugar	Sugarcane Management, Weigh bridge, Sugarcane farmer billing, Harvesting and transport billing
Saswad Mali	Sugar sale, Store inventory, Purchase and Store costing, Financial accounting
Kukadi SSK	Sugar sale, Time office, Molasses sale, Press mud and Other sale
Jawahar Shriram	Financial accounting, Time office, Store inventory, Purchase and Store costing
Indapur SSK	Time office, Molasses sale, Press mud and Other sale, Distillery
Kranti Sugar	Weigh bridge for other products
Bhima Patas	Time office, Weigh bridge for other products
Anuraj Sugar	Weigh bridge for other products, Molasses sale, Press mud and Other sale
Vighnahar SSK	Distillery
Sharayu agro	Sugar manufacturing and chemical laboratory analysis, Distillery
Makai SSK	Store inventory, Purchase and Store costing, Petrol pump

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 in case of cane details, cane inward, lists waiting for load weight & unload weight, Gat-village-wise tonnage reports, daily/fortnightly tonnage report, slip reprint etc.

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 was provided. Facility for Cheque printing on pre-printed stationery was 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 (HT) 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 sent to other mills, 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.

Store inventory, purchase and store accounting

The system is designed as per the requirement such as material purchase register, indent-wise and division-wise allocation summary, store group-wise and division-wise, job allocation summary, annual purchase register. The weighted average method was used for costing.

Time office

As per the requirements of sugar mill, modifications were made in the Time office software module. Detailed records 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, income tax, auto voucher facility for account, monthly reports of slip, pay sheet, bank list, yearly report of employee, all leave balance etc. were made.

Sugar sale

Sugar mills sold sugar by calling tenders. The sugar sale module was modified to incorporate this information. Software was also modified to enable contract with sugar purchaser and automatic maintenance of sugar stock and sugar purchase ledger. Various reports such as tender allotment, party wise balance, sale summary, periodic and GST were generated

Financial accounting

This 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 were made. In addition, voucher passing level authentication, division-wise and consolidated reports maintenance, centre-wise recovery of deduction, cane account system integration with account, interest calculation based on fortnight etc. were also made.

ACADEMICS

The department is involved in teaching and training to the courses viz. Sugar Instrumentation Technology, Alcohol Technology and Biofuels, Sugar Technology, Sugar Engineering Diploma and Environmental Sciences conducted by the Institute.

Instrumentation

INSTRUMENTATION

Now-a-days, advanced instrumentation and automation systems incorporated in sugar mills that require less maintenance mainly due to increased MTTR and MTBF of various system components used and its proper technical specifications laid down by the department. However, need of automation systems to have standard protocols for data communication as well as the simplicity of software to configure both structure of the database and graphic display has not been fulfilled yet. Presently, the instrumentation engineers maintaining DCS/PLC systems in sugar industry are having knowledge in hardware systems but they entirely rely on system integrators for any kind of software changes. In order to resolve the system problems on day to day basis and to carry out essential system additions, the instrumentation staff is poised to be proactive in this area.

The department has been improving the status of instrumentation systems in sugar mills through its various activities. This mainly includes extension and advisory services, teaching & training, project consultancy and in-house instrumentation work.

EXTENSION AND ADVISORY SERVICES

Online measurement of moisture and weight of bagasse

Measurement of moisture and weight of bagasse is required in sugar mills for material balancing, mill & imbibition water flow settings and bagasse generation/consumption calculations. Presently, the bagasse moisture is measured periodically by laboratory method which requires considerable time. Whereas the weight measurement of mill bagasse is not carried out and is inferred, this creates anomalies in preparing daily reports and calculating boiler efficiency. The issue was discussed with the Indian representative of foreign company for online measurement of bagasse and moisture. The issues regarding point of measurement and the necessary changes, nuclear radiation awareness, cost involved etc. have emerged. The efforts will be taken to address technical and commercial issues for trials during 2018-19 crushing season.

Polarimeter servicing

The polarimeter is being used for pol measurement in sugar mills. Till date majority of mills have its analog type. As it contains rotary parts and dust present in mill blurs the optical vision, it is essential to overhaul and calibrate such polarimeters annually. Being a skilled job, the department has been providing overhauling services since last three decades. These services were provided to the following sugar mills :

- Ashok SSK
- Ajinkyatara SSK
- Adinath SSK
- Bhimashankar SSK
- Baramati Agro
- Bhairavnath Sugar Works
- Bhaurao Chavan SSK Unit I, II, III & IV
- Dr. B Ambedkar SSK
- Dnyaneshwar SSK
- Kadwa SSK
- Jaywant Sugars
- Kukadi SSK
- Kranti Sugar & Power
- Lok. Balasaheb Desai SSK
- KS Kale SSK
- Manas Agro Ind. Bela
- Lok. S Solankhe SSK
- Pad. Dr. VV Patil SSK
- Nira Bhima SSK
- Sant Tukaram SSK
- Purna SSK Unit I & II
- SMSM Patil SSK
- Sahyadri SSK
- Utopian Sugars
- SMB Thorat SSK
- Vikas SSK, Unit I
- SMSN Nagawade SSK
- Vitthal SSK
- Vasantraodada Patil SSK,
- Vitthalrao Shinde SSK
- VVD Manjara SSK

In addition to regular servicing, the critical problems such as moon mismatching, improper fitting of lenses in telescope, disturbed analyzer, polarizer and lamp settings were successfully attempted in sugar mills.

Inspection of instrumentation and control (I & C) systems in project

The department is playing a vital role for I&C systems in co-generation and distillery projects undertaken by concern departments. The different activities completed in respective projects are given in table 1.

Guidelines for molasses mass measurement

In sugar mills, generally, the molasses mass is calculated by taking dip of molasses tank, float level indicator and online magnetic flowmeter. The mass readings achieved by these methods give erroneous mass results due to various reasons. Nira Bhima SSK requested for the guidelines for installation of suitable system for measurement of molasses mass. In view of this, various techniques were studied which include, molasses weighing tank, magnetic flow meter & oval gear meter with density compensation, mass flow meter and tank level gauging system. The selection criteria for the same were decided and suitable technical specifications were given to the sugar mill for further installation. Similar services were also rendered to Jaywant Sugars.

Selection of manpower for instrumentation posts

To ease the selection process of technical persons for the post of Instrument Engineer, Instrument Mechanic and DCS/ Plant operator, Chhatrapati SSK, Bhavaninagar, Vitthal SSK and Malegaon SSK availed services of the department by conducting interviews.

Table 1 : I & C activities in co-generation and distillery projects

Name of mill/Project	Activities
Chhatrapati SSK, Bhavaninagar, Co-generation	Inspection of brix sensors & transmitters, conductivity sensors & transmitters, ultrasonic level transmitters, density meters and guidelines for I&C problems
SMSN Nagawade SSK, Co-generation	Checking of P&I diagrams and DCS I/O list
LPSV Patel SSK, Sugar and co-generation	Co-ordination meetings and guidelines for I&C problems
Malegaon SSK, Distillery	Co-ordination meetings, checking of P&I diagrams, redundancy, inspection of air compressor & dryer, control valves, magnetic flowmeters, PLC, rotameters, orifice plate assemblies & guidance in installation of I&C systems
KA GD Bapu Lad SSK,Distillery	Co-ordination meetings, inspection of control valves, DCS/PLC for distillery, boiler & evaporation, rotameters and UPS
PDKNN HK Ahir SSK,Distillery	Guidance for I&C in distillery and evaporation plants
\Jaywant Sugars,Distillery	Co-ordination meetings, checking of P&I diagrams, PLC drawings, redundancy and inspection of PLC
KS Kale SSK,Evaporation & Incineration boiler	Inspection of evaporation PLC system & instrumentation hardware, Checking of WTP PLC wiring diagrams & DCS specifications
Bhaurao Chavan SSK, Unit I, Distillery	Checking of P&I diagrams of distillery and FA plant
Sonhira SSKDistillery	Checking of P&I drawings, guidance in installation of I&C systems
Kisanveer Satara SSK,Distillery	Inspection of rotameters and RTD sensors
KA Tope Samarth SSK,Ehanol	Checking of P&I diagrams, redundancy, PLC wiring diagrams and inspection of butterfly/globe control valves, vortex flowmeter, rotameters
Dnyaneshwar SSK,Evaporation	Checking of P&I diagrams, redundancy, PLC wiring diagrams, inspection of PLC
SM Kagal Taluka SSK,Distillery	Checking of P&I diagrams

Pan automation

The batch and continuous pan boiling is an art rather than science. Hence, it requires skilled and experienced operators to optimize crystal sugar production. This puts heavy demand on staffing, training and skills transfer. However, automation of both these pans has the potential to provide substantial benefits in terms of plant capacity, process performance and product quality. The pan automation success depends on reliable working of instrumentation which measures appropriate process parameters as well as a suitable control strategy that relies both on crystallization fundamentals and control hardware. In this regard, the department has provided technical guidance to Ashok SSK and Ambalika Sugars for ensuring proper working of automation systems installed for batch and continuous pans respectively.

ISO 9001: Calibration work of instruments

The department has been equipped with essential standard instruments with traceability from NABL laboratories. These instruments are being used to perform the calibration work of process and laboratory instruments in sugar mills as per ISO requirements. The department had completed such work of 440 instruments and issued calibration reports to following sugar mills.

- Ajinkyatara SSK
- Baramati Agro
- Bhaurao Chavan SSK, Unit I, II & IV
- Bhairanath Sugar Works
- Bhimashankar SSK
- Chhatrapati SSK, Bhavaninagar
- Core Green Sugar & Fuels
- Gangakhed Sugar & Energy
- Jaywant Sugars
- Jagruti Sugars & Allied Ind.
- Lok. Balasaheb Desai SSK
- Lokmangal Agro. Ind.
- Lokmangal Sugar Ethanol & Cogeneration
- Lokmangal Mauli Ind.
- Mula SSK
- Nira Bhima SSK
- Natural Sugars & Allied Ind.
- Om Datta Enterprises
- Purna SSK, Unit I
- Swaraj Agro Ind.
- Samarth SSK, Unit I & II
- SMSM Patil SSK
- TK Warana SSK
- Utopian Sugars
- Vikas SSK, Unit I & II
- VVD Manjara SSK
- Vithalrao Shinde SSK
- Urjankur ST Kore Warana Power Co.

In-house instrumentation

The various services rendered by the Institute have been increasing day by day. This adds new equipments and instruments in respective research laboratories. In order to ensure its proper working, in-house maintenance and calibration services are essential. As per the requirements, such services are being provided by the department since beginning. Similar work for 162 instruments and equipments from various laboratories of Institute was completed.

ACADEMICS

Use of advanced instrumentation and automation systems in sugar mills has been increasing very rapidly. To match the speed of these industrial developments, it is necessary to employ skilled manpower as well as to train the existing ones with latest technologies in sugar mills. In view of this, the department has been conducting teaching courses and special/short term training programmes. The department had contributed in seven teaching and eight training programmes organized at Institute.

Annextures

Annexure I

AWARDS OF EXCELLENCE

The Institute recognizes the extraordinary work done by sugar mills, distilleries, employees working in sugar mills, distilleries, farmers and employees of Vasantdada Sugar Institute by annually conferring awards of excellence. The details of the awards for this year are as under:

- Late Dr. Vasantdada Patil award for the best overall performance - Sonhira SSK, Dist. Sangli
- Late Vilasrao Deshmukh award for the most innovative factory - Datta Shetkari SSK, Dist. Kolhapur
- Late Karmayogi Shankarrao Patil award for the best financial management - Padmashri Dr. DY Patil SSK, Dist. Kolhapur
- Late Raosahebdada Pawar award for the best distillery - Kisanveer Satara SSK (Distillery Unit), Dist. Satara
- Late Dr. Appasaheb alias SR Patil award for the best cane development performance - Chhatrapati Shahu SSK, Dist. Kolhapur
- Late Kisan Mahadev alias Abasaheb veer award for the best environmental conservation – Krantiagrani Dr. GD Bapu Lad SSK (Distillery Unit), Dist. Sangli

The following sugar mills received awards for achieving high technical efficiency.

Awards for technical efficiency

Prize	Sugar mills		
	South Zone	Central Zone	North-East Zone
First	Jaywant Sugars Dist. Satara	Venkateshkrupa Sugar Mills Dist. Pune	Bhaurao Chavan SSK (Unit IV) Dist. Nanded
Second	RB Patil SSK, (Unit III), Dist. Sangli	Someshwar SSK Dist.Pune	KA Tope Samarth SSK, (Unit I) Dist. Jalna
Third	Vishwasrao Naik SSK Dist. Sangli	Vighnahar SSK Dist. Pune	--

Zone-wise awards to sugar mills for good work in cane development and efficient financial management are given below.

Awards for cane development and best financial management

Award	Sugar mill		
	South Zone	Central Zone	North-East Zone
Cane Development	Sonhira SSK Dist. Sangli	Vighnahar SSK, Dist. Pune	--
Best Financial Management	Jaywant Sugars Dist. Satara	Bhimashankar SSK Dist. Pune	K A Tope Samarth SSK, (Unit I) Dist. Jalna

* Note : As per the rules and regulations of the Institute, no mill was found suitable for technical efficiency and cane development award in North-East Zone.

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
SOUTH ZONE			
Mr. Keraba Hari Mane Chhatrapati Shahu SSK, Dist. Kolhapur	Co 86032	261.36	First in Pre-seasonal planting
Mr. Abhijit Balasaheb Patil RB Patil SSK, Dist. Sangli	Co 86032	279.24	First in Seasonal planting
Mr. Rajendra Prataprao Mohite Jaywant Sugars, Dist. Satara	Co 86032	201.00	First in Ratoon
CENTRAL ZONE			
Mr. Ganesh Vasant Shitole Sant Tukaram SSK, Dist. Pune	Co M 0265	256.45	First in Pre-seasonal planting
* --	--	--	First in Seasonal planting
Mr. Bapu Prabhakar Sabale RP Ghodganga SSK, Dist. Pune	Co M 0265	229.34	First in Ratoon
STATE			
Mr. Sambhaji Ananda Misal Sharad SSK, Dist. Kolhapur	Co 86032 (Pre-seasonal)	266.59	Late Yashwantrao Chavan
Ms. Sushila Babasaheb Patil TK Warna SSK, Dist. Kolhapur	Co 86032 (*Suru*)	295.76	Late Vasantrao Naik
Mr. Vikas Baban Salunkhe YM Krishna SSK, Dist. Sangli	Co 86032 (Ratoon)	246.85	Late Annasaheb Shinde

* Note : As per the rules and regulations of the Institute no farmer was found suitable for Oos Bhushan award for seasonal planting in central zone, pre-seasonal, seasonal & ratoon planting in North-East Zone.

The outstanding performance by individuals in their field of work is also 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. MD Mallur, Shree Halasidhanath SSK, Karnataka
Best Finance Manager/Chief Accountant	Mr. A A Kore, Krantiagrani Dr. GD Bapu Lad SSK, Dist. Sangli
Best Chief Chemist	Mr. KA Lokhande, Green Power Sugars, Dist. Satara
Best Chief Engineer	Mr. RB Patil, Pandurang SSK, Dist. Solapur
Best Distillery Manager	Mr. SG Genge Patil, Nira Bhima SSK, Dist. Pune
Best Cane Development Officer	Mr. SS Heganna, Datta Shetkari SSK, Dist. Kolhapur
Best VSI Employee(s)	Mr. PR Surve, Senior Boiler Assistant, Agricultural Microbiology Mr. PS Tarade, Office Attendant Grade-II, Sugar Engineering

Mr. Sharad Pawar,
Hon. Former Minister for Agriculture and Food Processing
Government of India and President, VSI,
addressing Annual General Meeting

Mr. Dilip Walse-Patil,
Hon. Chairman, NFCSF, New Delhi and
Vice President, VSI,
addressing Annual General Meeting

Mr. Sharad Pawar, President, VSI
Mr. Dilip Walse-Patil, Chairman, NFCSF, New Delhi
Mr. Vijaysinh Mohite-Patil, Trustee, VSI
Mr. Shivajirao Nagwade, Chairman, MRSSK, Sangh Ltd.
Mr. Ajit Pawar, Trustee, VSI
releasing VSI publications

Late Dr. Vasantdada Patil Award
for the Best Overall Performance being presented to
Sonhira SSK, Sangli

Late Vilasrao Deshmukh Award for
Most Innovative Factory being presented to
Datta Shetkari SSK, Kolhapur

Late Karmayogi Shankarraoji Patil Award for Best Financial Management being presented to Padamshree Dr. DY Patil SSK, Kolhapur

Late Raosahebdada Pawar award for Best Distillery being presented to Kisanveer Satara SSK, Satara

Late Dr. Appasaheb alias SR Patil Award for Best Cane Development Performance being presented to Chhatrapati Shahu SSK, Kolhapur

Late Kisan Mahadev Alias Abasaheb Veerl Award for Best Environmental Conservation being presented to Krantiagrani Dr. GD Bapu Lad SSK, Sangli

Technical Efficiency Award (South Zone) being presented to Jaywant Sugars Ltd., Satara

Technical Efficiency Award (Central Zone)
being presented to
Venkateshkrupa Sugar Mills Ltd., Pune

Technical Efficiency Award (North-East Zone)
being presented to
Bhaurao Chavan SSK (Unit 4), Nanded

Financial Management Award (South Zone)
being presented to
Jaywant Sugars Ltd., Satara

Financial Management Award (Central Zone)
being presented to
Bhimashankar SSK, Pune

Financial Management Award (North-East Zone)
being presented to
Karmayogi Ankushrao Tope Samarth SSK, Jalna

Cane Development Award (South Zone) being presented to Sonhira SSK, Sangli

Cane Development Award (Central Zone) being presented to Vighnahar SSK, Pune

Oos Bhusan (Late Yashwantrao Chavan Award) being presented to Mr. SA Misal, Sharad SSK, Kolhapur

Oos Bhusan (Late Vasantrao Naik Award) being presented to Ms. SB Patil, Tatyasaheb Kore Warna SSK, Kolhapur

Oos Bhusan (Late Annasaheb Shinde Award) being presented to Mr. VB Salunkhe, Yashwantrao Mohite Krishna SSK, Satara

Best Managing Director Award
being presented to Mr. MD Mullur,
Halsidhanath SSK, Karnataka

Best Chief Engineer Award
being presented to Mr. RB Patil,
Pandurang SSK, Solapur

Best Chief Chemist Award
being presented to Mr. KA Lokhande
Green Power Sugars Ltd., Satara

Best Chief Agriculture Officer Award
being presented to Mr. SS Heggana,
Datta Shetkari SSK, Kolhapur

Best Distillery Manager Award
being presented to Mr. SG Genge-Patil,
Nira Bhima SSK, Pune

Best Chief Accountant Award
being presented to Mr. AA Kore,
Krantiagrani Dr. G.D. Bapu Lad SSK, Sangli

Best Employee Aaward (VSI)
being presented to
Mr. PR Surve (Microbiology Section)

Best Employee Aaward (VSI)
being presented to
Mr. PS Tarvade (Sugar Engineering)

Mr. Rohit Pawar Felicitated on
his selection as a
'Vice President' of ISMA, New Delhi

AGM Audience / Invitees

Annexure II

MEMBERSHIP OF OTHER ORGANIZATIONS

National

- Biotech Consortium India Ltd. (BCIL)
- Deccan Sugar Technologists' Association (DSTA)
- Indian Association of Special Libraries and Information Centers (IASLIC)
- Maharashtra Economic Development Council (MEDC)
- Maratha Chamber of Commerce, Industries and Agriculture (MCCIA)
- 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)
- Water Environment Federation (WEF)

INSTITUTIONAL COMMITTEES

Institutional Bio-Safety Committee

Mr. Shivajirao Deshmukh, DG, VSI	Chairman
Dr. P. Suprasanna, Head, FPBS, NABTD, BARC, Mumbai	DBT nominee
Dr. Vidya Gupta, Scientist - G, NCL, Pune	Member
Dr. SK Raut, Consultant Physician, Pune	Member
Dr. RM Devarumath, Scientist, VSI	Member
Dr. SG Dalvi, Scientific Officer, VSI	Member
Dr. AA Nikam, Scientific Officer, VSI	Member
Dr. K Harinath Babu, Sr. Scientist, VSI	Member Secretary

Inauguration of farmer's training programme - Dnyanlaxmi and Dnyanyag

Annexure III

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, Standing Advisory Committee, National Sugar Institute (NSI), Kanpur
- Member, Research Advisory Committee, Sugarcane Breeding Institute (SBI), Coimbatore
- Member, Management Committee, Sugarcane Breeding Institute (SBI), Coimbatore
- 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

Agricultural Sciences and Technology

Dr. K. Harinath Babu, Senior Scientist

- Member, Board of Studies, Sugar Technology, Gulbarga University, Kalaburagi, Karnataka
- Member, Board of Studies, Sugar Technology, Central University of Karnataka, Kalaburagi, Karnataka

Mr. PP Shinde, Scientist

- Member, State Level Drip and Sprinkler Irrigation Committee, Government of Maharashtra

Mr. BJ Takalkar, Scientific Officer

- Member, Advisory Committee, All India Radio and Doordarshan

Sugar Technology

Dr. RV Dani, Head & Technical Adviser

- Member, Project Review & Steering Group meeting, Department of Information Technology, Govt. of India, New Delhi.
- Member, Bureau of Indian Standards (BIS) - FAD2 committee

Dr. VP Sidnale, Senior Sugar Technologist

- Member, Technical Committee, Deccan Sugar Technologist's Association (India)
- Member, Board of Studies in Sugar Technology, Gulbarga University, Kalaburagi, Karnataka

Sugar Engineering

Mr. KR Patil, Head & Technical Adviser

- Member, Co-generation project implementation and co-ordination committee, Government of Maharashtra
- Member, State Level Machinery Purchase Committee (SLMPC), Government of Maharashtra
- Member, Committee for registration of non-critical items, Commissionerate of Sugar (MS)
- Technical Judge, Committee for engineering session to adjudicate the papers published by STAI
- Member, Energy and Cost Audit Committee, Government of Maharashtra
- Member, Committee appointed by Government of Maharashtra for selection of Managing Directors panel for co-operative sugar mills
- Member, Committee appointed by Government of Maharashtra for expansion of bagasse based co-generation project under renewable energy policy

- Member, Committee appointed by Joint Secretary (Sugar & Admn.), Govt. of India for ineligible items to be considered for SDF loan for modernization, co-generation and ethanol & ZLD projects
- Member, Committee appointed by Government of Maharashtra for revival of sick sugar mills
- Member (Group of expert), Committee appointed by Punjab State Federation of Co-operative Sugar Mills Limited for revival of old sugar mills

Mr. TS Ingle, Technical Adviser

- Member, Committee appointed by Government of Maharashtra for expansion of bagasse based co-generation project under renewable energy policy
- Member, Committee appointed by Joint Secretary (Sugar & Admn.), Govt. of India for ineligible items to be considered for SDF loan for modernization, co-generation and ethanol & ZLD projects

Mr. RA Chandgude, Jt. Technical Adviser

- Member, Staffing pattern committee for sugar mills, Government of Maharashtra
- Member, Monitoring modernization-cum-expansion along-with co-generation project of Chhatrapati SSK, Bhavaninagar, Government of Maharashtra
- Member, Committee for extension of financial and administrative approval for modernization along-with cogeneration project of Vasantrao Kale SSK, Government of Maharashtra

Alcohol Technology and Biofuels

Dr. 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, Ethanol working group constituted by Bureau of Indian Standards for finalization of specifications for E 85 and E 25 blends
- Member, State Level Machinery Purchase Committee (SLMPC)
- Member, Distillers' Association of Maharashtra (DAM)
- Member, Consultative Group Committee, Geographical Indications Registry, Trade Marks and GI (Whisky and wines)
- Chairman, Expert Committee constituted by CPCB to formulate Action Plan/Charter for distilleries in Ganga basin
- Invitee Member, Group of Expert appointed by the Punjab State Federation of Co-operative Sugar Mills Ltd., for revival of co-operative sugar mills in Punjab

Dr. AD Paradh, Scientist

- Member, Asia Pacific Section, Institute of Brewing and Distilling, London

Environmental Sciences

Dr.(Ms) Deepali Nimbalkar, Head & Senior Scientist

- Associate Referee, GS 4 Molasses, ICUMSA
- Member, Indian National Committee, ICUMSA
- Member, Board of studies, Environmental Sciences, Savitribai Phule Pune University
- Member, Women Complaint Committee, National Research Centre for Grapes, Pune
- Executive Member, Governing Body of Chevening Alumni India
- Member, Working group for sugar industry standards constituted by CPCB

Annexure IV

PUBLICATIONS

AGRICULTURAL SCIENCES AND TECHNOLOGY

Dalvi SG, Tawar PN, Suprasanna P (2017)
Gamma Irradiated chitosan a wonderful biostimulant for sugarcane yield improvement
Proceedings of 75th Annual Convention of STAI
210 - 223

Deshmukh PS, Phonde DB (2017)
Foliar sprays of seaweed extract on growth, yield and quality of sugarcane
Proceedings of 75th Annual Convention of STAI
85 - 96

Farsangi FJ, Thorat AS, Devarumath RM (2017)
Analysis of molecular assortment in sugarcane varieties using RAPD and ISSR markers
Research Journal of Biotechnology
12 (12)
20 - 28

Hapase RS, Repale JM, Pawar DS (2017)
CoVSI 03102 - Sugarcane variety for high rainfall zone of Maharashtra
Proceedings of 75th Annual Convention of STAI
142 - 151

Hapase RS, Repale JM, Pawar DS (2017)
Yield stability analysis on sugarcane cultivars trials in high rainfall area of Maharashtra
International Symposium on Sugarcane Research since Co 205: 100Years and Beyond (SucroSym 2017) at Sugarcane Breeding Institute, Coimbatore, Tamil nadu
110 - 113

More RR, Ghodke SD, Patil MA (2017)
Isolation, identification of weed pathogen and development of consortium of their toxins as a bio-weedicide for controlling weeds in sugarcane crop
Proceedings of 75th Annual Convention of STAI
293 - 299

More RR, Phonde DB (2017)
Bioavailability of silicon by silicate solubilizing micro - organisms for increasing yield and quality of sugarcane
Proceedings of abstracts, 7th International Conference on Silicon in Agriculture, UAS, Bengaluru
120

Nerkar GA, Purankar MV, Sheelavantmath SS, Devarumath RM (2018)
Biotechnological approach: A new dimension for sugarcane improvement
In: Kalpana Sengar (Ed) Biotechnology to Enhance Sugarcane Productivity and Stress Tolerance CRC Press, Taylor & Francis Group, NY
1 - 24

Pawar BH, Patil DG, Dalvi SG (2017)
A simple approach for rapid screening of sugarcane genotypes against wilt and induction of disease resistance
Proceedings of 75th Annual Convention of STAI
279 - 292

Phonde DB, Deshmukh PS, More RR, Banerjee K (2017)
Studies on soil silicon status in vertisols and silicon management in sugarcane
Proceedings of abstract, 7th International Conference on Silicon in Agriculture, UAS, Bengaluru
122

Kale RR, Wadyalkar P, Kawar PG, Ghole VS, Babu KH (2017)
Development of sugarcane plastid transformation system using particle bombardment
J. Plant Development Sciences
9(6)
523 - 530

Repale JM, Hapase RS, Chapde PD (2017)
Studies on performance of promising sugarcane genotypes in North-East Maharashtra
Proceedings of 75th Annual Convention of STAI
137 - 141

Shinde PP (2017)
Mechanized cultivation in sugarcane crop
Proceedings of 75th Annual Convention of STAI
174 -181

Nalawade VM, Naidu MR, Kale RR, Thorat AS, Babu KH (2017)
Detection and eradication of major microbial contaminants during callus culture of Sugarcane (*Saccharum offcinarum* L.) genotype Co 86032
Research Journal of Pharmaceutical, Biological and Chemical Sciences
8(1)
1153 -1160

Annexure IV (Contd.)

SUGAR TECHNOLOGY

Panda S, Dumanavar PS, Dani RV (2017)
A concept of conversion of existing sulphitation plant to refined sugar plant with 38% steam on cane
Proceedings of 75th Annual Convention of STAI
14 - 20

SUGAR ENGINEERING

Kale KB (2017)
Modification in existing milling tandem to get 98% mill extraction
Proceedings of 75th Annual Convention of STAI
E 377 - 388

Kale KB (2017)
Moisture reduction system by trash plate modification
Proceedings of 63rdAnnual Convention of DSTA
E 274 - 278

Patil KR, Ingle TS (2017)
Solar energy application in Indian sugar industry
Proceedings of 75th Annual Convention of STAI
E 445-455

Patil PG, Changude RA (2017)
Improved drive system for fibrizer application
Proceedings of 47th Annual Convention of SISSTA
E 229-239

ALCOHOL TECHNOLOGY AND BIOFUELS

Burase RV, Patil SV, Patil RS, Rathod G, Misale G (2017)
Pilot scale studies of biomethanation of high brix spent wash
Proceedings of 63rdAnnual Convention of DSTA
325-335

Ingle S, Paradh A, Dudhane A, Patil S (2017)
Enhanced bio-ethanol production from different sugarcane bagasse cultivars using co-culture of *Saccharomyces cerevisiae* and *Scheffersomyces (Pichia) stipitis*
Journal of Environmental Chemical Engineering, 5(3)
2861-2868

PAPER PRESENTATIONS

AGRICULTURAL SCIENCES AND TECHNOLOGY

Dalvi SG, Muley AB, Suprasanna P (2017)
Elicitation effect of chitosan and oligochitosan on morpho-physiological parameters and expression of chitinase and chitosanase in potato
International Conference on bio-technological aspects of Chitosan and chitooligosacccharides (ICBAC) & 6th Indian Chitin and Chitosan Society Symposium(ICCCSS-2017), University of Hyderabad

ALCOHOL TECHNOLOGY AND BIOFUELS

Patil SV (2017)
Adequacy of Effluent Treatment Plants- Self Assessment
All India Distillers' Association (AIDA), New delhi

Patil SV (2017)
Producing alcohol and extracting yeast from molasses cassava and bagasse
5th TTC Annual International Sugarcane Conference, jointly organized by the TTC Group and Vietnam Sugarcane and Sugar Association (VSSA) at Phan Thiet city, Binh Thuan Province, Vietnam

Patil SV (2017)
Augmenting fuel ethanol supply alternate feedstock sustainability and policy interventions
Conference on Ethanol as a Transport Fuel at Central Institute of Road Transport, Pune, India

Farmers in Dnyanyag training programme

POSTER PRESENTATIONS

AGRICULTURAL SCIENCES AND TECHNOLOGY

Deshmukh PS, Phonde DB (2017)
Assessment of field scale spatial variability of soil chemical properties of Lonarwadi research farm of VSI, Pune, India using geostatistical approach
International Symposium on "Sugarcane research since Co 205: 100 years and beyond (SucroSym 2017)" at Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India

Farsangi FJ, Devarumath RM (2018)
Internal transcribed spaces (ITS) region in sugarcane diversity analysis
National seminar on "Advances in plant sciences" at Savitribai Phule Pune university, Pune, Maharashtra, India

Mirajkar SJ, Dalvi SG, Suprasanna P (2017)
Study of effect of normal and gamma irradiated chitosan on *in vitro* shoot and gene expression
International conference on "Bio-technological aspects of Chitosan and Chitooligosacccharides (ICBAC) & 6th Indian Chitin and Chitosan Society Symposium(ICCCSS-2017)" at University of Hyderabad, Hyderabad, India

Nalavade VM, Chavan SM, Farsangi FJ, Babu KH (2018)
Evaluation of SoMYB18 gene transformed sugarcane lines using ISSR markers National conference on "Multidisciplinary approaches in life science: Research and Application for Sustainable Development" organized by Yashwantrao Chavan Institute of Science, Satara, Maharashtra, India

Negi P, Rai AN, Pandey MA, Nikam AA, Devarumath RM, Suprasanna P (2017)
Physiological basis of salt tolerance in a radiation-induced mutant of sugarcane
National conference of plant Physiology "Emerging role of plant physiology for food security and climate resilient agriculture" at IGKV , Raipur, Chattisgarh

Purankar MV, Devarumath RM (2018)
Media optimization protocol for plant regeneration through embryogenesis for the sugarcane variety CoM 0265
National seminar on "Advances in plant sciences" at Savitribai Phule Pune university, Pune, Maharashtra, India

Repale JM, Hapase RS, Pawar DS (2017)
Evaluation of promising clones of sugarcane developed at VSI
International Symposium on "Sugarcane research since Co 205: 100 years and beyond (SucroSym 2017)" at Sugarcane Breeding Institute, Coimbatore, Tamil nadu, India

ENVIRONMENTAL SCIENCES

Nalavade VM, Ghogare SC, Nimbalkar DS, Deshmane AB (2018)
Use of microalgae *Chlorella vulgaris* for the treatment of bio-methanated distillery spentwash
National conference on 'Multidisciplinary approaches in Life Science: Research and Applications for Sustainable Development' organized by Yashwantrao Chavan Institute of Science, Satara, Maharashtra, India

Annexure V

SEMINARS / WORKSHOPS / TRAINING PROGRAMMES / MEETINGS

I) SEMINARS / WORKSHOPS / TRAINING PRGRAMMES ORGANIZED BY VSI

Date	Particulars
Apr. 22, 2017	Workshop on 'Sugarcane varieties in Maharashtra, their planning and sugar processing'
May 27, 2017	Workshop on 'EPN based bio-control of white grub in sugarcane'
Jun. 7, 2017	Workshop on 'Environmental challenges in the sugar industry and the way forward'
Sep. 9, 2017	Workshop on 'Cane development action plan for increasing sugarcane productivity'
Sep. 23, 2017	Workshop on 'Soil organic carbon management and its importance'
Oct. 1, 2017	Workshop on 'Sugarcane seed multiplication & production technology'
Oct. 16 to Dec. 22, 2017	Training programme for Fiji Delegates at VSI Campus
Oct. 28, 2017	Workshop on 'Interculturing operations for better sugarcane productivity''
Dec. 6, 2017	Seminar on 'Art of brewing and operational excellence' organized in collaboration with Weyermann Specialty Malting Company, Germany and Fermentis, France
Jan. 27, 2018	Workshop on 'Fertigation in sugarcane'
Feb. 24, 2018	Workshop on 'Management of important diseases and pests in sugarcane'
Mar. 24, 2018	Workshop on 'Review of cane development activities in sugar mills'

II) PARTICIPATION IN SEMINARS / WORKSHOP / TRAINING PROGRAMMES BY VSI SCIENTISTS

Title	Scientists Participated
ISO 9001:2015 Awareness: OPS Mumbai, VSI Apr. 10, 2017	Dr. AB Deshmane
Training on Improving satellite derived data analysis and interpretation for improving water use efficiency in sugarcane farming, by Solidaridad Network Asia Apr. 11 - 12, 2017	Dr. (Ms) PS Deshmukh
STAI Workshop at Gangtok, Sikkim May 11 - 12, 2017	Mr. S Panda
National Bio-diversity Targets 2020: Challenges and opportunities for business, India Business & Biodiversity Initiative, Mumbai Jun. 8, 2017	Dr. AB Deshmane
47th Annual Convention of SISSTA Jun. 30, 2017	Mr. RA Chandgude, Mr. PG Patil
Capacity Building of EIA Consultant Organizations 'Preparing Good Quality EIA Reports' QCI/NABET, MITCON Pune Jul. 4 - 7, 2017	Dr. (Ms) DS Nimbalkar, Dr. AB Deshmane
63rd Annual convention of DSTA at Belgavi, Karnataka Jul. 14 - 15, 2017	Mr. RV Burase
Training programme on 'Measurement of uncertainity' organized by STQC, Pune Jul. 21 and Sep. 22, 2017	Dr. ST Devkar, Ms. SM Hawale, Ms. NM Naik
Annual Convention of STAI at Cochin, Kerala Aug. 2 - 5, 2017	Mr. Shivajirao Deshmukh Dr. RV Dani, Mr. KR Patil, Mr. TS Ingle, Dr. DB Phonde, Mr. PP Shinde, Mr. BH Pawar, Dr. SG Dalvi, Mr. DS Pawar, Ms. SD Ghodke

Annexure V (Contd.)

Title	Scientists Participated
Inauguration of training programme on 'Management development programme for sugar cooperative on sugar by-products-demand creation & marketing' at VAMNICOM, Pune Sep. 7, 2017	Mr. Shivajirao Deshmukh
Training on Agriculture Genetics: Understanding and improving plants & animals for food & agriculture at Department of Botany, SPPU, Pune, under Global Initiative on academic Network (GIAN) Sep. 11 - 15, 2017	Dr. RM Devarumath, Ms. MV Purankar
International Symposium on 'Sugarcane Research since Co205: 100 years and beyond (Sucrosym2017)' organized by ICAR-SBI, Coimbatore Sep. 18 - 20, 2017	Mr. Shivajirao Deshmukh, Dr. RS Hapase, Dr. DB Phonde, Dr. JM Repale, Dr. (Ms) PS Deshmukh, Dr. KH Babu, Mr. BH Pawar, Mr. PV Ghodke, Mr. RG Yadav, Ms. RA Sawant, Mr. RB Bhoite, Ms. SD Ghodke, Ms. JP Kharade
Training programme on 'Environmental regulators understanding environmental laws for better compliance' CSE, Delhi Sep. 18 - 22, 2017	Dr. EA Alhat
Workshop on "Alternate source for production of alcohol/ ethanol quality control and efficiencies (water & power) and effluent treatment for ZLD" at AIDA, New Delhi Oct. 5 - 6, 2017	Dr. SV Patil, Mr. AB Deshmukh, Mr. RS Patil
STAI seminar on Decanter at Kolhapur as Chairman of the session Oct. 6, 2017	Dr. RV Dani
7th International Conference on Silicon in Agriculture, Bengaluru Oct. 24 - 28, 2017	Dr. DB Phonde
Workshop on 'Upcoming technology for ETP in sugar industry' at NSI, Kanpur Oct. 24, 2017	Dr. RV Dani
Solidaridad-The annual steering committee meeting for the FDW sugarcane programme- 'Increasing water use efficiency in sugarcane growing in India' in Mysore / Bangalore Nov. 16 – 17, 2017	Mr. Shivajirao Deshmukh
CIRT conference for 'Ethanol as transport fuel' at Pune Nov. 24, 2017	Mr. Shivajirao Deshmukh Dr. SV Patil, Mr. DR Takate, Mr. RV Godage, Dr. KS Konde, Mr. RS Patil
Training programme on 'Laboratory management and internal audit as per ISO/IEC 17025:2005' organized by STQC, Pune Dec. 4 - 6, 2017	Mr. RV Burase
Visit to Janata Sikshan Sanstha, Wai, Satara Jan.31, 2018	Mr. Shivajirao Deshmukh
Seminar on 'Column chemistry, sample preparation and waters certified consumable' organized by Waters, Pune Feb. 8, 2018	Dr. ST Devkar, Ms. NM Naik
Seminar on 'Automation solutions for sugar applications' organized by ABB Ltd. Pune Feb. 21, 2018	Mr. DN Gare, Mr. PG Patil Mr. SG Kaduskar

Annexure V (Contd.)

Title	Scientists Participated
Seminar on 'Process Weighing Solutions' organized by Precia Molen, Pune Feb. 28, 2018	Mr. DN Gare
NABL awareness training program 17025:2017 latest revision general: Requirement for the competence of testing and calibration laboratories, organized by STQC, Pune Mar. 7 - 8, 2018	Dr. ST Devkar, Ms. AS Urdukhe
Seminar on 'Role of automation in connecting enterprise' organized by Rockwell Automation, Pune Mar. 16, 2018	Mr. SG Kaduskar
As a resource person for the National Seminar on 'Strengthening of co-operative sector in India' organized by Yashwantrao Chavan School of Rural Development, Shivaji University, Kolhapur Mar. 16 - 17, 2018	Mr. Shivajirao Deshmukh
Entrepreneurship in sugarcane sector, IISR, Lucknow Mar. 19 - 28, 2018	Mr. RG Yadav, Mr. RN Gaikwad
Workshop at NSI on charter for sugar mills in the river Ganga basin Mar. 23, 2018	Dr. RV Dani
Training programme on 'How to improve laboratory productivity' organized by Agilent Technology, Pune Mar.23, 2018	Ms. NM Naik, Ms. SM Hawale
Seminar on 'Variable frequency drives' organized by Mitsubishi Mar. 30, 2018	Mr. PG Patil
Schnider - Seminar on Switchgear	Mr. PG Patil
L&T- Seminar on Power quality	Mr. PG Patil

III) PARTICIPATION IN MEETING BY VSI SCIENTISTS

Title	Scientists Participated
Research Planning Meeting, MPKV, Rahuri Apr. 7, 2017, Feb. 20, 27, Mar. 5, 2018	Mr. BH Pawar, Mr. PV Ghodke, Ms. RR More, Ms. SD Ghodke, Ms. KG Nigade
Meeting with Chairman and Directors, Thanh Thanh Cong Sugars (TTCS) Vietnam, Apr. 5, 2017	Mr. PV Ghodke
Pre- RRC and RRC Meeting, MPKV, Rahuri Apr. 5, Dec.6, 7, 8, 11, 12, 18, 21, 22, 2017Mar. 20, 2018	Dr. DB Phonde, Mr. PP Shinde, Mr. RG Yadav, Mr. JH Yadav, Ms. RR More, Ms. SD Ghodke, Ms. KG Nigade, Mr. DS Jadhav
Meeting with Ethiopia delegation, Rana Sugars, UP and Rajashree Sugars, TN Apr. 20, 2017, Aug. 10 , 2017 and Aug. 31, 2017	Mr. PV Ghodke
Joint Agresco of SAU's of Maharashtra May 28-31, 2017	Dr. RS Hapase, Mr. BH Pawar, Mr. RG Yadav
Meetings of Expert Committee at CPCB office, New Delhi Jul. 17, Sep.27, 2017 and Feb. 20, 2018	Dr. SV Patil

Annexure VI (Contd.)

Title	Scientists Participated
Review meeting 'Seed production in Agricultural Crops' ICAR Seed project at Pantnagar Jul. 29 - 30, 2017	Mr. SS Katake
Sucrosym International Conference at Tamil Nadu Agricultural University, Coimbatore Sep. 20, 2017	Mr. PV Ghodke
Meeting with various stakeholders for ensuring compliance of revised standards for sugar manufacturing units notified by Gazette, OCEMS connectivity and related issues, CPCB New Delhi Sep. 2, 2017	Dr. RV Dani, Mr. DB Sapkal
Indo Europian countries dissemination event meeting of 'Nano3 Bio –The Future Of Chitosan' at University of Hyderabad Sep. 19, 2017	Dr. SG Dalvi
AICRP(S) group meeting, Tamil Nadu Agriculture University, Coimbature Sept. 22 - 23, 2017	Dr. RS Hapase, Dr. DB Phonde, Dr. JM Repale, Dr. (Ms) PS Deshmukh, Mr. BH Pawar, Mr. PV Ghodke, Mr. RG Yadav, Ms. SD Ghodke,
Biannual workshop of AICRP(S) at Tamil Nadu Agricultural University, Coimbatore Sep. 23, 2017	Mr. PV Ghodke
Meeting of the Expert Committee to formulate Action plan for up-gradation by sugar mills identified as discharging effluent into Ganga main stream and its tributaries - CPCB, New Delhi Sep. 27 - 28, 2017	Dr. RV Dani, Mr. DB Sapkal
Meeting regarding ITEC programme in Ministry of External affairs at New Delhi Oct. 12, 2017	Dr. RV Dani
Meeting with Director of research & planning, Fiji Islands Dec. 12, 2017	Mr. PV Ghodke
Visit to agriculture exhibition at Krishi Vidyan Kendra, Baramati Jan. 19, 2018	Mr. PV Ghodke
Meeting regarding water balance and ETP adequacy at Lucknow Feb. 26 - 27, 2018	Dr. RV Dani
Meeting with Director and Senior Scientists of BARC, Mumbai Mar. 26, 2018	Mr. Shivajirao Deshmukh, Dr. DB Phonde, Mr. PV Ghodke, Mr. PN Tawar, Mr. SS Katke, Dr. SG Dalvi, Ms SD Ghodke

Inauguration of the 'National Seed Day'

Participants in the programme of 'National Seed Day'

Annexure VI

LECTURES DELIVERED BY VISITORS AT VSI

Date	Subject	Name of the Speaker / Orgnization
May 2, 2017	Applications of various chemicals in sugar & distillery industry	Mr. Nandu Dhekane, Vice President, Asia Pacific, Solenis Chemicals Co. Ltd., Shanghai, China Mr. Sachin Kukade, Director, Equipment & Services, Asia Pacific, Solenis Chemicals India Pvt. Ltd., Pune
May 27, 2017	Entomopathogenic nematodes: Mass production, formulation and field delivery methods	Dr. Sunanda Patil, NIPHM Research, Hyderabad
Jun. 3, 2017	Applications of various chemicals in sugar & distillery industry	Mr. Shrikant Ahirrao, Solenis Chemicals India Pvt. Ltd.
Jul. 25, 2017	Applications of various chemicals in sugar & distillery industry	Mr. Fabresio Farero, Solenis Chemicals Pvt. Ltd., Brazil
Oct. 5, 2017	Change in Agricultural practices and its impact on Wildlife	Mr. Pandurang Shitole, Founder, Gram Parivartan Sanstha
Oct. 5, 2017	Bio-diversity of Purandar Taluka	Mr. Rajkumar Pawar, Co-ordinator, Ela Foundation, Pune
Oct. 6, 2017	Role of water in conservation of bio-diversity	Mr. Prashant Borawke, Gram Gaurav Pratishthan, Saswad
Oct. 6, 2017	Intelligence of plants	Dr. Satish Pande, Ela Foundation, Pune
Oct. 6, 2017	Environment conservation and Indian traditions	Dr. Suruchi Pande, Ela Foundation, Pune
Oct. 25, 2017	Electrical motors and alternators	Mr. N Dhaygude, Nova Power, Pune
Oct. 28, 2017	Weed control in sugarcane	Dr. AB Kamble, Professor of Agronomy, College of Agriculture, Pune
Nov. 1, 2017	Equipment design and drawing - Pump / impeller / vane design	Mr. Z Patait P K Pumps and Precicast Pvt. Ltd., Sangli
Nov. 2, 2017	Non-destructive testing of material	Mr. RS Jadhav Oilfield training Experts, Mumbai
Nov. 7, 2017	DCS control system for co-generation	Mr. Atish ABB Engineering, Pune

Annexure VI (Contd.)

LECTURES DELIVERED BY VISITORS AT VSI

Date	Subject	Name of the Speaker / Orgnization
Nov. 8, 2017	Designing of vacuum and continuous pan	Mr. SK Bhojraj, President, Sugar Division, Crystal Engineering, Pune
Nov. 21, 2017	TG set auxiliaries and its control	Mr. Ashish Khandge Kirloskar Ebara Pumps Ltd., Pune
Dec. 5, 2017	Rotary screen after raw juice heating and decanter	Mr. Aniket Suviron Eqpt. Pvt. Ltd.
Dec. 6, 2017	Sugar mill maintenance	Mr. RD Patil Pandurang SSK
Dec. 7, 2017	Sugar mill management	Mr. Dilip Wate Management Consultant, Pune
Dec.12, 2017	Factory lay out and mechanical circulators	Mr. SK Bhojraj, President, Sugar Division, Crystal Engineering, Pune
Dec. 19, 2017	Sugar process automation	Mr. Sanjay Nikam Versatile Automation, Pune
Dec. 20, 2017	Use of solar energy	Mr. BH Shrikant, Chief Consultant, Sciencia Industrial Projects, Pune
Dec. 20, 2017 \	High pressure boilers and safety	Mr. Sanjay Gaikwad Thermax Ltd., Pune
Jan. 19, 2018	Case study - A real 2G ethanol demonstration plant in Asia	Mr. SR Soni, Vice President, India Glycol Ltd., Uttarakhand

Lighting of lamp by the Commissioner of Sugar, MS on the occasion of 42nd foundation day of VSI

Felicitation of Vice Chancellor, SPPU, Pune by Vice President, VSI, on the occasion of 42nd foundation day of VSI

Annexure VII

INVITED LECTURES BY VSI SCIENTISTS

Date	Subject	Place	Speaker
May 15, 2016	*Ganna buai ki Adhunik taknik aur Ganna Jadi Prabandhan*	Valsad Khand Udyog, Gujarat	Mr. PV Ghodke
Jul. 18, 2017	*Adhunik oos lagwad and oos khodwa vyavasthapan*	Bhimashankar SSK, Dist. Pune	Mr. PV Ghodke
Aug.12, 2017	Latest aspects in clarification and filtration of sugar processing for improvement in final product.	Dhampur Sugars, Technical Conclave 2017, New Delhi	Dr. VP Sidanale
Sep. 17, 2017	Scenario of sugar industry in Maharashtra	ICAR - SBI, Coimbatore	Mr. Shivajirao Deshmukh
Oct. 24, 2017	Treatment technologies for sugar factory effluent	National Sugar Institute, Kanpur	Mr. DB Sapkal
Nov. 24, 2017	Augmenting fuel ethanol supply alternate feedstock sustainability and policy interventions	CIRT conference for 'Ethanol as transport fuel' at Pune	Dr. SV Patil
Jan. 09, 2018	*Oos khodwa vyavasthapan*	Sonhira SSK, Dist. Sangli	Mr. PV Ghodke
Jan. 17, 2018	*Oos khodwa vyavasthapan*	Bhimashankar SSK, Dist. Pune	Mr. PV Ghodke
Feb. 13, 2018	Career opportunities in Environmental Science	Abeda Inamdar Senior College, Pune	Dr. (Ms) DS Nimbalkar
Mar. 27, 2018	*Oos khodwa vyavasthapan*	KS Kale SSK, Dist. Ahamadnagar	Mr. PV Ghodke

Felicitation of Ethiopian delegates from Ethiopian Sugar Corpoaration

Visit of Agronomists from Netafim Pvt.Ltd., Thailand to the Tissue Culture Laboratory of VSI

Annexure VIII

RADIO AND TELEVISION PROGRAMMES

Date	Topic	Name of Scientist
	All India Radio	
May 12, 2017	*Oosawaril udpanna kharch kami karnache upay*	Mr. BJ Takalkar
Jun. 28, 2017	*Thibak sinchan paddhatichi niga ani kalaji*	Mr. PP Shinde
Jul. 28, 2017	*Oos pikavaril pokkah boeng rog va tyache niyantran*	Mr. BH Pawar
Jul. 28, 2017	*Pavsala hangamat oos pikavar aadhalnare rog va tyanche niyantran*	Mr. BH Pawar
Sep.12, 2017	*Purvahangami oosasathi eakatmik khat vyavasthapan*	Ms. JP Kharade
Oct.10, 2017	*Yantrik paddhatine oos lagwad*	Mr. PP Shinde
Oct. 20, 2017	*Oos utpadan vadhisathi jamin supikata vyavasthapan*	Dr. (Ms) PS Deshmukh
Feb. 2, 2018	*Khodwa peek kami kharche*	Mr. BJ Takalkar
Mar. 3, 2018	*Suru oos laglad kifayatsheer*	Mr. BJ Takalkar
	Doordarshan	
Sep. 27, 2017	*Oosasathi thibak sinchan*	Mr. PP Shinde

Inauguration of training programe on
'Modern Technologies in Sugarcane Agriculture'

Dignitories of training programe on
'Modern Technologies in Sugarcane Agriculture'

VSI stall in the Exhibition at KIsanveer Satara SSK

VSI stall in the Exhibition at KIsanveer Satara SSK

Annexure IX

AWARDS

Award	Awardees	Article
Life Time Achievement award presented in 75th Annual convention of STAI	Mr. KR Patil	---
ISGEC Gold Medal - Engineering Excellence	Dr. RV Dani	In recognition to the invaluable contribution made in the development of the sugar industry in India & abroad
Noel Deerr Gold Medal in 75th Annual Convention of STAI	Mr. KR Patil, Mr. TS Ingle	Comparative study of three roller mills with UFR, TRPF, GRPF and two roller mill

PhD AWARDS

Name	Title of Thesis	University / Subject	Name of Guide
Mr. PN Tawar	Development of sugarcane variety from CoC 671 by using callus culture technique	Bharati Vidyapeeth Deemed University, Pune Subject : Biotechnology	Dr. Neelambika Meti, Associate Professor, Department of Biotechnology, Rajiv Gandhi Institute of Information Technology and Biotechnology, Pune
Ms. Forough Jomeh Farsangi, (PhD student)	Assessment of Genetic Diversity in Sugarcane Germplasm Using DNA Markers	Savitribai Phule Pune University Subject : Biotechnology	Dr. RM Devarumath, Scientist, MB & GE Laboratory, VSI
Ms. Hemangi Sakharam Kolte, (PhD Student)	Treatability Study Of Anaerobically Digested Spent Wash through Selective Oxidation Processes	Savitribai Phule Pune University Subject : Environmental Sciences	Dr. (Ms) DS Nimbalkar, Head & Sr. Scientist, Environmental Sciences, VSI and Dr. SV Patil,Head & Technical Adviser, Alcohol Technology & Biofuels, VSI

Mr. KR Patil, Head & Technical Adviser, Sugar Engineering, VSI receiving 'Life Time Achievement' award from STAI

Recognition

- **Dr. K Harinath Babu**,
  Sr. Scientist & Head, Molecular Biology & Genetic Engineering Laboratory, has been granted recognition as a guide for MPhil / PhD in Biotechnology by Savitribai Phule Pune University.
- **Dr. SG Dalvi**,
  Scientific Officer, Tissue Culture, has been granted recognition as a guide for MPhil / PhD in Biotechnology and Environmental Sciences by Savitribai Phule Pune University.

RESEARCH PROJECTS

Proposals submitted to funding agencies

- **Development of treatment technology for spray pond/cooling tower overflow**
  Project submitted to Indian Sugar Exim Corporation Ltd., New Delhi.

PUBLICATIONS

- Performance of Sugar Mills in Maharashtra: 2016-17 and 2015-16
- Financial Performance of Co-operative Sugar Mills in Maharashtra: 2016-17
- Performance of Co-operative Distilleries in Maharashtra: 2016-17 and 2015-16
- Oos Sheti Dnyanyag: A comprehensive guide for sugarcane farming
- Hindi Oos Sheti Dnyanyag: A comprehensive guide for sugarcane farming

Mr. TS Ingle, Technical Adviser, Sugar Engineering, VSI receiving 'Noel Deerr Gold Medal' award from STAI

Annexure X

DISTINGUISHED VISITORS

- Mr. Hemendra Sharma, Director (DPA-II), Ministry of External affairs (MEA), Govt. of India, New Delhi
- Mr. Navin Chandra, COO of Fiji Sugar Corporation, Fiji
- Ms. Reshmi Kumari, Director Research and Policy, Govt. of Fiji,
- Dr. Tapas Bhattacharya, Vice-Chancellor, Dr. Balasaheb Savant Konkan Krishi Vidyapeeth, Dapoli
- Visit of Rajshree Sugars and Chemicals Ltd., Coimbatore (TN)
  - Ms. Rajashree Pathy, Chairperson
  - Mr. Aditya Pathy, Mananging Director,
  - Mr. G. Sathiyamoorthi, President;
  - Dr. K Mohan Naidu, Consultant;
  - Dr. Sudhakaran and Dr. Jayaram, Scientists
- Ethiopian delegation from Ethiopian Sugar Corporation (ESC) comprising team of
  - Mr. Jemal Aman Beshir, Technical Director of Training Center
  - Mr. Yohannes Mekuanint Teshome, Research & Development Executive,
  - Mr. Mengistab, Advisor to CEO,
  - Gebrekidan and Mr. MHS Ansari, Manager (Sugar Projects)
- Team of Agronomists from Netafim Pvt. Ltd.
  - Mr. Wachirapan Pongsala,
  - Mr. Narisara Doksnita from Netafim Pvt. Ltd., from Thailand
  - Mr. Deepak Saste, Sr. Agronomist, Netafim Pvt. Ltd., Pune (India)
- Representatives of Solenis Chemical India Pvt. Ltd.
  - Mr. Shrikant Ahirrao, Consultant
  - Mr. Sachin Kukade, Director, Equipments and Service, Asia Pacific
- Dr. Sanjay Patil, Territory Manager, Dhanuka Agri Tech Ltd., New Delhi
- Mr. Naiknaware, Managing Director, NFESF, New Delhi
- Mr. Sambhaji Kadupatil, Sugar Commissioner (Maharashtra state)
- Dr. Sunanda, Scientific Officer, NIPHM Research, Hyderabad
- Mr. Hanif Sayyad, Head, New Product Development Atul Ltd. Valsad, Gujarat
- Dr. Dinesh K. Agarwal, Principal Scientist & Director, Indian Institute Seed Science, Kushmaur, Mau (UP)
- Mr. Sherawat, Shamli sugar mills, Muzzafarpurnagar, UP
- Mr. Arvind kumar, Agriculture Dept., Mumbai
- Dr. Arun B. Kamble, Professor of Agronomy, College of Agriculture, Pune
- AD Chairman, TTC group, Vietnam
- Ms. Tanuja Mulik and wives of IAS officers
- Mr. SR Soni, Vice-president, India Glycols Ltd.
- AICRP(S) monitoring team
  - Dr. AS Jeena, College of Agriculture, GB Pant University of Agri. & Tech., Pantnagar, Uttar Pradesh (Plant Breeding);
  - Dr. SBP Thimmagowda, ZARS, Mandya, Karnataka (Agronomy);
  - Dr. (Ms.) Swagatika Mohanty, SRS, Nayagarh, Orissa (Pathology),
  - Dr. SK Pandey, SBI RC, Karnal, Haryana (Entomology) and
  - Mr. Adil Zubair, AICRP(S) Co-ordination Unit, IISR, Lucknow

- Team of fourteen delegates from Mauritius under the leadership of Mr. Abdool Abeydeen Sahodeea, Principal Co-operative Officer from Ministry of Business Enterprises & Co-operatives
- Dr. Kutty, Assistant Professor and Mr. Nikhil Kadale, Research Officer from Vaikunth Mehta National Institute of Co-operative Management
- A team of scientists from BARC, Mumbai lead by
  Dr. Venugopal, Associate Director, Biosciences group, Nuclear Agriculture Biotechnology Division along with Dr. P Suprasanna Head, Stress Physiology section, Dr. S Mehtre, Biocontrol Section, Dr. Anand Badginnawar and Dr. JG Manjaya
- Mr. Nitin Shinde, Sub-Regional Officer, MPCB, Pune
- Mr. Arun Jadhav, President, The Environment Association of Maharashtra
- The team of Board of Directors, officers and staff of agriculture department of four sugar mills viz. KS Patil SSK, Nira Bhima SSK, RB Patil SSK, Someshwar SSK and Indreshwar Sugar

Details of other visitors are as follows :

Particulars	No. of visitors
Farmers	2284
Outside state farmers	548
Officers from sugar mialls	46
Govt. officers	15
Officers from other state	28
Board of Directors within state	42
Board of Directors outside state	06
Students within state	934
Teachers within State	62
Students from outside state	114
Teachers from outside state	18
Trainee teachers	20
Visitors from foreign countries	95
Total	**4212**

Mr. Vijaysinh Mohite-Patil visited VSI stall in exhibition of Zilha Krushi Mohostav, Pune

Visitors to VSI stall in exhibition of Zilha Krushi Mohostav, Pune

Annexure XI

VISITS TO OTHER INSTITUTES

- Fiji Sugar Corporation, Fiji
- Thanh Thanh Cong Sugars (TTCS), Vietnam
- Danfoss Ind. Ltd., Vassa, Finland
- University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka
- Abeda Inamdar Senior College, Pune, Maharashtra
- Agharkar Research Institute(ARI), Pune, Maharashtra
- Agriculture Research Station, Tirupathi, Andhra Pradesh
- ATUL, India, Gujarat
- Bhabha Atomic Research Center (BARC), Mumbai, Maharashtra
- Bharati Vidyapeet Deemed University, Pune, Maharashtra
- Central Pollution Control Board (CPCB) New Delhi
- Central Sugarcane Research Station (CSRS), Padegaon, Maharashtra
- Central University Gujarat, Gandhinagar, Gujarat
- DOW Chemicals Ltd., Mumbai, Maharashta
- EID Parry, Tamilnadu
- GB Pant Agriculture University, Uttaranchal
- Gulbarga University, Kalaburgi, Karnataka
- Indian Agriculture Research Institute (IARI), Karnal, Haryana
- Indian Institute of Sugarcane Research(IISR), Lucknow, Uttar Pradesh
- Krishi Vidnyan Kendra, Baramati, Maharashtra
- Mahatma Phule Krishi Vidyapeeth, (MPKV), Rahuri, Maharashtra
- Ministry of Environment Forests & Climate Change, New Delhi
- National Bureau of Soil Survey & Land Use Planning, Nagpur, Maharashtra
- National Chemical laboratory (NCL), Pune, Maharashtra
- National Research Centre (NRC) for Grapes, Pune, Maharashtra
- National Research Institute for Biotic & Abiotic stress, Baramati, Maharashtra
- Navsari Agriculture University, Gujarat
- Rajendra Agriculture University (RAU), Pusa, Bihar
- Rana Sugars, Amritsar, Punjab
- Rashtriya Chemicals & Fertilizers (RCF), Mumbai, Maharashtra
- Regional Sugarcane & Jaggary Research Station, Kolhapur, Maharashtra
- Savitribai Phule Pune University (SPPU), Pune, Maharashtra
- Shivaji University, Kolhapur, Maharashtra
- Sugarcane Breeding Institute (SBI), Coimbatore, Tamil Nadu
- Sugarcane Research Station, Sankeshwar, Karnataka
- Sugarcane Research Station, Thiruvalla, Kerala
- Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
- UPL Ltd., Bandra (E), Mumbai, Maharashtra
- Vasantrao Naik Marathwada Krushi Vidyapeeth, Parbhani, Maharashtra
- Yashwantrao Chavan Academy of Administration (YASHADA), Pune, Maharashtra
- Zonal Agriculture Research Station, Mandya, Karnataka

Annexure XII

VISITS BY TECHNICAL PERSONNEL

Purpose of Visit	No. of Visits
Agricultural Sciences and Technology	
Cane development activities	43
Farmers rallies	24
Inspection of plots *Oos Bhushan* prize winners	20
Participation of seminars/ workshops/ conferences	7
SDF Monitoring	1
Research activities	97
Mill test	3
Pest and disease management	25
Hybridization programme	3
Low recovery rectification	11
Promotional cane development award scheme	68
Staff training of sugar mill officers	6
Sick mill visits for preparation of revival report	25
Exhibition participation	5
Meeting for the TV & Radio programmes	3
To attend the training programmes	4
laboratory establishment consultancy (Soil testing, Bio-fertilizer and TC)	19
Other visits	26
Foreign visits	3
Total	**393**
Sugar Technology	
Extension service including modernization of sugar plant	39
Preparation of tender technical specifications, scrutiny of design and drawing of equipments	9
Improvement in capacity utilization of the mills	24
Minimizing the sugar losses in boiling house	10
Improvement in sugar quality with colour audit team	17
Guiding the mills to improve the overall technical performance	33
Conservation of steam, power and water	15
Optimization of use of chemicals	0
Off-seasonal maintenance	8
Increasing awareness about automation of different units	0
Research and development	10
Guiding the mills for water and waste water management	101
Selection of candidates for technical posts in sugar mills	8
Educational visits	4
Foreign visits	3
Conference / Seminar / Workshops	13
Other visits	21
Total	**315**
Sugar Engineering	
Extension services including modernization of sugar mills	220
Co-generation projects	79
Inspection of machineries	73
Machine manufacturers meetings	17
Non-member sugar mills	31
Foreign visits	2
Pre-bid and technical committee meetings	21
SLMPC and co-generation co-ordination meetings	11
SDF / NCDC meetings	3

Annexure XII (Contd.)

Purpose of Visit	No. of Visits
Research and development Projects	14
Conference / Seminar / Workshop / Training programmes	13
Distillery incineration projects	10
Sick sugar mills revival reports	20
Registration committee meetings for non-critical machinery	4
Mantri committee meetings	2
COS visits	20
Other visits	36
Total	**576**
Alcohol Technology	
Inspection of project execution and performance of distillery plants	41
Inspection of plant and machinery at vendor's workshops	32
Inspection of plant and machinery of existing distilleries	16
Troubleshooting of process problems and related issues	10
Board of Directors meetings for distillery projects	22
Meetings at COS office	16
SLMPC and technical committee meetings for distillery proposal	10
Distillery modernization proposals	7
Bio-gas plant inspection and process problems	2
Adequacy assessment report preparation- Evaluation of distillery ETPs performance	22
Validation of adequacy assessment report	5
Revival report for sick distilleries affiliated to co-operative sugar mills in Maharashtra	7
Revival report for sick distilleries affiliated to co-operative sugar mills in Punjab	3
Seminars / Workshop / Training / Others	5
R & D projects related work	10
DBT & BIS	5
SDF and CPCB Committee meetings	5
Punjab Sugar Federation	2
Other visits	5
Total	**225**
Environmental Sciences	
Industrial visit	76
Maharashtra Pollution Control Board	2
Ministry of Environment, Forest and Climate Change	8
State Environment Department	6
Student excursion and industrial visit	3
Training and workshop	3
Equipment and other maintenance work	1
Total	**99**
Electronics and Computer	
Demonstration of VSIsugarERP	5
Computerization of project report	3
Interviews of staff of sugar mills	1
VSIsugarERP software installation and maintenance	180
Total	**189**
Instrumentation	
Co-generation / Distillery project work	39
Rectification and calibration work	55
Advisory services	18
Training	3
Total	**115**
Grand Total	**1912**

Annexure XIII

VISITS ABROAD

Dates	Persons	Place and Purpose
Apr. 4 - 8, 2017	Mr. Shivajirao Deshmukh, Dr. RV Dani, Mr. KR Patil, Dr. DB Phonde, Mr. PV Ghodke	Thanh Thanh Cong Sugars (TTCS), VietnamStudy and suggestions for improving sugarcane productivity and overall technical performance in TTC sugar mills, Vietnam
Aug. 17 - 18, 2017	Mr. Shivajirao Deshmukh, Dr. SV Patil, Dr. RS Hapase	The 5th TTC Annual International Sugarcane Conference was organized jointly by the TTC Group and Vietnam sugarcane and sugar association at Phan Thiet city, Binh Thuan Province, Vietnam
Sep. 15 - 30, 2017	Dr. VP Sidanale, Mr. LS Dalvi	Fiji Sugar Corporation, FijiFor conducting laboratory equipment & process audit in three sugar mills
Nov. 19 - 26, 2017	Dr. RM Devarumath	University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka for PhD Viva-voce examination in the subject of Bio-technology
Mar. 21 - 27, 2018	Mr. TS Ingle, Mr. UA Kulkarni	M/s. Danfoss Ind. Ltd., Vassa, Finland Workshop for development of MV divers for sugar mill application

Annexure XIV

STATUS OF CO-GENERATION PROJECTS

(CONTRIBUTED BY VSI TILL MARCH 2017)

Name of plant	Power Installed (MW)	Power Export (MW)
A) Projects Completed (C)		
Co-operative-Maharashtra		
Chopda SSK	6	1.5
Jawahar Shetkari SSK	27	15
Bhimashankar SSK, Phase I and II	19	11.95
RB Patil SSK, Unit II	12	7.5
Dnyneshwar SSK, Phase I	15	8
Vaidyanath SSK	21	11.4
Vikas SSK	18	10
Malegaon SSK	21	14
Adinath SSK	11	4.5
Vitthalrao Shinde SSK Phase I & II	38	22.87
Dr.Babasaheb Ambedkar PhaseI	16	9.7
Sanjivani (Takli) SSK	12	6.6
Sonhira SSK	22	12.92
Vasantraodada Patil SSK	17	11
KA Tope Samarth SSK	18	12.54
SM Kagal Taluka SSK	12	7
Devagiri SSK	5	1.5
Terna SSK	17.5	7
Bhima SSK, Patas	19.5	11.4
Vighnahar SSK	18	10
Lok. S Solanke SSK	22	14.68
Mula SSK, Phase I & II	30	20
Vishwasrao Naik SSK	15	10.77
KS Patil SSK	15	7.66
Kukadi SSK, Phase I	12	6
VVD Manjara Shetkari SSK	20	11.7
Kumbhi Kasari SSK	19.5	12.59
Nira Bhima SSK	18	10.7
Sant Tukaram SSK	15	10.02
Sharad SSK	13	6.6
Dnyneshwar SSK, Phase II	19.5	10.28
Chhatrapati SSK, Bhavaninagar	18	10.87
RP Ghodganga SSK	20.5	13.08
Kukadi SSK, Phase II	15	13
Rena SSK	12	6.5
Total	**609.5**	**360.83**
Private - Maharashtra		
Ambalika Sugars	15	9.2
Dwarkadhish Sugar	13	8.5
Indreshwar Sugar	12	7.16
Vitthal Sugar Corporation	12	6.5
Shankarratna Sugar	12.5	8.1
K G S Sugars	12	7
Udagiri Sugar	14	9
Dnyanyogi Sugar, Phase-I	9	4.5
Total	**99.5**	**59.96**

Annexure XIV (Contd.)

Name of plant	Power Installed (MW)	Power Export (MW)
Krishna SSKN, Athani, (Karnataka)	27	17
Halsidhanath SSK (Karnataka)	15	8.9
LPSV Patel, Chhattisgarh	14	7.27
Total	**56**	**33.17**
Total (A)	**765**	**453.96**
B) Projects Under Execution (UE)		
Co-operative- Maharashtra		
Bhausaheb Birajdar SSK	6	3.2
Shrigonda SSK	27	16
Chhatrapati Rajaram SSK	15	9.9
Bhima SSK- Takali	25	17
Karmayogi SSK, Indapur Phase II	25	24
Karmveer Shankarrao Kale SSK	16	9
Sanjivani (Takali) SSK- Phase-II	14	10
Total	**128.0**	**89.10**
Private - Maharashtra		
Shivprabha Sugars	16.5	11
Kranti Sugar & Power Ltd	12.5	6.58
Vijay Sawant sugar & Agro Ltd	12.5	6.58
Prasad Sugar	25	16.5
Dhannama Devi	10	6
Siddhi Sugar	18	12
Tridhara Sugar	27	17
Pannageshwar	12	6.3
Khatav Man Taluka Agro Process Ltd.	12	6.5
Swami Samarth & Agro Ind. Ltd.	12	7.46
Cane Agro Sugar & Power	35	23
Jagmitra Sugar Mills Ltd	15	9.18
Swami Samarth Sugar and Power	14	10
Tulja Sugars Ltd.	12	10
Diligence Sugar Ltd.	12	8
Total	**245.5**	**156.1**
Outside Maharashtra		
Jamkhendi Sugar (Karnataka)	27	14.54
Indian Sugar Phase-I (Karnataka)	8	3.5
Venkteshwara Power Project, Phase-II (Karnataka)	36	25.35
Nandi SSKN (Karnataka)	37	28.04
Total	**108**	**71.43**
Total (B)	**481.5**	**316.63**
A) Completed (C) - 38 nos.	**765.0**	**453.96**
B) Under Excution (UE) - 28 nos.	**481.5**	**316.63**
Total (A + B) - 66 nos.	**1246.5**	**770.59**

Annexure XV

ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
ACFC	Auto Cane Feed Control
ACVFD	Auto Cane Variable Frequency Drive
A.D.	After Death
AGM	Annual General Meeting
AGRESCO	Agriculture Research Committee
AICRP	All India Coordinated Research Project
AICRP(S)	All India Coordinated Research Project (Sugarcane)
APFC	Automatic Power Factor Correction
ASSCT	Australian Society of Sugar Cane Technologists
ASR	Auto Slip Regulator
ata	Atmospheric absolute
ATL	Accredited Test Laboratory
AVR	Automatic Voltage Regulator
AVSI	Associateship of Vasantdada Sugar Institute
AVT	Advanced Varietal Trial
B	Boron
BARC	Bhabha Atomic Research Centre
BBrMV	Banana Bract Mosaic Virus
BCIL	Biotech Consortium India Ltd.
B:C	Benefit Cost Ratio
betA & betB	Glycinebetaine accumulating genes
BMSW	Bio-methanated spent wash
BOM	Bill Of Material
BOT	Build Operate & Transfer
BP	Back Pressure
BRNS	Board of Radiation and Nuclear Science
BSV	Banana Streak Virus
BVM	Beauveria Verticillium and Metarrhizium
^{0}C	^{0}Celcius
Ca	Calcium
$CaCl_2$	Calcium Chloride
CaO	Calcium Oxide
CCS	Commercial Cane Sugar
CDAC	Centre for Development of Advanced Computing
CFD	Computational Fluid Dynamics
CFU	Colony Forming Units
C&I	Control & Instrumentation
cm	Centimeter
CMV	Cauliflower Mosaic Virus
C:N	Carbon : Nitrogen
CNG	Compressed Natural Gas
Co	Bred and selected by SBI Coimbatore
CO	Carbon Monoxide
CO_2	Carbon di-oxide
CoC	Bred in Coimbatore and selected in Cuddalore
COD	Chemical Oxygen Demand
CoJ	Bred in Coimbatore and selected in Jalander
CoJN	Bred in Coimbatore and selected in Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP)
CoM	Bred in Coimbatore and selected in Maharashtra
CoSnK	Bred in Coimbatore and selected in Sankeshwar (Karnataka)
CoT	Bred in Coimbatore and selected in Tirupathi (AP)
CoTl	Bred in Coimbatore and selected in Thiruvalla (Kerala)
CoVC	Bred in Coimbatore and selected in Visvarayya
CoVSI	Bred in Coimbatore and selected in Vasantdada Sugar Institute
CPCB	Central Pollution Control Board
CPU	Condensate Polishing Unit
CREP	Corporate Responsibility for Environment Protection
CSIR	Centre for Scietific and Industrial Research
CSRS	Central Sugarcane Research Station

Annexure XV (Contd.)

ABBREVIATIONS AND ACRONYMS

CSTR	Conventional Stirred Type Reactor
CT	Current Transformer
Cu	Copper
cv	Cultivar
DAE	Department of Atomic Energy
DAP	Di Ammonium Phosphate/Days After Planting
DBT	Department of Biotechnology
DC	Direct Current / Dithiocarbamate
DCH	Direct Contact Heater
DCS	Distributed Control System
DEC	Double Extraction Condensing
DG set	Diesel Generating set
DHG	Distant Hybridization Garden
DIFAT	Diploma Course in Industrial Fermentation and Alcohol Technology
DM	Demineralized
DNA	Deoxyribo Nucleic Acid
DPR	Detailed Project Report
DSLC	Digital Synchronizer and Load Control
DSIR	Department of Scientific and Industrial Research
DSTA	Deccan Sugar Technologists Association
EA	Environmental Audit
EAC	Expert Appraisal Committee
EC	Electrical Conductivity / Environmental Clearence
ECOCERT	Certifying Agency for National programme for organic production standards
EDTA	Ethylene Diamine Tetra Acetic Acid
EIA	Environmental Impact Assessment
ELISA	Enzyme Linked Immuno Sorbent Assay
EMS	Ethyl methyl sulphonate
ENA	Extra Neutral Alcohol
EPF	Entomo Pathogenic Fungi
EPN	Entomo Pathogenic Nematode
EQRS	Export Qaulity Rectified Spirit
ERP	Enterprise Resource Planning
ERQV	Equivalent Ratio Quotient Value
ESB	Early Shoot Borer
ESR	Environmental Statement Report
EST	Expressed Sequence Tag
ETP	Effluent Treatment Plant
FA plant	Fuel Alcohol
Fe	Iron
FE	Fermentation Efficiency
FID	Flame Ionization Detector
FLD	Front Line Demonstration
FPU	Filter Per Unit
FRP	Fair and Remunerative Price
FSC	Fiji Sugar Corporation
FVT	Final Varietal Trial
GA	General Arrangement
GA3	Gibberlic Acid
GC	Gas Chromatography / General Collection / Governing Coucil
GCV	Gross Calorific Value
GE	Genetic Engineering / General Electric
GIS	Geographycal Information System
gm / g	Gramme
GN	Ground Nursery
GoI	Government of India
GoM	Government of Maharashtra
Govt.	Government
GPS	Geographycal Positioning System
GST	Goods and Sales Tax
GUS	β - Glucuronidase
ha	Hecter
H_2	Hydrogen
H_2O_2	Hydrogen peroxide
HPLC	High Performance Liquid Chromatography
HRD	Human Resource Development
HS	Heating Surface/Highly Susceptible
HT	High Tension
H&T	Harvesting and Transport

Annexure XV (Contd.)

ABBREVIATIONS AND ACRONYMS

HWM	Hazardous Waste Returns
IARI	Indian Agriculture Research Institute
IASLIC	Indian Association of Special Libraries and Informaion Centre
ICAR	Indian Council of Agricultural Research
ICGEB	International Center for Genetic Engineering and Biotechnology
ICSB	International Consortium of Sugarcane Biotechnology
ICT	Institute of Chemical Technology
ICUMSA	International Commission on Uniform Methods for Sugar Analysis
I&C systems	Instrumentation and Control systems
ID	Induced Draft
IEC	International Electro-technical Commission
IGKV	Indira Gandhi Krushi Vidhyapeeth
IISR	Indian Institute of Sugarcane Research
IK	Indoneria-Kalimanatan
IJ	Infective juvenile
IMFL	Indian Made Foreign Liquor
IMViC	Indol, Methyl Red and Voges-Proskauer test (Biochemical test)
I/O	Input & Output
IPM	Integrated Pest Management
IRRSS	Irradiated and salt selected
IS	Impure Spirit
ISH	Inter Specific Hybrid
ISMA	Indian Sugar Mills Association
ISO	International Organization for Standardisation / International Sugar Organization
ISP	Impure Spirit Purification
ISSCT	International Society of Sugar Cane Techologists
ISSR	Inter Simple Sequence Repeat
ITC	Indian Tobacco Company
ITS	Internal Transcribed Spacer region
IU	ICUMSA Unit
IVT	Initial Varietal Trial
IWFC	Imbibition Water Flow Control
K	Potassium
Kcal	Kilocalories
Kg	Kilogram
KLPD	Kilo Litres Per Day
km	Kilometer
KV	Kilo Volt
KW	Kilo Watt
Lac / ha	Lakh per hectare
LAN	Local Area Network
LAVT	Lighting Arestor Voltage Transformer
LD_{50}	Leathal Dose at 50%
L:D ratio	Length:Diameter ratio
lit.	Litre
lit./ha	Litre per hectare
lit./t	Litre per tonne
Ltd.	Limited
m	Meter/Million
M	Medium / Metric / Molar
MAS	Marker Aided Selection
MB	Molecular Biology
MCC	Motor Control Centre
MD	Managing Director
MDA	Melondialdehyde
MCCIA	Maratha Chamber of Commerce Industry & Agriculture
ME	Mill extraction
MEE plant	Multiple Effect Evaporation Plant
MEDA	Maharashtra Energy Development Agency
MEDC	Maharashtra Economic Development Council
Mg	Magnesium
mg	Milligramme
$MgCl_2$	Magnesium Chloride

Annexure XV (Contd.)

ABBREVIATIONS AND ACRONYMS

mg/lit.	Milligrammes per litre
$MgSO_4$	Megnisium Sulphate
MHAT	Moist Hot Air Treatment
Min.	Minute
MIC	Minimum Inhibitory Concentration
MIS	Management Information System
ML	Mid-late
MLT	Multi-location Trials
mm	Millimeter
mM	Milli Molar
m^2	Square meter
m^3/day	Cubic meter per day
m^3/hr	Cubic meter per hour
MM	Multimacronutrient/Multimicronutrient
MNLF	Micronutrient Liquid Fertilizer
Mo	Molybdinum
MoA	Memorandum of Association
MOL	Milk of Lime
MoEF	Ministry of Environment and Forests
MoEFCC	Ministry of Environment Forests and Climate Change
MoU	Memorandum of Understanding
MP	Madhya Pradesh
MPCB	Maharashtra Pollution Control Board
MPKV	Mahatma Phule Krishi Vidyapeeth
LPM	Liters per minute
MRSSK Sangh	Maharashtra Rajya Sahakari Sakhar Karkhana Sangh
MS	Mass Spectrometer
MSLC	Master Synchronizer and Load Control
MSc	Master of Science
MSDH	Molecular Sieve De-Hydration
MSEB	Maharashtra State Electricity Board
MSEDCL	Maharashtra State Electricity Distribution Company Limited
MSETCL	Maharashtra State Electricity Transmition Company Limited
MT	Metric Tonne
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
M. Tech.	Master of Technology
MUs	Million Units
MVA	Mega Volt Ampere
MW	Mega Watt
N	Nitrogen
Na	Sodium
NABET	National Accreditation Board for Education & Training
NABL	National Accreditation Board for Laboratories
NABRD	National Agriculture Board for Rural Development
NaCl	Sodium Chloride
NaH_2PO_4	Sodium Di-Hydrogen Phosphate
NBS fermenter	New Brunswick Scientific fermenter
NCBI	National Centre for Biotechnological Information
NCL	National Chemical Laboratory
NCS-TCP	National Certification System for Tissue Culture raised Plants
NGR	Neutral Grounding Resistor
NH_4	Ammonia
NHG	National Hybridisation Garden
nm	Nano Meter
NMC	Number of Millable Canes
NPK	Nitrogen Phosphorus Potash
NRC	National Research Centre
NRCPB	National Research Centre for Plant Biotechnology
O_2	Oxygen
OD	Optical Density
OMC	Oil Marketing Companies
OPAC	Online Public Access Catalogue
P	Phosphorus

Annexure XV (Contd.)

ABBREVIATIONS AND ACRONYMS

P&I	Process & Instrumentation
pCAMBIA	Cambia Plasmid
PC	Polly cross
PCC	Power Control Centre
PCR	Polymerase Chain Reaction
PE	Primary (Mill) Extraction
PEG	Poly Ethylene Glycol
pET	Bacterial Expression Vector
pH	Hydrogen Ion concentration
PF	Provident und
PFDs	Process Flow Diagrams
PFVT	Pre-Final Varietal Trial
PGR	Plant Growth Regulator
PhD	Doctor of Philosophy
PHE	Plate Heat Exchanger
PK	Phosphorous and Potassium
PLC	Programmable Logic Controller
PMC	Press Mud Cake
PMI	Positive Material Identification
PPM	Parts per million
POBs	Polyhydral Occlusion Bodies
PP	Potassium Permanganate
PRDS	Pressure Reducing and Desuperheating Station
PSB	Phosphorus Solubilizing Bacteria
Pvt.	Private
QCI	Quality Council of India
qtl/ha	Quintal per Hectare
`	Rupees
R & D	Research and Development
RACE-PCR	Random Amplification of cDNA Ends PCR
RAPD	Randomly Amplified Polymorphic DNA
RBHR	Reduced Boiling House Recovery
RDBMS	Relational Data Base Managment System
RDF	Recommeded Dose of Fertilizers
RDK	Recommended Dose of Potash
RDN	Recommeded Dose of Nitrogen
RE	Restriction Enzyme
RFLP	Restriction Fragment Length Polymorphism
RFRC	*Regional Forest Research Centre*
RH	Relative Humidity
RKVY	Rashtreeya Krushi Vikas Yojana
RME	Reduced Mill Extraction
RO	Reverse Osmosis
ROE	Reduced Overall Extraction
RPM	Revolutions per minute
RRC	Research Review Committee
rRNA	Ribosomal Ribo Nucleic Acid
RS	Rectified Spirit / Reducing Sugar/ Reference Service
RTD sensors	Resistance Temperature Detector sensors
RT-PCR	Reverse Transcriptase PCR
SA	Secondary Air
SBC	Sugarcane Breeding Center
SBI	Sugarcane Breeding Institute
SCB	Sugarcane Bagasse
SCW	*sugarcane weight*
SDF	Sugar Development Fund
SDS	Special Denatured Spirit
SDS-PAGE	Sodium Dodicyl Sulphate-Poly Acrylamid Gel Electrophorosis
SEAC	State Expert Appraisal Committee
SIRO	Scientific and Industrial Research Organization
SISSTA	South Indian Sugar and Sugarcane Technologists Association
SIT	Sugar Industry Technologists
SKUM	Sahakari Khand Udyog Mandali
SLD	Single Line Diagram
SLMPC	State Level Machinery Purchase Committee
SMBS	Sodium meta bi-sulphite
SME	Sugar Mill Effluent

ABBREVIATIONS AND ACRONYMS

SMS	Short Message Service
SNP	Single Necleotide Polymorphism
SO_2	Sulphur Di-oxide
Sq.ft.	Square feet
SRS	Sugarcane Research Station
SSI	Sustainable Sugarcane Initiative
SSK	Sahakari Sakhar Karkhana (Cooperative Sugar Factory)
SSR	Simple Sequence Repeats
STAI	Sugar Technologists Association of India
STCR	Soil Test Crop Response
STP	Sewage Treatment Plant
STTP	Short Term Training Programme
SUPA	Steiner's Universal Philosophia Agrica
SWOT	Strength, Weakness, Opportunity, Threat
T	Tonne
TC	Tissue Culture
TCD	Tonnes of Cane per Day
TCH	Tonnes Cane Crushed per Hour
TCPU	Tissue culture production unit
TDS	Total Dissolved Solids
TERI	Tata Energy and Resoruces Institute
TG	Turbo Generator
t/ha	Tonnes per Hectare
TN	Tamil Nadu
T_0	Generation one
TOR	Terms of Reference
TPD	Tonnes Per Day
TPH	Tonnes Per Hour
tRNA	Transfer Ribonucleic Acid
TRF	Tooth Roller Feeder
TRPF	Tooth Roller Pressure Feeder
TRS	Total Reducing Sugar
TSS	Total suspended solids
TSC	Thermo tolerant *Saccharomyces cerevisiae*
TSDF	Treatment Storage and Disposal Facilities
TVC	Total Viable Count
UE	Under Execution
UP	Uttar Pradesh
UPNRM	Umbrella Programme for Natural Resources Management
USB	Universal Serial Bus
USDA	United States Department of Agriculture
UV	Ultra Violet
V	Voltage
Var.	Variety
VB	Visual Basic
VCB	Vacuum Circuit Breaker
VFD	Variable Frequency Drive
viz.	Namely
VKT	Vertical Continuous Pan
VLJH	Vapour Line Juice Heater
VSI	Vasantdada Sugar Institute
v/v	Volume by volume
WBAT	Wine Brewing and Alcohol Technology
WBM	Water Bond Macadam
WTP	Water Treatment Plant
WSRO	World Sugar Research Organization
w/v	Weight by Volume
YE	Yeast Extract
YLD	Yellow Leaf Disease
ZLD	Zero Liquid Discharge
Zn	Zinc
ZVT	Zonal Varietal Trial
'	Feet
"	Inch

संशोधनेन संवृद्धिः
ISO 9001:2015

Vasantdada Sugar Institute

Manjari Bk., Pin 412 307; Dist. Pune, Maharashtra, India .
Phone: (020) 26902100, Fax: (020) 26902244
E-mail: vsilib@vsnl.com | Website: www.vsisugar.com