ISO 9001:2008

20th Annual Report

2017-2018

SARDAR SWARAN SINGH
NATIONAL INSTITUTE OF BIO-ENERGY
(An Autonomous Institution of Ministry of New and Renewable Energy)

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Executive Summary

Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), Kapurthala is an autonomous Institution under the Ministry of New and Renewable Energy (MNRE), Govt. of India, set up as an apex Institution for carrying out *state-of-the-art* research and developmental activities, biomass resource assessment, testing, validation and training for promotion of bioenergy in the country. During the year 2017-18, R&D activities were taken up in the frontier areas including biogas production from agro-residue, biomass cookstove performance testing and certification, biodiesel and bio-crude production, and lignocellulosic bioethanol production. The research carried out was published in reputed journals of the frontier bioenergy area.

Research Fellows were engaged in carrying out research and analysis in biogas and biofuels. The Institute imparted short term training to around 50 fellows, starting from undergraduate to postdoctoral level and cater their motivation towards bioenergy applications. A Bio-Energy Alliance was also formed to play pivotal role in bringing the stakeholders, researchers, policy makers, and industry to the same platform and set the national target for bioenergy applications and research priorities and same has been registered under societies registration act vide XXI of 1860 No. 371 of 2016-17.

The Institute took leading role in preparing all technical documents related to bioenergy as entrusted by MNRE from time to time. The Institute participated in all technical programs and meetings of the Ministry of New and Renewable Energy, particularly related to bioenergy sector, for discussion on R&D, strategy and policy, progress and dissemination of knowledge and technology in the area.

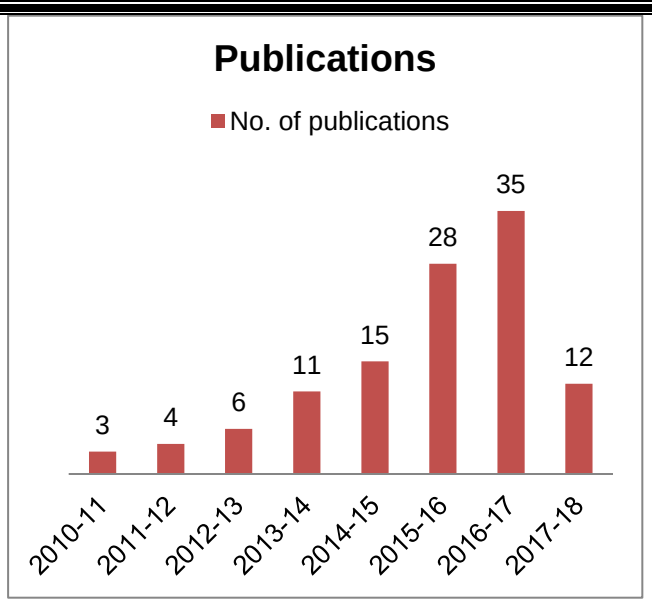
The Institute received Rs. 1.00 Crore grant-in-aid from MNRE during the FY 2017-18. However, including the unspent balance of the previous FY 2016-17 Rs. 1.12 Crores have been spent. Routine maintenance of the Institute with 75 acres of land covering green landscape and beautiful campus was done with the available resources so as to move towards the future plan to develop the Institute as a Global Centre of Excellence in Bio-Energy. The Institute observed all routine celebration as instructed by the Government of India from time to time.

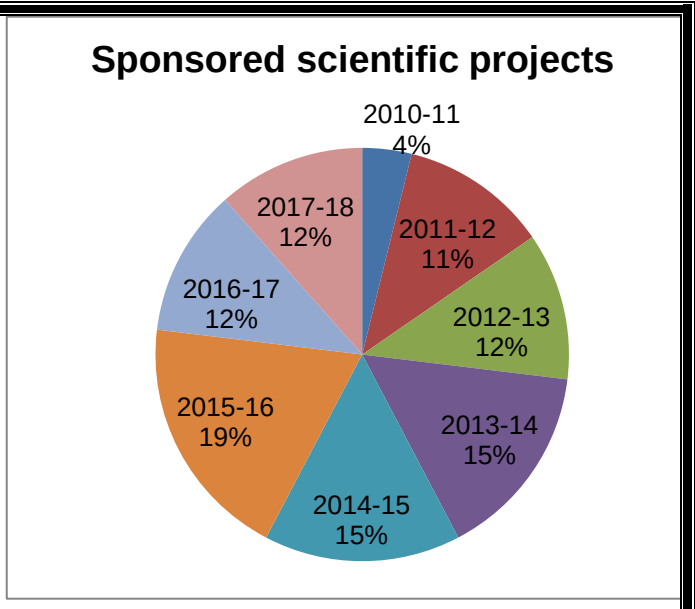
MNRE is implementing various programmes for promotion of bioenergy for various applications in the country. These programmes are based on biogas generation, biomass gasification, and biomass cook stoves. SSS-NIBE can play a key role in biomass resource assessment, field evaluation, testing, and standardization of biomass energy systems and training for skill development for proper installation, maintenance and project development, and implementation in bioenergy sector.

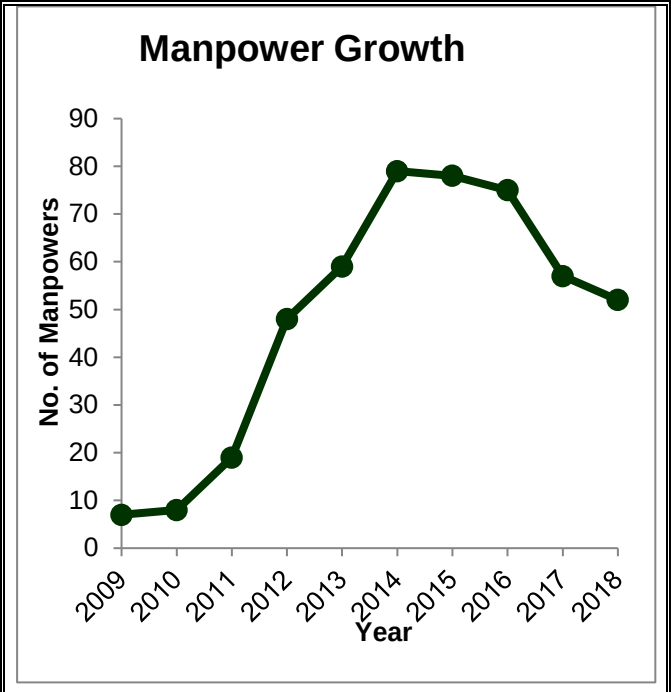
At SSS-NIBE, the biomass cookstove and biofuel testing and characterization laboratory have been well set up that requires further upgradation for NABL accreditation. However, in biogas area appropriate facilities for testing and validation of biogas plants, purification systems and other components used in biogas projects are required to be created at par with other leading European Nations such as Germany, Italy and Denmark.

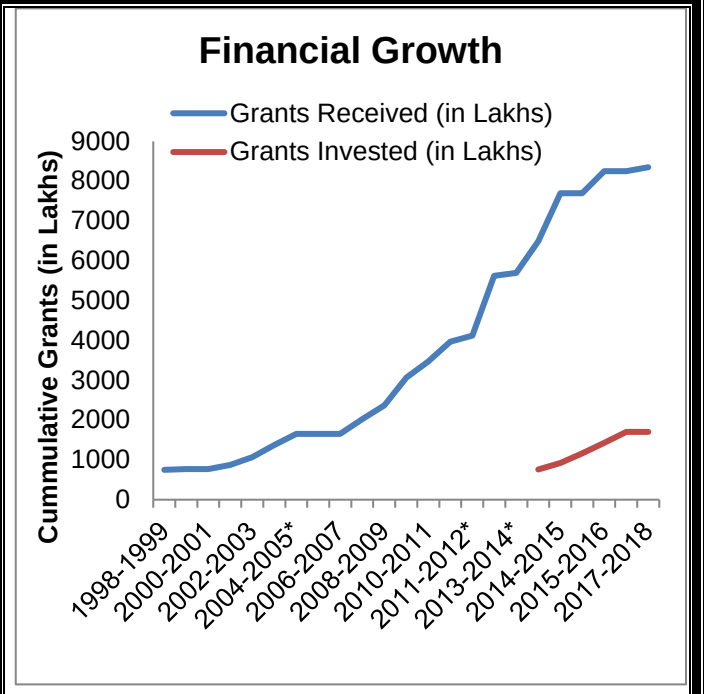
The Institute has acute shortage of scientists and scientific manpower. Nevertheless, various tasks already initiated have been continued. Recruitment of new scientific position is under process at MNRE. Continuation and regularization of the 26 posts of NIBE is also processed and under consideration. It is therefore high-time to redefine the R &D activities of the Institute.

Institute Growth: At A Glance









1. INTRODUCTION

Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE), Kapurthala is an autonomous Institution of the Ministry of New and Renewable Energy (MNRE), Govt. of India, created for carrying out R&D, testing, evaluation, and training in bioenergy. The Institute has 75 acres of beautiful land with green carpet and unique buildings at the 12thKM Stone, Jalandhar-Kapurthala national highway with plentiful research infrastructure and an eco-friendly research environment. The Institute has 10 nos. of sanctioned posts only, out of which at present 8 posts are occupied.

A Governing Council under the Chairmanship of the Secretary, MNRE and comprising diverse eminent personalities and experts in the field reviews the progress of the Institute and also suggests steps for utilizing the Institute for the promotion of bioenergy in the country. The Council has a vision to develop SSS-NIBE as a Global Center of Excellence in bioenergy.

The Institute has an approved vision documents for 5 years (2013-2017) research plan and created five research divisions encompassing all aspects of bioenergy research including biofuel. The broad spectrum of bioenergy covers biomass resource assessment & management, biomass characterization, biomass conversion technologies (gasification, combustion, pyrolysis), solid waste/solid state bio-methanation, liquid bio-fuels (biodiesel, bioethanol, bio-oils, green diesel), algal biomass production, biohydrogen production, solid waste treatment & management, life cycle analysis/assessment of bioenergy system, 1st, 2nd and 3rd generations of biofuels, etc. The 16th meeting of the Governing Council approved the vision document and creation of 16 nos. of new scientific posts for the smooth running of the R&D activities under the different divisions. The proposal has been submitted by MNRE for approval of the Ministry of Finance, and process has been initiated for the recruitment. The Institute was certified by Intertek as an ISO 9001:2008, under R&D institution.

The Institute functions with a limited scientific manpower, supported by limited supporting staff. However, the Institute has landmarked its fame in the international arena. Several vital R&D and testing facilities are required to be created at the Institute for strengthening the R&D activities, technology demonstration and validation activities in bioenergy. Dedicated equipment facility, technical and support manpower will also be required for handling these vital equipment's for efficient and safe operation.

2. OBJECTIVES AND FUNCTIONS

VISION

To become an apex Institution for carrying out *state-of-the-art* research and developmental activities in the area of bioenergy.

MISSION

- To be knowledge-based R&D Institution of high quality and dedication.

- To impart the training to professionals of bioenergy sector
- To provide the services and optimum solutions for the major stakeholders across the entire spectrum of the bioenergy sector.
- To support bioenergy sector in developing the knowledge for promoting new technologies.
- To develop Human Resources for the bioenergy sector at all levels.

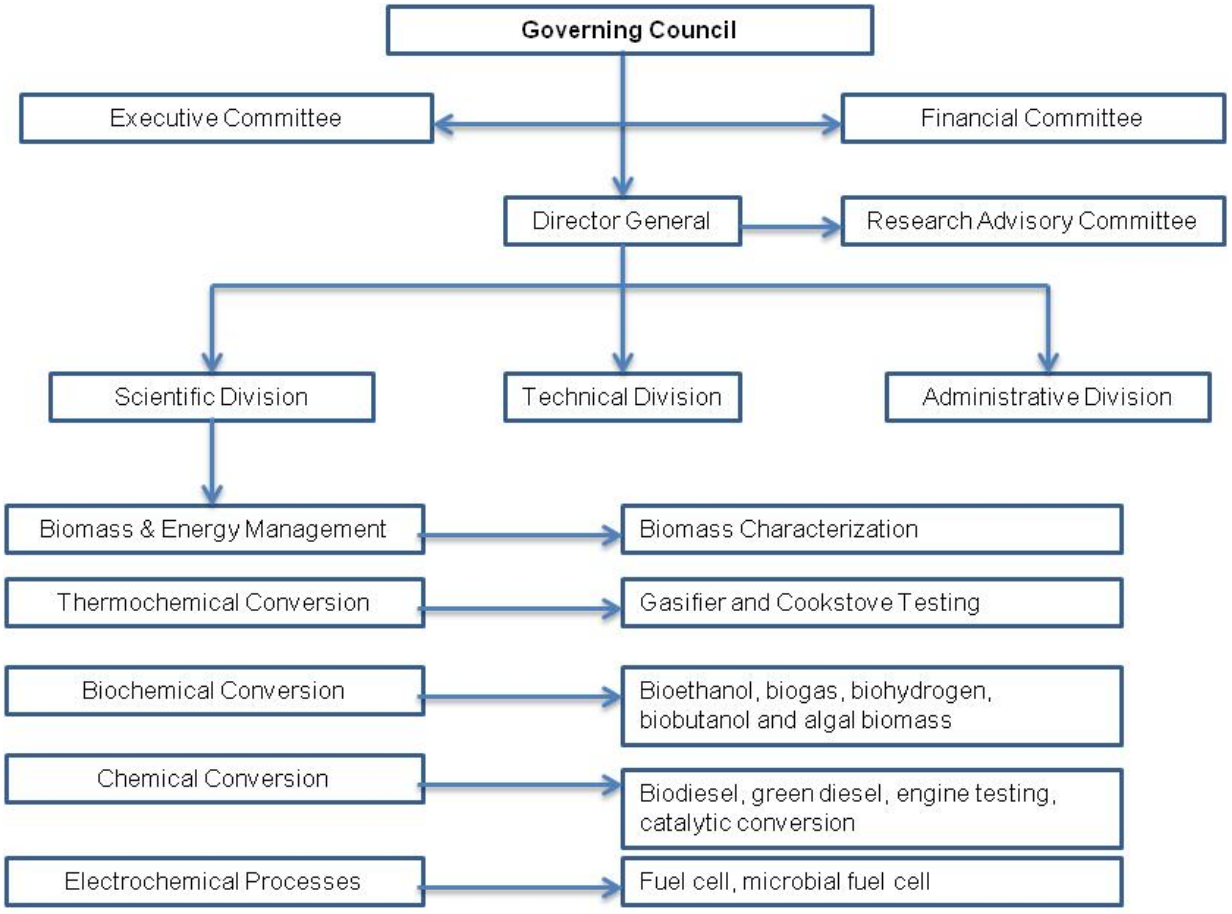
OBJECTIVES

- To carry out and facilitate research, design, development, testing, standardization and technology demonstration eventually leading to commercialization of RD&D output with a focus on:
  a. Biomass resource assessment;
  b. Bioenergy, biofuels and synthetic fuels in solid, liquid and gaseous forms for transportation, portable and stationary applications; and
  c. Development of new technologies for effective utilization of different type of wastes and production of value added products
- To undertake and facilitate human resource development and training including post-doctoral research in the area of bioenergy.
- To create facilities for operationalization of the Institute.

FUNCTIONS

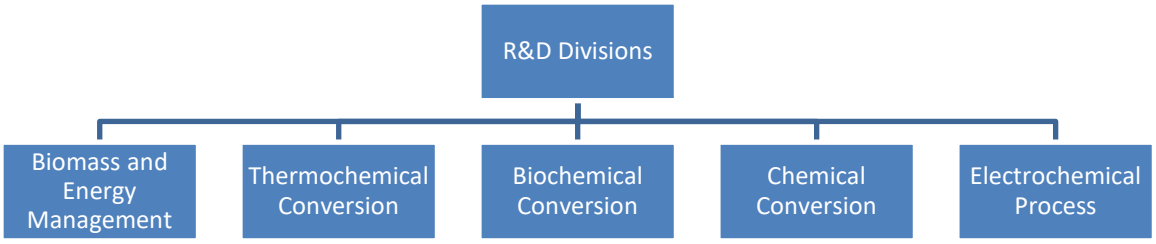
- Conduct resource surveys and assessment of potential across the country in the bioenergy sector.
- In-house R&D programmes in all emerging fields of bioenergy.
- Joint technical programmes with other national institutions and testing centres.
- Testing and certification of devices and systems.
- Techno-economic evaluation of bioenergy equipments and systems.
- Creating data base for bioenergy including information on patents.
- Compilation and dissemination of information on resources, technologies, products and applications.
- Providing technical support to industry on new product design and development and up-gradation of products and manufacturing processes.
- Providing technical support to the biomass energy project in achieving and sustaining quality such that systems of highest quality and reliability are installed.
- Organization of training programmes, seminars and workshops.
- Cooperation with scientific and technical Institutions abroad under bilateral and multilateral agreements and MoU.
- Assistance in curriculum development in renewable energy and undertaking concrete programmes for human resource development.
- Consultancy and advisory services in the bioenergy sector.
- Providing technical support to MNRE in policy planning and implementation.
- Cookstove dissemination projects through Carbon Financing (CDM).
- Information, Communication and Education (ICE).

3. ORGANIZATION CHART



4. RESEARCH DIVISIONS AND LABORATORY SETUP

There are total five R&D divisions as given below:



The R&D laboratories of the Institute and facilities are subdivided under the following headings as per application point of view.

i R&D Block-I (Chemical and Electrochemical Conversion Laboratory, viz. Biodiesel, Hydro processing, Catalysis and Fuel Cell).
ii R&D Block-II (Biochemical Conversion Laboratory viz. Bioethanol, Biobutanol, Biogas, Biohydrogen, Algal biomass, Metabolic Engineering).
iii R&D Block-III (Thermochemical Conversion Laboratory, viz. Biomass Characterization, Gasification, Pyrolysis, Cookstoves, New and Hybrid Energy Systems).
iv Common Facility Building (Computer Lab, Library, Conference Hall and Canteen).
v Workshop (Common Workshop Machines & Tools and Test Engines).
vi Gasifier shed (Biomass Gasification and Testing Facilities).

5. CHARTER

With a view to manage, administer, direct and control the affairs of SSS-NIBE, an environment and culture conducive to achievement of excellence, will be created by ensuring:

i Commitment to the mission: sense of purpose and direction to policies, programmes & activities to achieve the aims and objectives;
ii Commitment of staff members: liberal, positive and people-sensitive personnel policies, training and management development with special reference to advance technologies equipment and result orientation;
iii Commitment to excellence: professional competence, encouragement to creativity, innovation, initiative and career development; and
iv Commitment to society: application of the state-of-the-art research and development to national/social priorities.

6. LABORATORY DEVELOPMENT- FACILITY CREATED

The state-of-the-art research facility is being developed for biodiesel, bioethanol, gasification, biogas, cook stoves research & testing and for other areas in bioenergy. The consumables including chemicals, glass wares and plastic wares have also been procured for experimental work in the laboratories.

Chemical Conversion

The equipment facilities available under this division includes Gas Chromatograph dedicated for biodiesel analysis viz. % Fatty acid methyl ester conversion, monoglyceride, diglyceride, free glycerol content in biodiesel, and hydrocarbons up to the boiling range 380^{o}C, Rams bottom Carbon Residue, Oxidation Stability Apparatus, High Pressure High Temperature Reactor, True Boiling Point Distillation Apparatus, Automatic Density Meter, Flash point apparatus(automatic open cup), Radleys Reactor, Rotary Vacuum Evaporator,

Computerized Diesel Engine Test Rig and Exhaust gas analyser, FTIR, low temperature autoclave, Irox diesel etc.

Biochemical Conversion

Biochemical Conversion Division has been established in R&D-II with the facilities of Analytical, Bioprocess, Microbiology and Molecular Biology Laboratories. Analytical laboratory contains the equipment such as HPLC, Gas Chromatography, UV-vis spectrophotometer and Fibertech, FPLC; Bioprocess laboratory has the equipment such as Bioreactor (3.0 & 7.5 L), Refrigerated Centrifuge, Water Purification System, Lyopholizer, Micro-disintegrator, Water Bath, Autoclaves, etc. Microbiology laboratory have the equipments such as Environmental Shaker, Microscope with camera, Incubator, CO_2 Incubator-cum-shaker, BOD Incubator, Hot Air Oven, Horizontal Laminar Flow, Automatic Colony Counter, Deep Freezer, Refrigerators and Molecular Biology laboratory contains the equipment such as Gradient PCR, Real Time PCR, Biophotometer, SDS-PAGE, 2-D gel Electrophoresis, Horizontal Gel Electrophoresis, Gel Documentation and Electroporation Unit.

Different views of Biochemical Conversion Laboratory

Thermochemical Conversion

The basic testing facilities for biomass characterization, biomass gasification and cookstove testing, etc, have been created for thermochemical conversion of biomass including gasification, combustion, etc. and some of the important equipment like Differential Scanning Calorimeter, Online Gas Analyzer, Stack Monitoring System (for SPM Measurement) and Testing Hood for biomass cookstove, pots of different size and dimensions, besides, few important instruments such as, CHNS analyzer, TG-DTA, etc. were procured and installed in the biomass characterization laboratory.

Division-wise progress

6.1 Biomass and Energy Management Division

Biomass samples (wood, pellets, etc.) are being tested and the generation of database is going on as per the requirements of the Scientists and the mandate of the division in particular and the Institute in general. To study the composition of different types of biomass resources available in Punjab (India) and to generate a database thereof to help researchers, academicians and bio-based industries initiatives have been taken as under:

i) Total 86 Biomass Samples have been collected from Kapurthala & Jalandhar Districts of Punjab.
ii) The collected samples belong to different categories: Agro Residues (25); Fruit Wastes (13); Vegetable Wastes (14); Wasteland Biomass (23); Agro-Industrial Wastes (11).
iii) Studies pertaining to calorific values and proximate analysis of collected samples are being carried out.
iv) Further, ultimate analysis, ash elemental analysis and thermo-gravimetric studies will be undertaken to evaluate the potential of different biomass for biofuel production.

Working at biomass characterization lab

6.2 Thermochemical Conversion Division

6.2.1 Biomass Cookstove Testing and Certification Centre

The development of cookstove testing facilities under the R&D project sanctioned by MNRE with an outlay of Rs. 97.908 lakhs in March, 2014 has been summed up and the report has been submitted to the concerned division of MNRE for evaluation.

Working at biomass cookstove testing lab

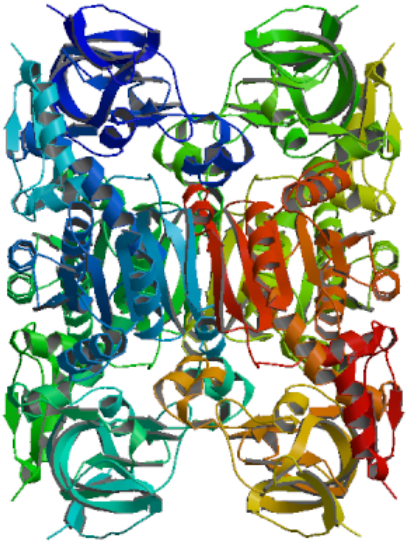
6.3 Biochemical Conversion Division

6.3.1 Development of $NADP^+$ dependent xylitol dehydrogenase in *Kluyveromyces marxianus*

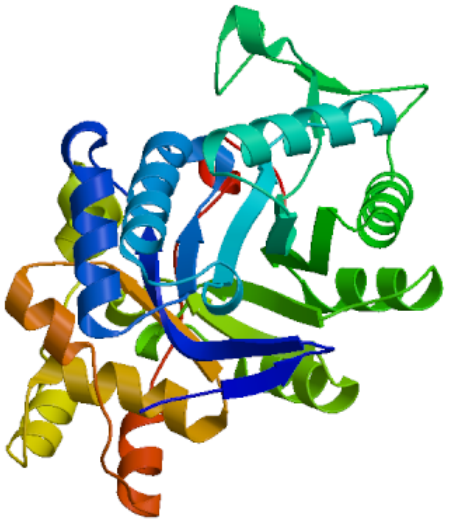
The project entitled 'Development of $NADP^+$ dependent xylitol dehydrogenase in *Kluyveromyces marxianus*' was funded by the Department of Biotechnology, Ministry of Science and Technology, Government of India for fulfilment of the objectives of Bioenergy-Awards for Cutting Edge Research (B-ACER). The work was carried out at South Dakota School of Mines and Technology, Rapid City, SD, USA. The report has been submitted to IUSSTF. The achievements under the project are as follows:

The research activities on 'Development of $NADP^+$ dependent xylitol dehydrogenase in *K. marxianus*' was carried out at South Dakota School of Mines and Technology. For fulfilling the proposed objectives, *K. marxianus* NIRE-K3 was selected as model organism, which was isolated at my parent organization. The gene *KmXYL2* encoding for xylitol dehydrogenase (KmXDH) was extracted from model organism and sequenced. The gene *KmXYL2* sequence was aligned with other reported sequences in NCBI nucleotide database and showed maximum similarity with *K. marxianus* DMKU3-1042. The protein sequence

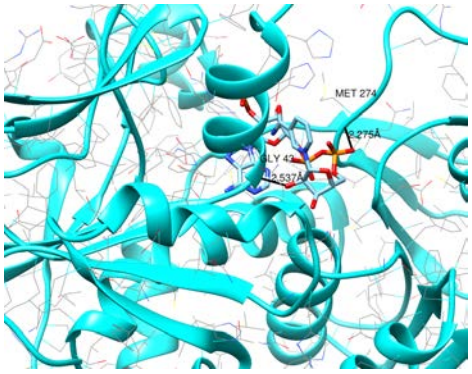
from *KmXYL2* gene was obtained through in-silico translation using ExPASy-Translate tool (https://web.expasy.org/cgi-bin/translate/). Three-Dimensional protein structure of KmXDH was modeled through MODELLER 9.19. Further, the structure was evaluated on the basis of Ramachandran plot, stereochemical quality and statistics of non-bonded interactions between different atom types through RAMPAGE server, PROCHECK and ERRAT plot, respectively, and the modeled 3-D KmXDH structure was found stable. Three-D kmXDH structure was used for molecular docking with NAD^+ and $NADP^+$ ligands in Swiss Dock Platform (http://www.swissdock.ch/) and identified the binding sites. Molecular dynamic simulation was performed to check the binding stability of ligands with KmXDH using AMBER platform in UCSF Chimera 1.11.2. NAD^+ showed the stable binding with two residues Gly 55 and Arg 298, while, $NADP^+$ was unstable. Based on the literature, three residues were selected, which repel the binding of $NADP^+$ and those residues were replaced as Asp 45 to Asn 45, Asp 56 to Asn 56 and Asp 277 to Asn 277. Further, in-silico protein engineering was using UCSF Chimera 1.11.2 and binding stability was found with Gly 43 and Met 274. Reverse translation was done by replacing base pairs for selected residues in *KmXYL2* gene. Site-directed mutation in KmXDH was performed using Q5 Site-Directed Mutagenesis Kit (NEB). pAUR 101 chromosomal integrated vector was selected for integrating the desired gene in the genome of *K. marxianus* NIRE-K3. The mutated gene was ligated with the vector using Gibson Assembly. The ligated gene with vector was transformed using Yeast Alkali Transformation Kit. However, due to limitation of time, the work could not be completed, which I am extending at my parent organization.



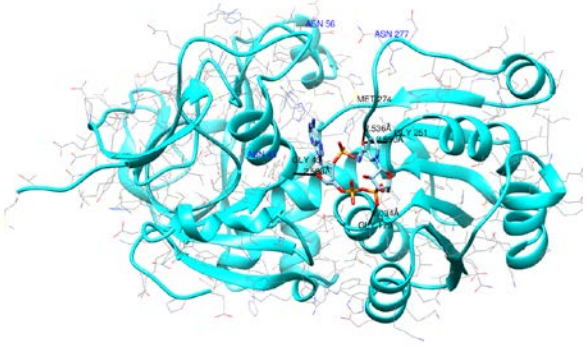
2-Dstructure of KmXDH enzyme



2-D structure of KmXR enzyme



Molecular interaction of amino acid residues of KmXDH with $NADP^+$



Molecular interaction of amino acid residues of mutant KmXDH with $NADP^+$

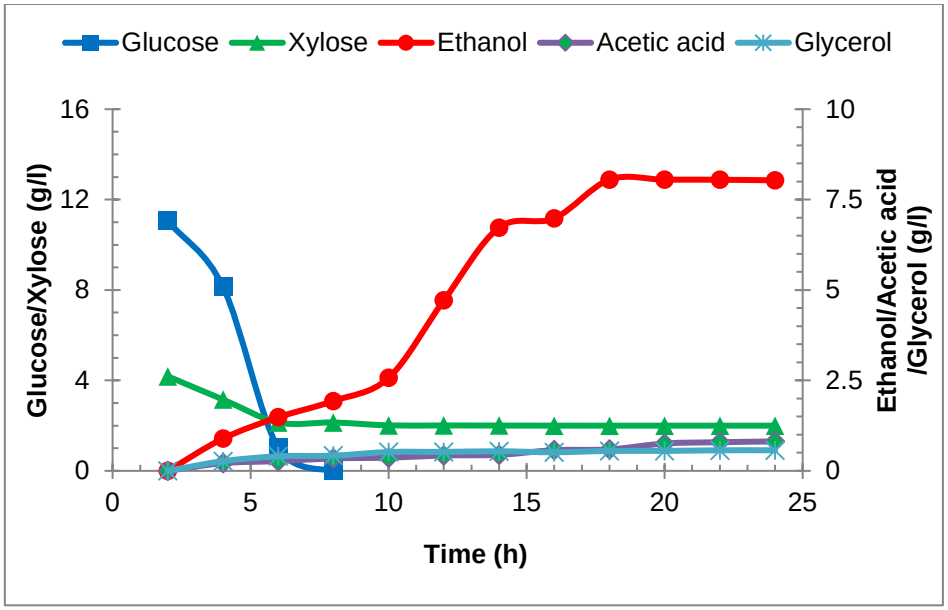
6.3.2 Biorefining of sugarcane bagasse for production of bioethanol and value-added products

A project entitled 'Biorefining of sugarcane bagasse for production of bioethanol and value-added products' under Indo-Brazil bilateral collaboration with IFSC/USP, Brazil and GNDU, Amritsar, funded by the Department of Biotechnology (DBT), Ministry of Science and Technology is going on since May 2016. The project cost from Indian side is INR 129.264 Lakhs. The progress of the project is as follows:

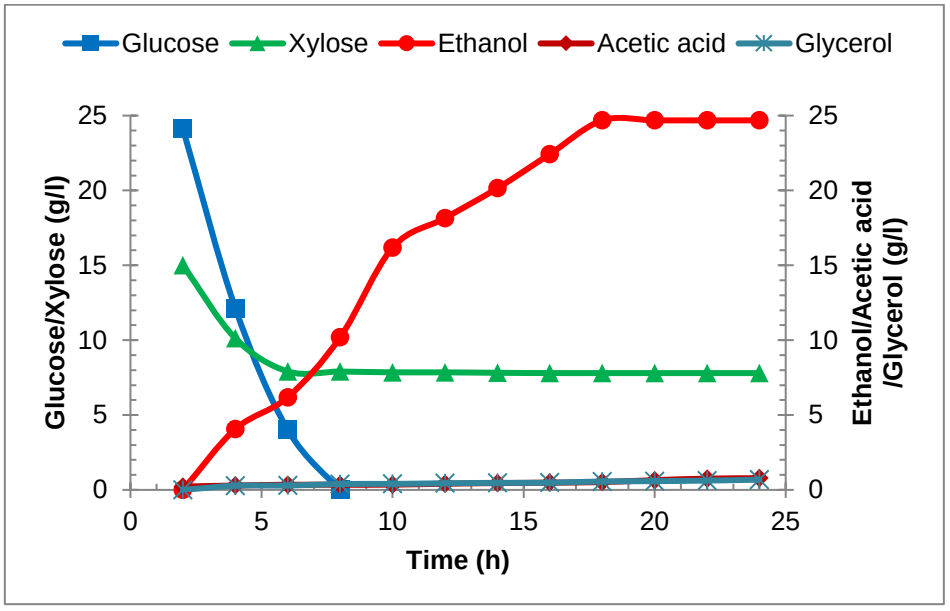
The process of ethanol production form sugarcane bagasse (SCB) includes biomass pretreatment for breakdown of lignocellulosic structure, washing for neutralization of pretreated biomass, enzymatic hydrolysis/ saccharification with cellulolytic enzymes and fermentation using fermentative microorganism. Different pretreatment techniques including acid, alkali, were optimized to pretreat the SCB prior to enzymatic saccharification. Enzymatic saccharification was performed using Cellic Ctec2 with 10 % pretreated solid loading and pH 5.5 was maintained with the help of 50 mM sodium citrate buffer at 50 ^oC for 72 h. Simultaneous saccharification and fermentation (SSF) of different optimized pretreated SCB was optimized using response surface methodology (RSM) with design expert software. The xylanase from *T. lanuginosus* was purified and its role in enhancing the saccharification of native, hydrothermally and auto-hydrolysis pre-treated SCB (samples received from the Institute of Physics of Sao Carlos, University of Sao Paulo (Brazil) at different substrate loading was evaluated. Effect of xylanases; commercially available HTec2 as well as in-house developed CM-11T were optimized in addition to cellulose Ctec2 using design expert software. After ethanol production, SSF residue/ stillage were utilized for biogas production using in house developed thermophilic consortium.

Ethanol production from ammonia pretreated bagasse in SSF

Optimized NaOH pretreatment conditions of sugarcane bagasse were found to be; chemical concentration (%)-0.79, solid loading (%)-08.57, and time (min)- 35.73 and temperature (^{o}C)- 120.51. Further, for H_2SO_4pretreated biomass, optimized SSF conditions were; inoculum size (g/l) 03.77, solid loading (%)-05.21, and enzyme loading (CTec 2) (mg/g)-52.62, whereas, for NH_4OH pretreated biomass, optimized conditions were; inoculum size (g/l)-03.23, solid loading (%)-09, enzyme protein loading (CTec 2) (mg/g-); 145.45. Optimized hydrothermal pretreatment conditions were found to be solid loading; 15 % and temperature; 163 ^{o}C time. Hydrothermal pretreatment using cattle urine as a solvent was conducted at 120°C for 15 min at 10% solid loading in High Pressure reactor. Optimized loading for xylanases; HTec2 and in-house developed CM-11T in addition to cellulases (CTec2) in NH_4OH pretreated bagasse were found to be 11.63 and 0.05 mg/g-db, respectively. Ethanol concentration from SSF of NaOH pretreated bagasse with optimized loadings of additional HTec2 and CM-11T with CTec 2 were found to be 24.56 and 22.75 g/l, respectively. Further, biogas yield from residual biomass/stillage of H_2SO_4 pretreated SCB was found to be 45 L/Kg-TS in 3 days, whereas NH_4OH pretreated SCB residual biomass/stillage resulted in 69.58 L/Kg-TS biogas yield in 5 days.



SSF of acid pretreated sugarcane bagasse



SSF of ammonia pretreated sugarcane bagasse

6.3.3 Biorefinery approach for generation of platform chemicals and bioethanol from indigenous lignocellulosic agrowaste bioresources

A project entitled 'Biorefinery approach for generation of platform chemicals and bioethanol from indigenous lignocellulosic agrowaste bioresources' has been sanctioned by DBT vide letter no. **BCIL/NER-BPMC/2017/164 dated 14.03.2017 through the sanction (BT/PR16008/NER/95/47/2015 Dated. 13.02.2017)** in collaboration with Tezpur University, Assam. The project cost is INR 69.60 Lakhs. The project was taken up after my

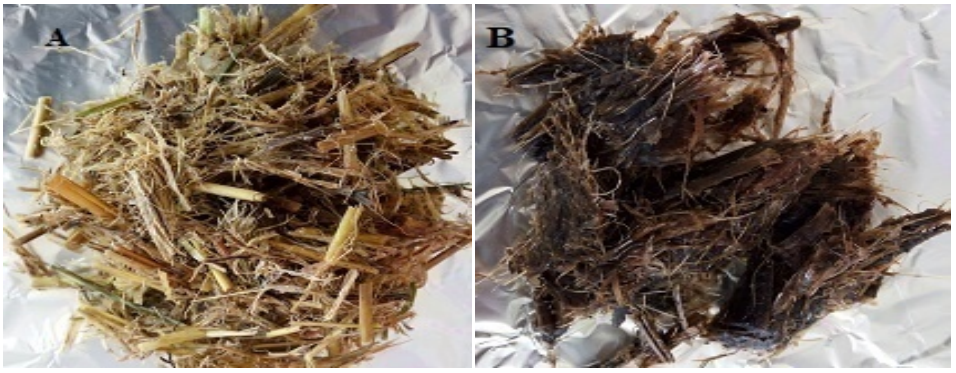
return from USA after Oct 26, 2107 and recruited fellow under the project joined on Jan 15, 2018. The progress of the project is as follows:

The extraction of cellulose fibers from *Saccharum spontaneum* was carried out using stepwise physico-chemically assisted hydrothermal process. Steam explosion coupled with alkali treatment on the *S. spontaneum* sample was found to be effective in the depolymerization and defibrillation of the fibers to produce cellulose. The XRD diffractograms of the extracted cellulose strongly resembled to that of the crystalline cellulose (Cellulose I) derivatives and the comparative FTIR spectra shows the dominant presence of cellulose. Further, the X-ray diffraction spectra show that the crystallinity of the concentration based cellulose variants increases along with the increase in alkali concentration. Also, maximum cellulose (~79%) was achieved with 3% (wt/vol) NaOH, soaked for 14 h and then autoclaved at 121 °C for 5 h.

Saccharum spontaneum (Kans grass) whole plant with flower (a, b, c) stem with leaf (d)

The maximum reducing sugar concentration 23.90 g/l was achieved in 48 hrs with 0.5% NaOH concentration of kans grass pretreatment, and maximum sugar recovery 19.1% was observed. The maximum reducing sugar concentration 22.68 g/l was achieved in 48 hrs with 0.5% NaoH concentration of banana pseudostem pretreatment, and a maximum sugar recovery 15.1% was observed. However, the optimization of process parameters such as NaOH concentration, pretreatment temperature, process time, and solid loading is going on for both kans grass and banana pseudostem. Further, the chemical pretreatments would also be optimized for maximum recovery of sugars.

Raw material: A) Kans Grass B) Banana pseudostem



Pretreated Biomass A) Kans grass B) Banana pseudostem

6.3.4 Process development for enhanced biobutanol production using butanol-tolerant isolate

A startup research grant project entitled “Process development for enhanced biobutanol production using butanol-tolerant isolate” was sanctioned by Science and Engineering Research Board (SERB) to Dr. Shuvashish Behera, Young Scientist cum Principal Investigator to work at SSS-NIBE vide File No. YSS/2015/000295 dated 13 November 2015 at a total cost of Rs. 32,30,000/- (Rs. Thirty Two Lakh Thirty Thousand Only) for a duration of three years.

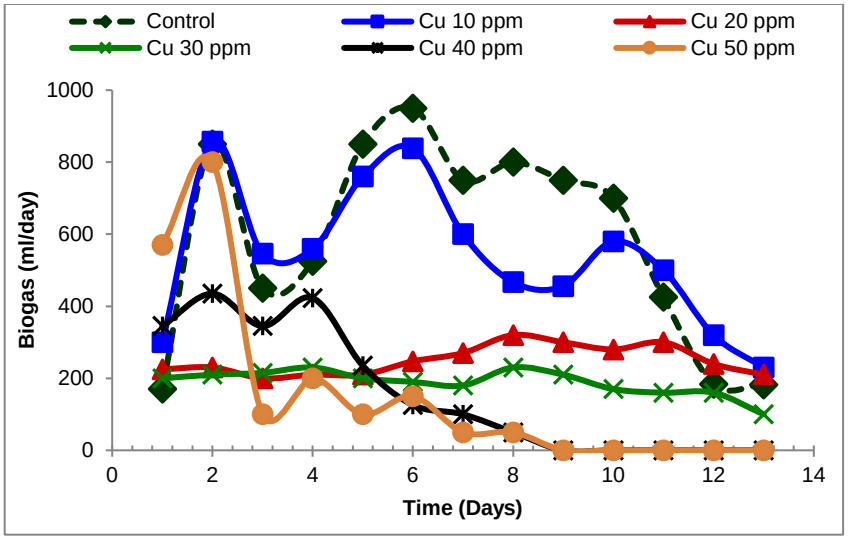
Two isolated bacteria NIBE-V1 and NIBE-A1 were identified as *Clostridium sporogenes* and *Clostridium pasteurianum* by MTCC which could produce biobutanol without lowering its production. Further, optimization of different parameters like pH, temperature, different medium components, initial addition of butyric acid for the growth and fermentation is going on for the enhancement of biobutanol production using Design Expert software version 8.0. The optimized values for the pH, temperature, inoculums volume and initial butyric acid concentration were 6.5, 34 ^{o}C, 8% and 2%, respectively. *C. sporogenes* NIBE-V1 has the ability to utilize biodiesel industry waste like glycerol, which produce 4.54 ± 0.05, 7.56 ± 0.07 and 12.1 ± 0.1 g l^{-1} of butanol, ethanol and total solvent using 9.5 and 15.17 g $l^{-1}$of fructose and glycerol, respectively. This strain could produce both ethanol and butanol without any production of acetone when glycerol was added to the medium containing glucose. This bacterial isolate can be applied to any biodiesel industry having glycerol as

the waste. The strain has the ability to produce biobutanol from xylose, arabinose, fructose, glycerol indicating its potential capability to utilize agricultural wastes and biodiesel industry waste. However, the optimized value for pH and temperature was 6.5 and 40 ^{o}C for growth and 5.01 and 34.22 ^{o}C for fermentation using *C. pasteurianum*NIBE-A1 which seems to be thermotolerant nature. This strain could produce 6.69 ± 0.15, 9.23 ± 0.21, 2.34 ± 0.09 and 18.26 ± 0.19 g l^{-1} of acetone, butanol, ethanol and total solvent using 32. 31 ± 0.11 g l^{-1} of glucose sugar. The high values of correlation for the culture indicated very high significance of the model. In another way, the bacterial isolate is undergone process of adaptation for butanol acclimatization which shows in improvement of butanol tolerance. Therefore, solvent production can be enhanced with different optimization and adaptation process and the produced solvents by the isolated bacteria will fulfil the future requirements of biofuel.

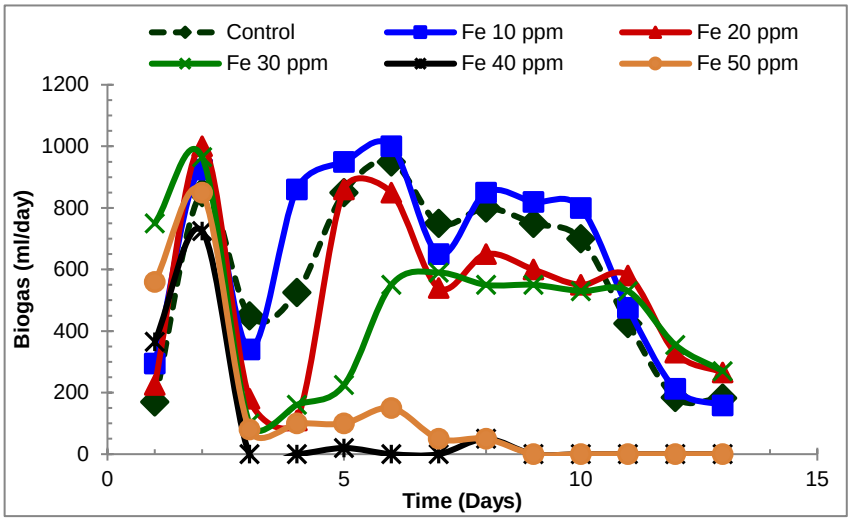
6.3.5 Enhancement of thermophilic consortium based biogas production from paddy straw using minerals

It was observed that iron supplementation showed 15% increased biogas as compared to control. Similar results found in case of Cu^{+2} ions (10 ppm) with an increase of 14.6%. Fe and Cu showed positive effect on biogas production but at low concentrations only. Ni^{+2} showed different pattern as compared to Fe^{+2} and Cu^{+2}. At low concentration of Ni, less biogas production was observed, but at high concentration (40 ppm) it showed an increase of 24% as compared to control. Co^{+2} and Zn^{+2} showed negative effect on biogas production. At 10 ppm, Co and Zn showed almost similar result as that of control. On increasing their concentrations, biogas production starts decreasing. It means Co and Zn have negative effect biogas production. Thus Co and Zn were neglected for further optimization. The optimization was done through RSM for effect of Fe (10 ppm), Cu (10 ppm) and Ni (40 ppm) on enhancing biogas production.

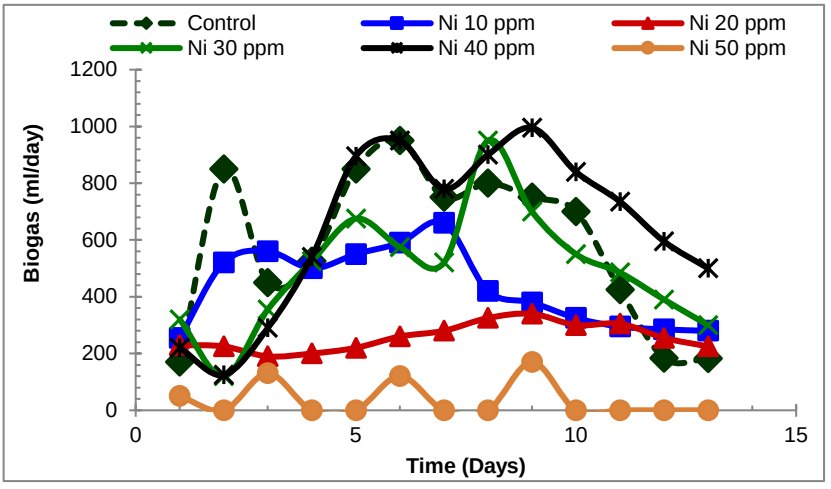
Biogas production from paddy straw and garden grass using thermophilic consortium



Effect of copper on biogas production using thermophilic consortium



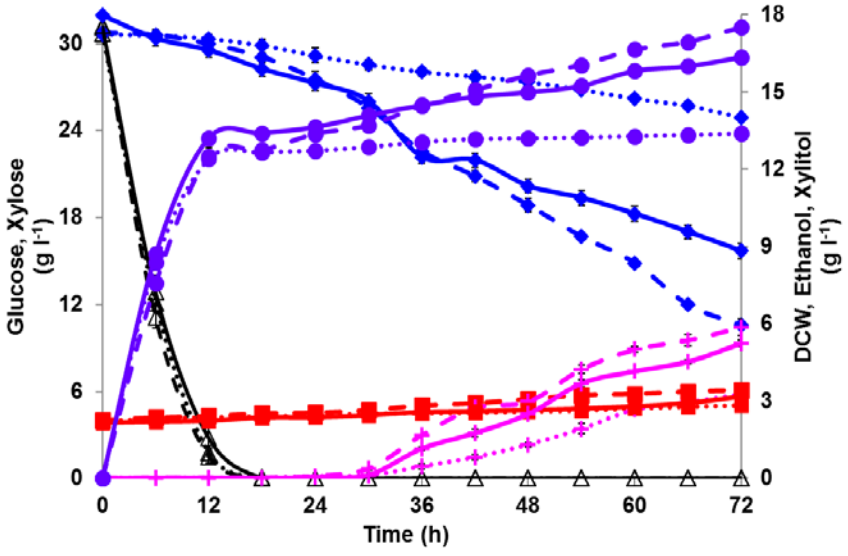
Effect of iron on biogas production using thermophilic consortium



Effect of nickel on biogas production using thermophilic consortium

6.3.6 Development of yeast strain with enhanced xylose utilization and ethanol production

In the series of strain improvement, protoplast fusion was approached to enhance the xylose utilization. A fusion between *K. marxianus* NIRE-K3.2 and *Scheffersomyces stipitis* was performed. Selection of *S. stipitis* and *K. marxianus* NIRE-K3.2 was made on the basis of XR and XDH assay, which was carried out for potential xylose utilizing strains including *S. stipitis*, *Candida shehatae*, *Candida intermedia* and *Dekkera naardenensis* together with *K. marxianus* NIRE-K1.2 and *K. marxianus* NIRE-K3.2. Out of those, *S. stipitis* showed maximum specific activity for XR and XDH as 1.58 ± 0.052 and 1.42 ± 0.074 U mg^{-1} over rest of the strains. However, *K. marxianus* NIRE-K3.2 showed higher specific activity for XR and XDH as 1.24 ± 0.041 and 0.89 ± 0.034 U mg-1, respectively, as compared to *K. marxianus* NIRE-K1.2. After protoplast fusion between *S. stipitis* and *K. marxianus* NIRE-K3.2, six fusant strains (NIRE-FKS.A, B, C, D, E and F) were isolated. Out of those, NIRE-FKS.A showed maximum potential as compared to rest of the fusants with specific xylose uptake rate of 0.07 g g^{-1} h^{-1}. Further adaptation in minimal medium (containing xylose as a sole source of carbon) was performed for the stability of evolved strain and adapted fusant strains were isolated and analyzed. Finally, after three rounds of screening, NIRE-FKS.A1 was found the most potential strain out of the isolated fusants with 0.089 ± 0.004 g g^{-1} h^{-1} of specific xylose uptake rate. Moreover, enzyme assay and gene expression, growth and fermentation analysis were performed to claim the improvement in evolved strain. Evolved strain NIRE-FKS.A1 showed improved growth and fermentation profile as compared to the parent strain *K. marxianus* NIRE-K3.2. NIRE-FKS.A1 showed 1.15-fold higher specific sugar uptake rate during growth. During fermentation NIRE-FKS.A1 showed 1.63-fold higher ethanol yield with 1.33, 1.69 and 2.32-folds higher specific xylose uptake rate, conversion into ethanol and volumetric product productivity, respectively, as compared to *K. marxianus* NIRE-K3.2 in MSX medium. Moreover, it also showed 1.22 and 1.6-folds higher ethanol and xylitol titre with 1.22-fold higher specific total sugar uptake rate than that of *K. marxianus* NIRE-K3.2 during fermentation on mixture of glucose and xylose. Further, during SSF, *K. marxianus* NIRE-FKS.A1 also produced 237.54 ± 12.31 g ethanol kg^{-1} of raw paddy straw.



Comparative fermentation profiling of NIRE-FKS.A1 (—), *K. marxianus* NIRE-K3.2 (····) and *S. stipitis* (---) in MS medium containing glucose and xylose as source of carbon. (♦) Xylose; (Δ) Glucose; (■) DCW; (●) Ethanol

6.4 Chemical Conversion Division

Several in-house R&D projects is in progress in this division through PhD students registered at Dr B R Ambedkar, NIT, Jalandhar and through the research fellows under NIBE fellowship.

6.4.1 Experimental investigation of hybrid micro emulsion biofuel on CI engine

An investigation is ongoing to study the effect of cetane improver 2-Ethylhexyl nitrate, (2-EHN) on performance, combustion and emission characteristics of a constant speed, single cylinder CI engine fuelled with E20 (bioethanol 20% - diesel 80%). The cetane improver 2-EHN was used at concentration of 1000 ppm and 2000 ppm with the test fuel blend and compared the results of combustion, efficacy and emission to that of petrodiesel. Earlier researcher Kim and Choi, examined the effects of bioethanol (99.5% purity) in concentration of 15% (V/V) with petrodiesel and with ethyl hexyl nitrate(2-EHN) as a cetane improver at concentration of 7500 PPM on nano-particles and reported the harmful emissions from CRDI diesel engine. For the test blend, 50% smoke reduction and increased NO_x emission were observed. Except B20, the blend of 15% biodiesel+ 5% bioethanol +80% petrodiesel was more effective for reduction in particle number and particle mass.

The fact that the first-hand distillation of bioethanol has about 5% (v/v) water content and their effects blending with petrodiesel, performance and emission parameters have not been mentioned in these research articles. The results of our investigation showed that E20EHN1000 had 3.8% higher BP to that of petrodiesel and the BSFC was similar to E20 and petrodiesel. BTE of E20EHN1000 was 4.9% higher to that of petrodiesel and η_{vol} was almost identical for all test blends. CP_{max}, NHR_{max}, $ROPR_{max}$ and MFB of E20EHN1000 was also favourable to those of E20 and petrodiesel. Except HC emission, E20EHN1000 showed acceptable results with that of petrodiesel and other test fuel blends. CO_2 and CO emission for E20EHN1000 was lower with petrodiesel and NO_x emission was almost comparable with that of petrodiesel. From the results, it was clearly unveiled that the E20 blend with 1000 ppm 2-EHN showed better results from E20 and petrodiesel and there were no any significant advantages of higher concentration of 2-EHN. The work is under review in a very reputed journal for publication.

6.4.2 Experimental investigation on production and performance analysis of waste cooking oil-based biodiesel, green diesel and micro-emulsion CI engine

In continuation to our previously reported biomass based thermal powerplant fly ash catalyst for biocrude production, modification in the composition of the catalyst has been studied mixing with additional CaO in different proportion. Subsequent utilization of the

catalyst for biocrude production from waste cooking oil and fractional distillation. About 60 % recovery of biocrude distillates as compared to previous recovery (54 %) was observed, when the catalyst was mixed with 20% additional CaO, in hydrocracking reaction. Recently, we carried out extensive studies for engine performance analysis and emission analysis of the green diesel fraction obtained from the biocrude and is at review stage in a high impact research journal for publication.

Moreover, we carried out technoeconomic studies of the use of waste cooking oil in India for biodiesel, microemulsion and green diesel production for 400 L/ batch capacity pilot plant. During the last three decades, hydrogenated fuels, biodiesel and hybrid fuels derived from vegetable oils and animal fats emerged as the prominent bio-fuels for CI engine. A comparative analysis of production, chemical structure, fuel properties and cost estimation of waste cooking oil-based biodiesel, hybrid fuel and green diesel, were carried out and reported in this article. Biodiesel was produced by transesterification process; hybrid fuel was prepared by 3-phase micro emulsion process while green diesel was produced via hydro-processing followed by true boiling point (TBP) distillation as per ASTM D2892 and ASTMD5236 specifications. The principal fuel properties of the biodiesel, hybrid fuel and green diesel were measured as per ASTM/EN standards and compared with those of petro-diesel. The production cost per litre(L) of each of the bio-fuel were computed at the lab scale level.

Moreover, the initial capital cost estimation for 400 L/batch/day pilot plant has been estimated on the basis of land, infrastructure, instruments, laboratory glassware, feedstock, chemicals and workers. More than 17 million INR (≈ 0.28 million USD) is required to start the 1200 L capacity pilot plant that can produce three types of bio-fuels each having capacity of 400 L per day.

This pilot plant is expected to create a revenue more than 7 million INR (≈ 0.1 million USD) per year in addition to the environmental benefits.

6.4.3 Conversion of crude glycerol into value-added products and its techno-economic feasibility

Glycerol is the principle by-product produced from the production of first-generation biofuels and large-scale production of biodiesel provides enormous amount of glycerol as a waste and is responsible for its low market value. The conversion of glycerol to a condensation product called solketal (valuable diesel additive) was achieved using acidic catalyst derived from agro-waste namely rice husk. The gas chromatograph (GC) obtained for different samples of the reaction at 100 ^{o}C for 2 h in a batch reactor setup confirms the glycerol conversion up to 55%. The yield of solketal was observed to be affected by reaction time i.e. reaction got completed within 120 min, after that there was not much difference in the conversion. Thus, this could be an alternative method for transforming glycerol obtained from biodiesel industry to value-added product named solketal which is an effective ingredient as a fuel additive during blending. Keeping in view the mandate of the Institute

in priority, process is ongoing for developing some important acid functionalised catalysts from rice straw, grass and corn stover cob shell. The work is ongoing.

6.4.4 Biomass characterization

More than 100 different agro-residues, leaves, barks, shell, husk and chaff (i.e. waste biomass) have been collected and are under characterization for proximate and ultimate analysis. Upon competition of complete characterization, a database will be generated for recommending these wastes for different conversion routes as per potential and as available.

7. RESEARCH AND DEVELOPMENT(R&D) PROJECTS/RESEARCH ACTIVITIES

SSS-NIBE can play a key role in field evaluation and testing and standardization of biomass energy systems. These programmes are based on biogas generation, biomass gasification, biomass cook stoves, etc. Biogas technology is emerging as key resource for supplying fuel for cooking, power generation and bio-CNG applications. A number of technology demonstration projects have been taken up by MNRE for biogas purification and bottling. Technology evaluation and validation has tremendous potential for technology development, development of technology package and standardization for biogas generation from different feedstock for various applications. These efforts will transform biogas as industry, which will help commercialization of biogas technologies/systems. This will require extensive studies on design and development of biogas plants. A tentative amount of 5 Crores may be allocated for setting up biogas testing standardization, cleaning, bottling and engine application lab for standard setting.

7.1 Ongoing Projects

1. Biorefinery approach for generation of platform chemicals and bioethanol from indigenous lignocellulosic agro-waste bioresources. PI: Dr. Sachin Kumar; Date of Start: Mar 2017; Duration: 3 years; Funded by DBT in collaboration with Tezpur University, Assam; Project cost: INR 69.60 Lakhs; Date of completion: Feb 2020.
2. Biorefining of sugarcane bagasse for production of bioethanol and value-added products (Indo-Brazil, Indian Partner: GNDU). PI: Dr. Sachin Kumar; Date of start: May 2016; Funded by DBT under Indo-Brazil bilateral collaboration with IFSC/USP, Brazil; Project cost: INR 129.264 Lakhs; Date of completion: Apr 2020.
3. Process development for enhanced biobutanol production using butanol tolerant isolate (SERB post doctoral fellow). PI: Dr. Shuvashish Behera; Project cost: INR 32.30 Lakhs; Date of start: Nov 2015; Funded by SERB; Date of completion: Oct 2018.

7.1 Projects submitted

1. Project proposal on ‘Biomass refining for renewable energy and green chemicals production to strengthen bio-economy of BRICS countries’ submitted to DST, India in collaboration with University of Jammu, Jammu, Engineering School of Lorena, University of Sao Paulo (USP), Lorena, Brazil, Guangxi Institute of Botany, The

Chinese Academy of Science, China, and Cape Peninsula University of Technology, Cape Town, South Africa; Project cost Indian Side: INR 50.00 Lakhs; Duration: 3 years

2. Project proposal on 'Setting up Biogas Technology Demonstration, Evaluation and Validation Project at SSS-National Institute of Bioenergy as Pilot Plant for Commercialization of Biogas Produced Co-Digestion of Paddy Straw and Cattle Dung for Sustainable Energy and Agriculture Development, Submitted to MNRE (April-May 2018), Project Cost. 2.16 Crore, Duration 3-years. (This project also envisages to set up complete biogas lab facility at the Institute).

8. SCIENTIFIC/OTHER EVENTS ORGANIZED

8.1 Training Program

A three days "National Training Program on Biogas Technology and its Implementation" was conducted during 7-9 March, 2018 at the institute. The event was inaugurated by Dr. B.S. Negi, Director General, SSS-NIBE & Adviser, Ministry of New & Renewable Energy (MNRE) and Dr. Sharad P. Kale, Eminent Expert in Biogas Technology, and Former Associate Director, Bhabha Atomic Research Centre, Mumbai on 7th March 2018. Dr. Negi emphasized on technology development packages, testing & evaluation, demonstration, and standardization in bioenergy sector particularly in biogas and waste to energy to wide spread promotion of bioenergy for various applications in the country. He also enlightened with upcoming MNRE's Technology Development and Innovation Policy. Dr. Kale addressed the social, environmental and energy security issues and relevance of people's participation in waste to energy programme. The Training Program was coordinated by Dr. Sachin Kumar, Deputy Director, SSS-NIBE.

Over 20 participants including representative of SNAs, entrepreneurs, academicians, research scholars and masters' students from different states, Industries, Universities and Institutions across the country participated in the training program. During the training, the expert lectures on Biogas - Science, Technology and Applications, Biogas Technology for Power Generation, Biogas Technology for Heat/Transportation Applications, and Policy and Financing aspects were delivered in different technical sessions. At the end of each session, interaction session of 30 minutes was allowed to address the issues of participants. Emeninet Speakers including Dr. S. P Kale, BARC; Dr. H.N. Chanakya, IISc, Bangalore; Dr. B.S. Negi, DG, SSS-NIBE & Adviser, MNRE; Dr. Yogesh V. Aghav, Kirloskar Oil Engines Ltd.; Dr. K.A. Subramanian, IIT Delhi; Dr. S.S. Sooch, PAU, Ludhiana; Dr. Srikanth Sandipam, IOCL, Faridabad; Sh. K.P. Philip, IREDA, and Dr. AK Sarma, SSS-NIBE delivered talks in the respective sessions on first two days of the training. A visit to Lab was organized on 08th March 2018. On the last day of the training, a field visit to a 1MW Paddy straw based innovative Biogas Power Plant at Sampurn Agri Ventures Pvt. Ltd., Village Painchawalli, Fazilka was organized. The feedback from participants was taken. The participants found the training highly useful for updating their knowledge in technology development, deployment and field implementation of biogas projects including

waste to energy for utilizing biogas generated from different feedstock for various applications such as cooking, power generation and bio CNG applications.

The program was concluded on 9th March at 09:00 pm after Valedictory Function. The certificate was distributed to all the participants on successful completion of three days national training program. It is expected that all the participants trained during the program will disseminate their knowledge among their working group and implement for energy security in their states.

8.2 Vigilance awareness week observed at SSS-NIBE

Vigilance Awareness Week 2017 (from 30th October – 04th November 2017) concluded at SSS-NIBE, Kapurthala in a function held at conference hall of the Institute. The programme was started with an intensive oath taking on Vigilance Awareness Theme "My Vision – Corruption Free India" on 30th October, 2017 and banners and posters were displayed at the Institute in all the primary locations so as to disseminate the information among all-level-workers.

The concluding ceremony was organized at 11.00 am on 04th November, 2017 in the conference hall. Dr. B. S. Negi was the Chief Guest of the event. Dr. Negi in his address stressed on the need of being vigilant for better life and governance. He pointed out that vigilance is not the sole duty of vigilance department rather it is the duty of everyone to be vigilant. The role of transparency, accountability and integrity are the basic feathers of good

governance and it would lead the organization towards a more profitable, efficient and effective direction. Above all, self-discipline is more important for all concerned in public service. Dr. Negi also emphasized that the Institute has taken initiative to become a plastic free green campus within this year. Thus, every one of the Institute is equally responsible for good works, time management and vigilant in all respect. He emphasized on self-vigilance for one's own improved performance and also of external environment to bring better competitive capabilities. Earlier discussions were held among all level workers about the need of vigilance in office and the vigilance officer welcoming the guest briefed the gathering about the different activities held during the week and greeted everyone for being alert in their respective work area.

Few photographs of Vigilance Awareness Week, 2017 at SSS-NIBE

8.3 Swachh Bharat Abhiyan

The Swachh Bharat Abhiyaan Pakhwada was initiated and celebrated at the Institute with the formal program held in the Conference Hall of the Institute. This mission has targeted its completion till 2019, the 150th birth anniversary of Mahatma Gandhi. This mission has targets to fulfil the sanitation facilities to all as well as eliminate all the unhealthy practices of people in the country. Dr. B. S. Negi was the chief guest of the function. Dr. Negi emphasized on cleanliness to be started from our inner soul. As we can clean our house, the same way this whole country is like our house and shall be cleaned up to make the environment free from diseases. He also emphasized on the team work to make it successful mission of the Govt. of India which was a long awaited activity by involving the

masses and shared his views on the cleanliness of other countries. He also told what to do to improve the cleanliness. He appreciated the effort of Swachh Bharat Abhiyan started by SSS-NIBE and suggested way forward. Finally Dr. Negi shared his thought on Swachh Bharat Abhiyaan and explained that SSS-NIBE is more responsible for this campaign, as we are working on Bio-Energy sector, which is basically the energy from wastes including Municipal Solid Wastes. The waste produced can be utilized for generating bioenergy and this improve India's economy as well as clean the environment. They recalled the dream of Mahatma Gandhi about "Swachh Bharat - Swasth Bharat" and told that this campaign is a footprint of Mahatma Gandhi's thought. His thought reflected cleanliness is next to GOD and it was really true and motivates the other audience for cleanliness. A pledge was also taken in the Institute.

Few photographs of cleanliness drive under Swachh Bharat Abhiyan at SSS-NIBE

8.4 Hindi Divas and Pakhwada

The Institute observed Hindi Divas and Pakhwada from 14th-28th September 2017. The program was coordinated by Hindi Officer of the Institute. Many banners and posters were displayed on at the Institute in all the primary locations so as to disseminate the information among all-level-workers.

9. PUBLICATIONS

Research Papers

- Sharma NK, Arora R, Behera S, Kumar S and Sani RK (2018) Xylose transport in yeast for lignocellulosic ethanol production: current status. Journal of Bioscience and Biotechnology, 125, 259-267.
- Shukla M and Kumar S (2018) Algal growth in photosynthetic algal microbial fuel cell and its subsequent utilization for biofuels. Renewable & Sustainable Energy Reviews, 82, 402-414.
- Sharma NK, Arora R, Behera S and Kumar S (2017) Evolutionary Adaptation of *Kluyveromyces marxianus* NIRE-K3 for Enhanced Xylose Utilization. Frontiers in Energy Research, 5:32. doi: 10.3389/fenrg.2017.00032.
- Deepak Singh, SS Sandhu, AK Sarma, An investigation of green diesel produced through hydro-processing of waste cooking oil using admixture of two

heterogeneous catalysts, Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 2018, 40(8) 968-976.

- Jaspreet Kaur, Poonam Gera, M K Jha, A K Sarma. A Study on the conversion of glycerol into solketal using rice husk catalyst, (2017) Presented and accepted for publication in the conference proceeding, ICRAER'17 (accepted for publication in Springer proceeding).

Book Chapter

- Arora R, Sharma NK and Kumar S (2018) Valorization of By-Products Following the Biorefinery Concept: Commercial Aspects of By-Products of Lignocellulosic Biomass. In: Chandel AK, Silveira MH (Eds.) Advances in Sugarcane Biorefinery, Elsevier, pp. 163-178.
- Behera S, Sharma NK, Kumar S (2018) Prospects of solvent tolerance in butanol fermenting bacteria. In: Kumar S, Sani RK (Eds.) Biorefining of Biomass to Biofuels: Opportunities and Perception, Biofuel and Biorefinery Technologies Series, Springer International Publishing, pp. 249-264.
- Shukla M, Kumar S (2018) Algal biorefineries for biofuels and other value-added products. In: Kumar S, Sani RK (Eds.) Biorefining of Biomass to Biofuels: Opportunities and Perception, Biofuel and Biorefinery Technologies Series, Springer International Publishing, pp. 305-341.

Books and Conference Proceedings

- Kumar S, Sani RK (Eds.) (2018) Biorefining of Biomass to Biofuels: Opportunities and Perception (Biofuel and Biorefinery Technologies Series); Springer International Publishing. (eBook ISBN 978-3-319-67678-4; Hardcover ISBN 978-3-319-67677-7).
- Kumar S, Sani RK, Yadav YK (Eds.) (2018) Conference Proceedings of the Second International Conference on Recent Advances in Bioenergy Research. Springer Proceedings in Energy. Springer Nature Singapore (eBook ISBN 978-981-10-6107-3; Hardcover ISBN 978-981-10-6106-6).

Presentations in conferences

- Hans M, Garg S, Kumar S, Bioethanol Production from Acid Pretreated Sugarcane Bagasse using Thermotolerant Yeast *Kluyveromyces marxianus* NIRE-K3.2. International Conference on Emerging Trends in Biotechnology for Waste Conversion (ETBWC-2017), CSIR-NEERI, Nagpur, Oct 08-10, 2017
- Arora R, Sharma NK, Kumar S, Bioprocessing of paddy straw to bioethanol in SSF using thermotolerant *K. marxianus* NIRE-K3. SIMB Annual Meeting 2017, Denver, USA, Jul 30-Aug 03, 2017.

10. AWARDS & HONOURS

- Mr. Nilesh Kumar Sharma, SRF was selected as the Bioenergy-Awards for Cutting Edge Research (B-ACER) Intern 2017 by the Department of Biotechnology, Govt. of India and the Indo-U.S. Science and Technology Forum (IUSSTF) to visit the USA for 6 months.

11. FELLOWS COMPLETED PHD DURING 2017-18

- Dr. Richa Arora, PTU Jalandhar

12. DOCUMENTATION CENTRE

A documentation centre has been established, having collection of large number of recently published books, journals, periodicals, newsletters, reports, conference proceedings, etc. on various aspects, relating to renewable energy. The further strengthening of the documentation centre is in progress.

13. ADMINISTRATIVE ACTIVITIES

Administrative/Purchase Committee/Finance Committee Meetings: Administrative meeting to discuss the plans of development and progress of R&D activities being carried out in the Institute were organized at regular intervals.

- 14thFinance Committee Meeting was held on 4th August 2017 at MNRE.
- 27th Governing Council Meeting was held on 4th August 2017 at MNRE.
- Independence Day was celebrated in the Institute on 15th August 2017.
- Republic Day was celebrated in the Institute on 26th January 2018.

14. ANNUAL AUDITED ACCOUNTS FOR THE FINANCIAL YEAR 2017-18

The annual audited accounts of the Institute for the year 2017-18 has been prepared and duly audited by Internal Auditors M/s. Arora Vikram & Associates, Jalandhar and Statutory Auditor M/s. K. Bhagat & Co., Jalandhar. The detailed Auditor's Report, Balance Sheet, Income, Expenditure, Receipts & Payment Accounts Schedules are attached herewith.

K. BHAGAT & CO.
Chartered Accountants
16-Brij Nagar
Jalandhar.

Phone : (O) 0181-2282829
(M) 98142-03435
99142-03435

FORM NO. 10B
[See rule 17B]

Audit report under section 12A(b) of the Income-tax Act, 1961

We have examined the balance sheet of SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY (SSS NIRE), KAPURTHALA as at 31.03.2018 and Income & Expenditure account for the year ended 31.03.2018 which are in agreement with the books of accounts maintained by the said Institute.

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of the audit. In our opinion, proper books of account have been kept by the Society so far as appears from our examination of books, subject to the notes to accounts annexed herewith.

In our opinion and to the best of our information, and according to information given to us, the said accounts give a true and fair view.

(i) In the case of the balance sheet, of the state of affairs of the abovenamed society as at 31.03.2018 and

(ii) In the case of the Income & Expenditure account, of the deficit of its accounting year ending on 31.03.2018.

For K. Bhagat & Co.
Chartered Accountants

Partner

Place : Jalandhar City

Dated :24.07.2018

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

(An Autonomous Institution of Ministry of New & Renewable Energy)
Kapurthala (Punjab)- 144601

BALANCE SHEET AS AT 31ST MARCH 2018

PARTICULARS	SCHEDULE	31st MARCH, 2018	31st MARCH, 2017
A. CAPITAL FUND AND LIABILITIES			
Corpus/Capital Fund	I	28,94,22,211.00	27,41,37,454.00
Reserve & Surplus	II	31,31,67,880.93	34,92,13,328.14
Current Liabilities & Provisions	III	38,31,585.00	44,21,642.00
TOTAL		60,64,21,676.93	62,77,72,424.14
B. ASSETS			
Fixed Assets	IV	22,48,42,443.00	24,95,61,299.00
Current Assets, Loans & Advances	V	9,06,36,914.93	10,28,95,496.14
Investment (Corpus Fund)	VI	29,09,42,319.00	27,53,15,629.00
TOTAL		60,64,21,676.93	62,77,72,424.14
Contingent Liabilities And Notes on Accounts	VII		

For SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

For K.Bhagat & Co.
Chartered Accountants

K. BHAGAT & CO. MEM NO. Ajay Kumar JALANDHAR CHARTERED ACCOUNTANTS

Deputy Director **Director General** **Partner**

Place: Jalandhar
Date: 24.07.2018

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

(An Autonomous Institution of Ministry of New & Renewable Energy)
Kapurthala (Punjab)- 144601

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2018

(Amount in Rs.)

PARTICULARS		31st MARCH, 2018	31st MARCH, 2017
INDIRECT INCOME			
Grant Received from MNRE during the year for General Expenses		50,00,000.00	-
Interest Received from FDRs (Corpus Fund)		1,48,72,257.00	1,95,20,888.00
Less: Transferred to Corpus Fund		(1,48,72,257.00)	(1,95,20,888.00)
Interest Received from Sweep A/c (IREDA NIBE Award)		4,12,500.00	5,47,500.00
Less: Transferred to Corpus Fund		(4,12,500.00)	(5,47,500.00)
Interest Received		51,57,613.00	88,34,028.00
Sponsorship Received		-	6,00,000.00
Licence Fees		1,00,240.00	1,07,975.00
Tender Fees		-	19,000.00
Registration Fees		1,40,000.00	72,500.00
Hostel Fees		1,03,780.00	1,04,500.00
Overhead Charges of Project Bio Butanol		1,50,000.00	1,00,000.00
Testing Fees Received		33,200.00	1,996.00
Electricity Charges Received from Housing		1,04,012.00	1,26,638.00
TOTAL	**A**	**1,07,88,845.00**	**99,66,637.00**
INDIRECT EXPENSES			
Advertisement		34,284.00	-
Audit & Legal Fees		72,252.00	1,12,696.00
Consumable Laboratory Workshop Exp.		2,95,702.00	14,53,737.00
Depreciation		2,65,28,390.00	2,92,26,924.00
Electricity & POL		30,97,479.00	27,13,946.00
Hiring of Prof. Services		93,11,841.00	96,95,257.00
Horticulture Expenses		35,399.00	68,011.00
Insurance Exp.		14,256.00	17,736.00
Meeting, Seminars, Workshop & Conference		6,20,558.00	18,32,148.00
Office/Guest House Exp.		63,349.21	1,11,175.00
Printing & Publications		-	1,32,317.00
Refreshment		39,815.00	45,396.00
Repair & Maintenance		4,20,790.00	2,57,565.00
Salaries		91,67,885.00	99,53,492.00
Stationary (Including Software Exp.)		1,35,432.00	2,04,690.00
Stipend		15,61,518.00	38,19,422.00
Telephone & Internet Exp.		3,37,870.00	4,07,004.00
Travelling Exp.		1,45,274.00	7,59,384.00
Previous Year Expenses		-	28,547.00
Provision for Expenses		8,40,000.00	19,05,000.00
TOTAL	**B**	**5,27,22,094.21**	**6,27,44,447.00**
Deficit Transfer to Reserve & Surplus	**A-B**	**(4,19,33,249.21)**	**(5,27,77,810.00)**

K. BHAGAT & CO. MEM NO. JALANDHAR CHARTERED ACCOUNTANTS

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

(An Autonomous Institution of Ministry of New & Renewable Energy)
Kapurthala (Punjab)- 144601

PARTICULARS		31st MARCH, 2018	31st MARCH, 2017
I. CORPUS/CAPITAL FUND			
Opening Balance		26,35,89,954.00	24,40,69,066.00
Add: Interest on FDR (Corpus)		1,48,72,257.00	1,95,20,888.00
Add: IREDA NIBE Award		1,05,47,500.00	1,00,00,000.00
Add: Interest on IREDA Fund		4,12,500.00	5,47,500.00
		28,94,22,211.00	**27,41,37,454.00**
II. RESERVE & SURPLUS			
Opening Balance		32,83,84,881.44	38,11,62,691.44
Add: Grant Received for Capital Expenses		50,00,000.00	
Add: Deficit for Current year		(4,19,33,249.21)	(5,27,77,810.00)
	Sub Total	**29,14,51,632.23**	**32,83,84,881.44**
RESERVE & SURPLUS- COMPLETED PROJECTES			
Bio Diesel Project (Dr. A.K. Sarma)		44,72,153.00	44,72,153.00
ICRISAT Project (Sh. R.A. Singh)		13,929.00	13,929.00
Bio Crude Project (Dr. A.K. Sarma)		23,83,061.00	23,83,061.00
National Renewable Energy Program Project		50,415.00	50,415.00
Bio Ethenol Project (Dr. Sachin Kumar)		54,41,996.70	
Bio Gas Project (Dr. Sachin Kumar)		59,929.00	
	Sub Total	**1,24,21,483.70**	**69,19,558.00**
Opening Balance		-	76,56,004.70
Less: Expenses for Bio Ethenol Project (Excluding Fixed Assets)		-	-
Less: Unutilized amount for Bio Ethenol Project Transferred to MNRE		-	(22,14,008.00)
	Sub Total	-	**54,41,996.70**
Opening Balance		-	13,37,285.00
Less: Expenses for Bio Gas Project (Excluding Fixed Assets)		-	(1,65,377.00)
Less: Unutilized amount for Bio Gas Project Transferred to MNRE		-	(11,11,979.00)
	Sub Total	-	**59,929.00**
RESERVE & SURPLUS- ON GOING PROJECTES			
Opening Balance Bio Mass Cook Stove Project (Dr. S.K. Tyagi)		41,43,511.00	47,10,635.00
Add: Testing Fees Received		-	20,000.00
Less: Expenses for Bio Mass CookStove Project (Excluding Fixed Assets)		(12,645.00)	(5,87,124.00)
	Sub Total	**41,30,866.00**	**41,43,511.00**
Opening Balance Bio Butanol Project (Dr. Suvashish Behra)		19,319.00	**9,21,140.00**
Add: Grant Received from MNRE during the year		11,00,000.00	
Less: Expenses for Bio Butanol Project (Excluding Fixed Assets)		(9,73,306.00)	
	Sub Total	**1,46,013.00**	

K. GUPTA & CO. MEM NO. JALANDHAR CHARTERED ACCOUNTANTS

PARTICULARS		31st MARCH, 2018	31st MARCH, 2017
Opening Balance Bio Mass Energy Tech. Project (Dr. S.K. Tyagi)		5,00,000.00	4,64,998.00
Add: Grant Received from MNRE during the year		-	35,002.00
	Sub Total	**5,00,000.00**	**5,00,000.00**
Opening Biorefinery Approach for generation of platform chemicals and bioethanol (Dr. Sachin Kumar)		9,10,000.00	9,10,000.00
Less: Expenses Biorefinery Approach for generation of platform chemicals and bioethanol (Dr. Sachin Kumar)		(3,59,412.00)	-
	Sub Total	**5,50,588.00**	**9,10,000.00**
Fellowship Grant Dr. Sachin Kumar		22,03,000.00	22,03,000.00
Less: Advance Given to Dr. Sachin Kumar		19,82,700.00	19,82,700.00
	Sub Total	**2,20,300.00**	**2,20,300.00**
Opening Balance Indo Brazil project		**26,13,833.00**	
Grant Received from MNRE during the year under Indo Brazil project		24,16,214.00	32,84,400.00
Less: Expenses for Project (Excluding Fixed Assets)		(12,83,049.00)	6,70,567.00
	Sub Total	**37,46,998.00**	**26,13,833.00**
		31,31,67,880.93	**34,92,13,328.14**
III. CURRENT LIABILITIES & PROVISIONS			
Cheques Issued But not Presented			
SBOP, Jalandhar		-	18,128.00
OBC, Mand		2,83,485.00	11,810.00
UBI, Jalandhar		1,77,961.00	
Salary Payable		6,83,628.00	9,45,945.00
Electricity Expenses		3,01,319.00	1,79,408.00
Telephone & Other Expenses		7,072.00	6,198.00
Statutory Audit Fee		20,563.00	9,660.00
Security		60,895.00	51,545.00
Airport Handeling Services, New Delhi		67,369.00	67,369.00
TDS Payable		34,342.00	46,600.00
Provision for Expenses		8,40,000.00	19,05,000.00
Provision for Leaseline		-	65,000.00
National Service Station		17,311.00	28,446.00
Nova Trading Co.		-	1,86,561.00
Chemicot Scientific Gases		3,810.00	3,810.00
Helix Technology		-	50,637.00
Sigma Gases & Services		6,525.00	6,525.00
TDS Management Consultant(P) Ltd.		4,55,170.00	
M/s Quadrant Televentures Ltd.		73,135.00	-
EMD		7,99,000.00	8,39,000.00
		38,31,585.00	**44,21,642.00**

K. BHAGAT & CO. MEM NO. JALANDHAR CHARTERED ACCOUNTANTS

PARTICULARS		31st MARCH, 2018	31st MARCH, 2017
V. CURRENT ASSETS, LOANS & ADVANCES			
A. CURRENT ASSETS			
Cash in Hand		17,402.00	682.00
Bank Balances			
In Saving A/c		61,065.23	1,01,87,469.95
In Current A/c		5,20,956.46	2,24,015.70
In Deposit A/c		18,91,16,376.00	9,27,15,127.00
	Total	18,97,15,799.69	10,31,27,294.65
Less: Deposit for Corpus		(10,97,91,039.00)	(1,00,00,000.00)
(Shown under Investment Corpus Fund)			
	Total (A)	**7,99,24,760.69**	**9,31,27,294.65**
B. LOANS, ADVANCES & OTHER ASSETS			
Advances Recoverable in Cash or in kind or for value to be received			
Deposit with CPWD		46,44,409.00	46,44,409.00
M/s Casa, New Delhi		3,00,000.00	3,00,000.00
M/s Deejay Corporation		63,279.00	63,279.00
M/s PEDA Chandigarh		17,42,000.00	17,42,000.00
M/s Indian Journals Com		2,000.00	2,000.00
M/s Godrej & Boyce Mfg. Co. Ltd.		5,725.00	5,725.00
M/s B.N. Constructions		5,00,000.00	5,00,000.00
M/s Signal Logistics Pvt. Ltd.		-	19,500.00
M/s PESCO		-	9,000.00
M/s Punjab State Council for Science & Technology		1,29,800.00	
Sundry Advances/Recoverable		98,211.24	41,055.49
Advance Income Tax Demand		4,28,395.00	-
Securities Telephone		-	2,000.00
Security Gas		7,100.00	7,100.00
Advance to Staff		-	10,000.00
Amount Deductable from Staff		187.00	-
Prepaid Expenses		345.00	3,146.00
Grant receivable		4,00,000.00	4,00,000.00
Cheque Deposited but not Presented		5,000.00	5,000.00
Postal Stamps in Hand		3,356.00	5,138.00
TDS Recoverable previous years		20,08,849.00	4,65,104.00
TDS previous year		3,73,498.00	15,43,745.00
	Total (B)	**1,07,12,154.24**	**97,68,201.49**
GRAND TOTAL (A+B)		**9,06,36,914.93**	**10,28,95,496.14**

K. BHAGAT & CO. MEM NO. JALANDHAR CHARTERED ACCOUNTANTS

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

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Kapurthala (Punjab)- 144601

PARTICULARS		31st MARCH, 2018	31st MARCH, 2017
VI.	**INVESTMENTS (Corpus Fund)**		
A	Fixed Deposits with Banks	18,01,67,864.00	26,01,50,263.00
	Interest Accrued on FDR	9,83,416.00	51,65,366.00
B	IREDA- NIBE Award Sweep Account	1,00,00,000.00	1,00,00,000.00
	Interest under MOD of NIBE Award	9,60,000.00	
	(Transferred from Deposit A/c)		
C	MOD with Bank for Corpus	9,61,80,256.00	-
	Interest under MOD for Corpus	26,50,783.00	
	(Transferred from Deposit A/c)		
	TOTAL	**29,09,42,319.00**	**27,53,15,629.00**

K. BHAGAT & CO
MEM NO.
JALANDHAR
CHARTERED ACCOUNTANTS

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

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Kapurthala (Punjab)- 144601

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR 2017-18

	RECEIPTS	31st MARCH, 2018	31st MARCH, 2017
A.	**OPENING BALANCES**	**37,08,31,972.65**	**37,57,98,266.65**
	Cash in Hand	682.00	4,057.00
	Grant Receivable	4,00,000.00	4,00,000.00
	Bank Balances		
	In Saving A/c	1,01,87,469.95	81,31,594.20
	In Deposit A/c	8,27,15,127.00	12,37,54,120.75
	In Current A/c	2,24,015.70	2,08,908.70
	Investments	26,01,50,263.00	24,01,62,255.00
	Interest Accrued on FDR & Securities	51,65,366.00	62,12,567.00
	IRDA Award Sweep Account	1,00,00,000.00	-
	TDS Recoverable	20,08,849.00	4,65,104.00
	Add: Cheque deposited but not credited	5,000.00	5,000.00
	Less: Cheque issued but not presented	(29,938.00)	(35,46,121.00)
	Stamps	5,138.00	781.00
B.	**GRANT RECEIVED**	**1,35,16,214.00**	**1,64,32,402.00**
	Grant Received for Capital Expenses	50,00,000.00	-
	Grant Received for General Expenses	50,00,000.00	-
	Grant from IREDA- NIBE Award	-	1,00,00,000.00
	Bio- Butanol Project	11,00,000.00	-
	Bio-Refinery	-	9,10,000.00
	Fellowship Grant Dr. Sachin Kumar	-	22,03,000.00
	Bio-Indo Brazil Project	24,16,214.00	32,84,400.00
	Bio Mass Energy Tech. Project	-	35,002.00
C.	**INTEREST RECEIVED**	**2,04,42,370.00**	**2,89,02,416.00**
	On Saving/Bank Deposits	51,57,613.00	88,34,028.00
	Interest on Corpus Fund	1,52,84,757.00	2,00,68,388.00
D.	**OTHER INCOME**	**6,42,582.00**	**15,88,459.00**
	Tender Fees	-	19,000.00
	Licence Fees	1,00,240.00	1,07,975.00
	Hostel Fees	1,03,780.00	1,04,500.00
	EMD/Security	11,350.00	4,35,850.00
	Registration Fees	1,40,000.00	72,500.00
	Sponsorship	-	6,00,000.00
	Testing Fees	33,200.00	21,996.00
	Overhead Charges of Project Bio Butanol	1,50,000.00	1,00,000.00
	Electricity Charges Recovered	1,04,012.00	1,26,638.00
E.	**OTHER ADJUSTMENTS**	**24,35,433.00**	**33,38,544.00**
	Expenses Payable/Creditors Outstanding During the Year	23,93,787.00	32,14,326.00
	Advances of Last Year Adjusted During the Year	41,646.00	1,24,218.00
		40,78,68,571.65	**42,60,60,087.65**

For SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

Deputy/Director
Place: Jalandhar
Date: 24.07.2018

Director General

As per our Audit Report Attached
For K.BHAGAT & CO.
Chartered Accountants

MEM NO. Ajay Kumar
JALANDHAR
Partner

K. BHAGAT & CO. CHARTERED ACCOUNTANTS

SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

(An Autonomous Institution of Ministry of New & Renewable Energy)
Kapurthala (Punjab)- 144601

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR 2017-18

	PAYMENTS	31st MARCH, 2018	31st MARCH, 2017
A.	**PAYMENT MADE AGAINST FUNDS FOR VARIOUS PROJECTS**		
	Out of Capital Grant		
	Revenue Expenditure	**2,61,93,704.21**	**3,35,17,523.00**
	Expenditure During the Year	5,27,22,094.21	6,27,44,447.00
	Less: Depreciation	(2,65,28,390.00)	(2,92,26,924.00)
	Capital Expenditure	**18,09,534.00**	**1,15,63,221.00**
	Fixed Assets	18,09,534.00	1,15,63,221.00
	Out of Grant for Projects	**26,28,412.00**	**76,33,576.00**
	Expenses Under Bio-Refinery Project	3,59,412.00	-
	Expenses Under Bio-Mass Cookstove Project	12,645.00	5,87,124.00
	Expenses Under Bio- Butanol Project	9,73,306.00	9,01,821.00
	Expenses Bio-Gas Production Project	-	1,65,377.00
	Expenses Indo Brazil Project	12,83,049.00	6,70,567.00
	Advance Given to Dr. Sachin Kumar	-	19,82,700.00
	Unutilized Amount of Project Transferred to MNRE	-	**33,25,987.00**
	Bio-Gas Production Project	-	11,11,979.00
	Bio- Ethenol Project	-	22,14,008.00
B.	**OTHER PAYMENTS**	**40,40,584.75**	**25,13,795.00**
	EMD,Security Refunded	40,000.00	1,51,500.00
	Advance Given During the Year	6,15,882.75	22,146.00
	Expenses Payable/Creditors of Pre. Year Paid During The Year	33,84,702.00	23,40,149.00
C.	**CLOSING BALANCES**	**37,31,96,336.69**	**37,08,31,972.65**
	Cash in Hand	17,402.00	682.00
	Grant Receivable	4,00,000.00	4,00,000.00
	Bank Balances		
	In Saving A/c	61,065.23	1,01,87,469.95
	In Deposit A/c	17,91,16,376.00	8,27,15,127.00
	In Current A/c	5,20,956.46	2,24,015.70
	Investments	18,01,67,864.00	26,01,50,263.00
	Interest Accrued on FDR & Securities	9,83,416.00	51,65,366.00
	IRDA Award Sweep Account	1,00,00,000.00	1,00,00,000.00
	TDS Recoverable	23,82,347.00	20,08,849.00
	Add: Cheque deposited but not credited	5,000.00	5,000.00
	Less: Cheque issued but not presented	(4,61,446.00)	(29,938.00)
	Stamps	3,356.00	5,138.00
		40,78,68,571.65	**42,60,60,087.65**

For SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

As per our Audit Report Attached
For K.BHAGAT & CO.
Chartered Accountants

Deputy Director
Place: Jalandhar
Date: 24.07.2018

Director General

K. BHAGAT & CO. MEM NO. JALANDHAR CHARTERED ACCOUNTANTS

Partner