SSS NIRE
ISO 9001:2008

17th Annual Report
2014-2015

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

12 K.M. Stone, Jalandhar- Kapurthala Road, Wadala Kalan,
Kapurthala-144 601 (Punjab)

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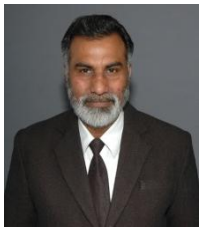


Preface

With great respect to the set vision "To become an apex Institution for carrying out ***state-of-the-art*** research and developmental activities in the area of bioenergy, human resource development at all levels including postdoctoral research" the Institute carried on the activities with sincere efforts although there are lot of hurdles and shortage of technical and experienced manpower at all levels. In the year 2014-15 a grant-in-aid of 12.0 Crore INR was received from the Ministry of New and Renewable Energy, Govt of India, out of which 4.4 Crore INR were spent from the budget allocated under different heads and an amount of 5.86 Crores INR was invested as Corpus fund raising the total corpus of the Institute to 22.60 Crores. Although not many new equipments were purchased during the year, the existing facilities were run with dedication for R &D and testing purposes. During this year 13 Nos of JRF/SRF/PDF and 2 Nos PA were appointed under Bioenergy Promotion Fellowship and Projects, respectively, to fill up the the different aspects of Bioenergy Research. The R&D activities in the frontier areas of bioenergy can be envisaged from the completed project on Biocrude Production, ongoing projects on Lignocellulosic Bioethanol Production, Biogas Production from Agroresidue, Biomass Cookstove Testing and Certification. In addition, growth of research publications in reputed journals in the frontier bioenergy area, deposition of gene sequence of new consortia, microalgae etc., from the in-house R & D unveil the scientific output.

The Institute imparted short term training to around 300 fellows, starting from undergraduate to postdoctoral level and cater their motivation towards bioenergy applications. The first International Conference on Recent Advances in Bioenergy Research (ICRABR -2015), was successfully organized by the Institute during March 14-17, 2015 that paved the way for R &D collaboration with several leading R&D Institution and Universities around the world. A Bio-Energy Alliance was also formed during the conference 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.

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

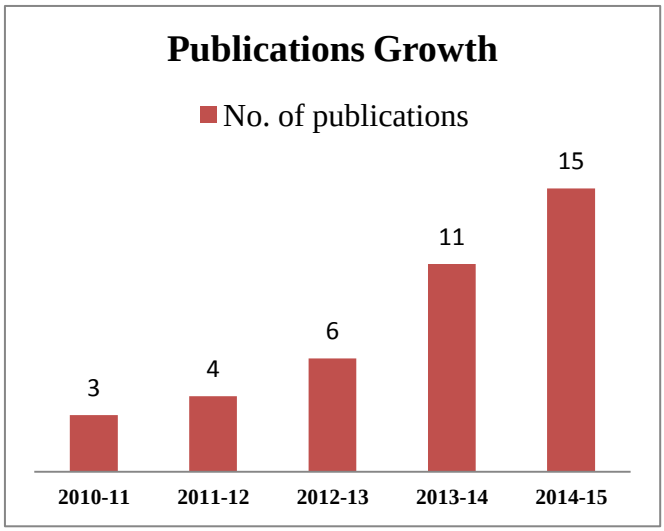
The Institute observed all routine celebration as instructed by the Government of India from time to time. Routine maintenance of the Institute with 75 acres of land covering green landscape and beautiful campus with limited human resources, with the future plan to develop as a **Centre for Global Excellence**, took a lot of time and efforts!

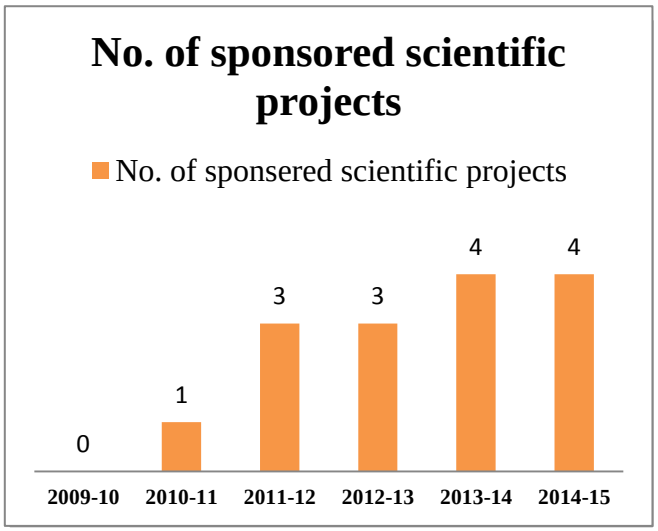
Prof. (Dr.) Yogender Kumar Yadav
Director

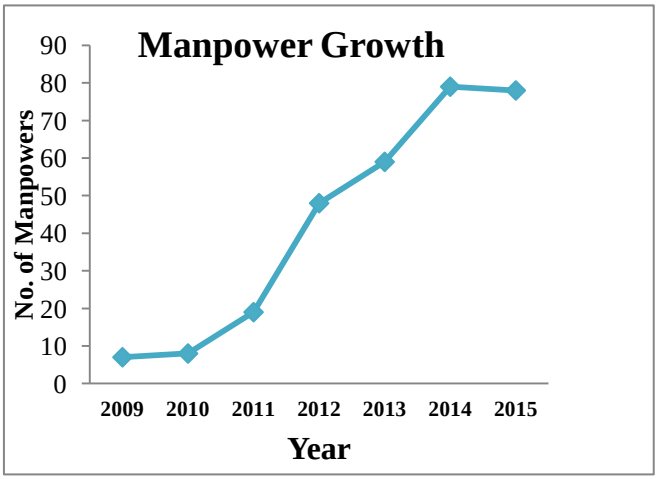
2. Graphic Corner

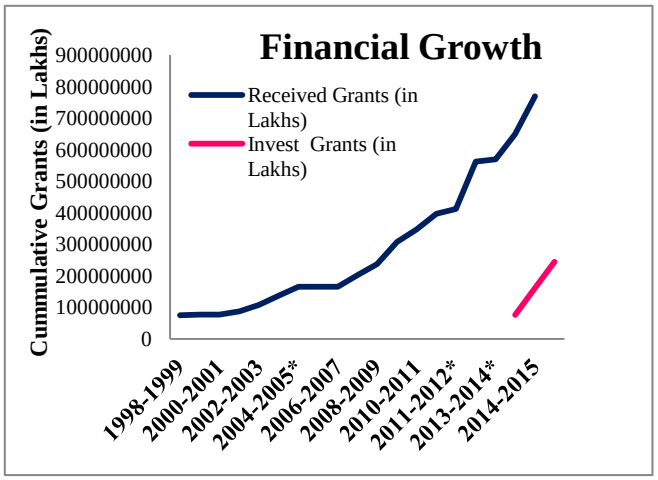
Graphical Presentation of Research, Design, Testing and Demonstration activities of the Institute

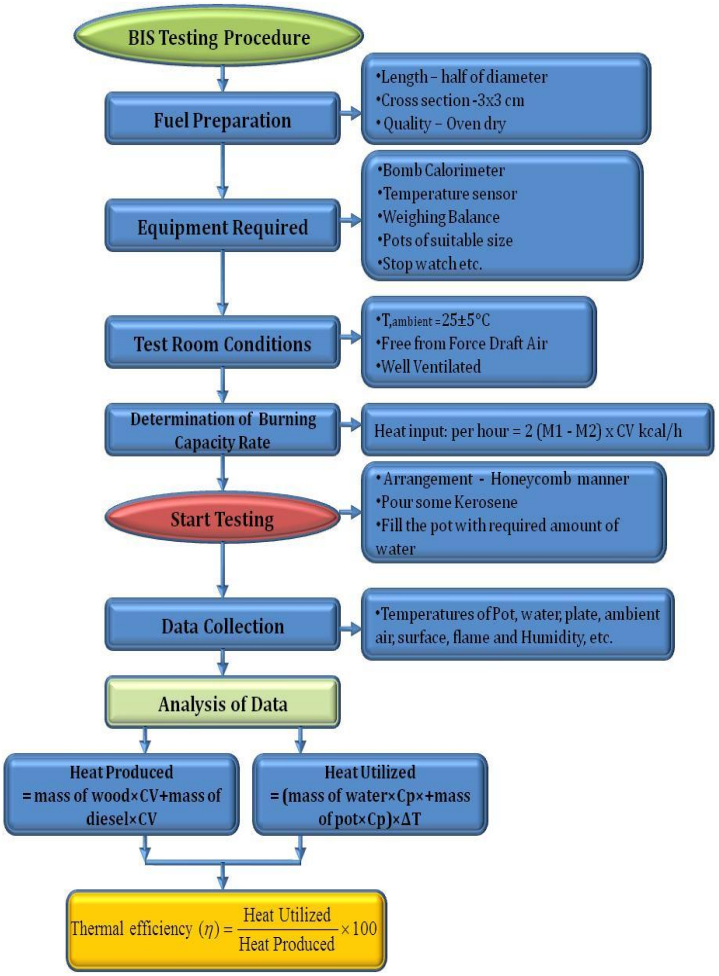
Institute Growth: At A Glance







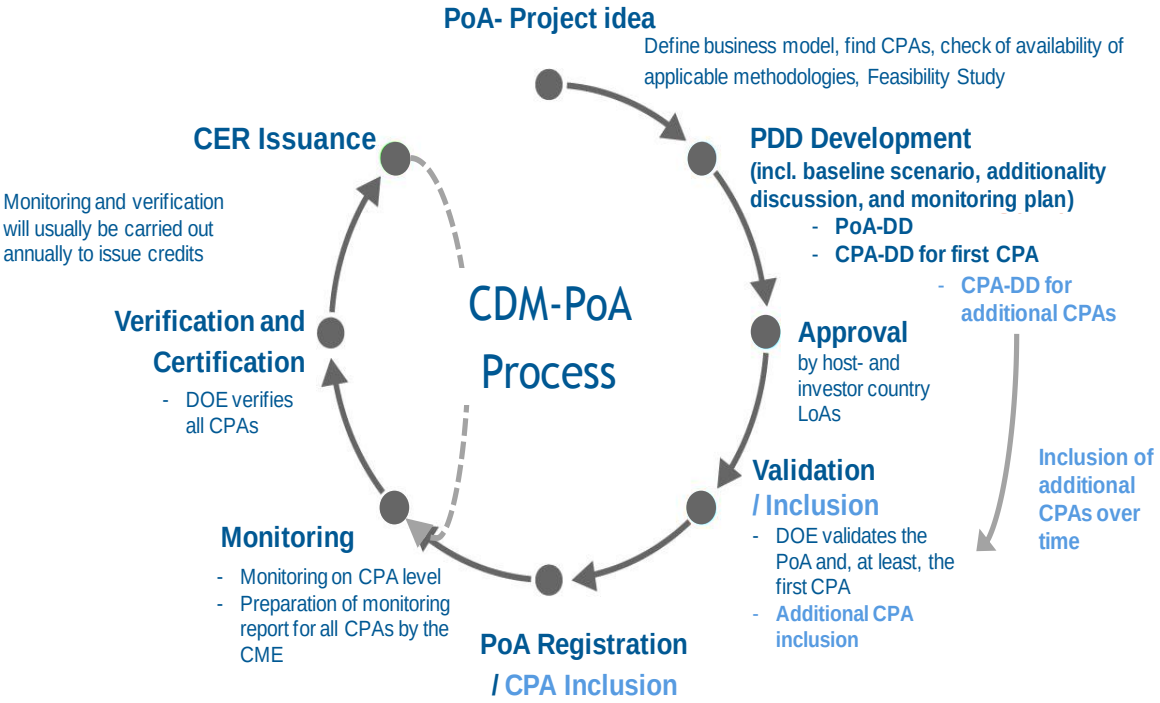




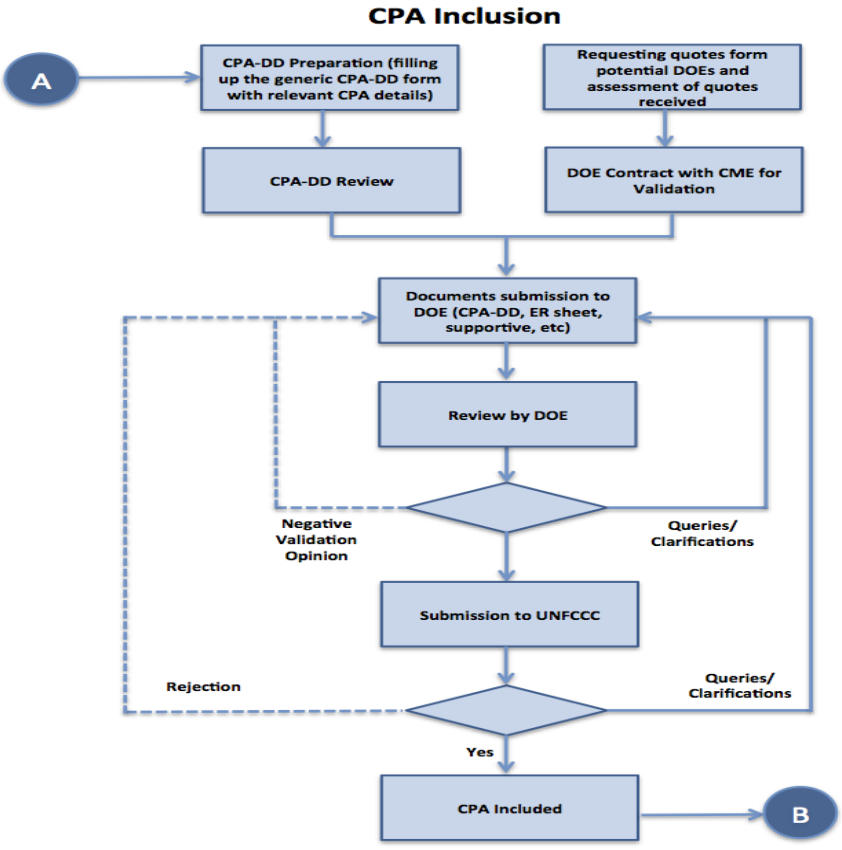
BIS Testing Protocol			
S. No.	Performance Parameters	Permissible limit	
		Natural Draft	Forced Draft
1.	Thermal Efficiency	≥25%	≥35%
2.	Total Particulate Matter (TPM) Emission	≤350 mg/MJ_d	≤150 mg/MJ_d
3.	CO & CO_2 Emission	≤5 g/MJ_d	
4.	Surface Temperature	≤60 °C	
5.	Quenching Test	Shall withstand the test without any crack and deformity	

Testing and certification procedure for Biomass Cookstove

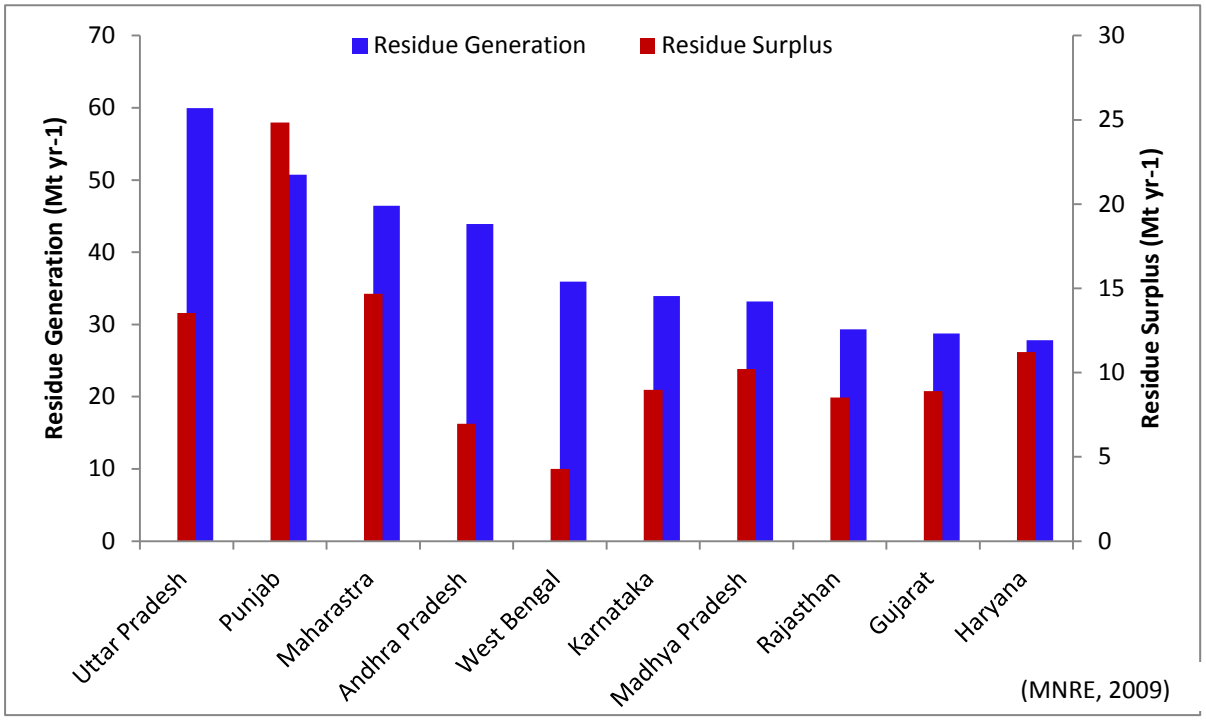
Biomass Cookstove and Certification Centre at SSS-NIRE



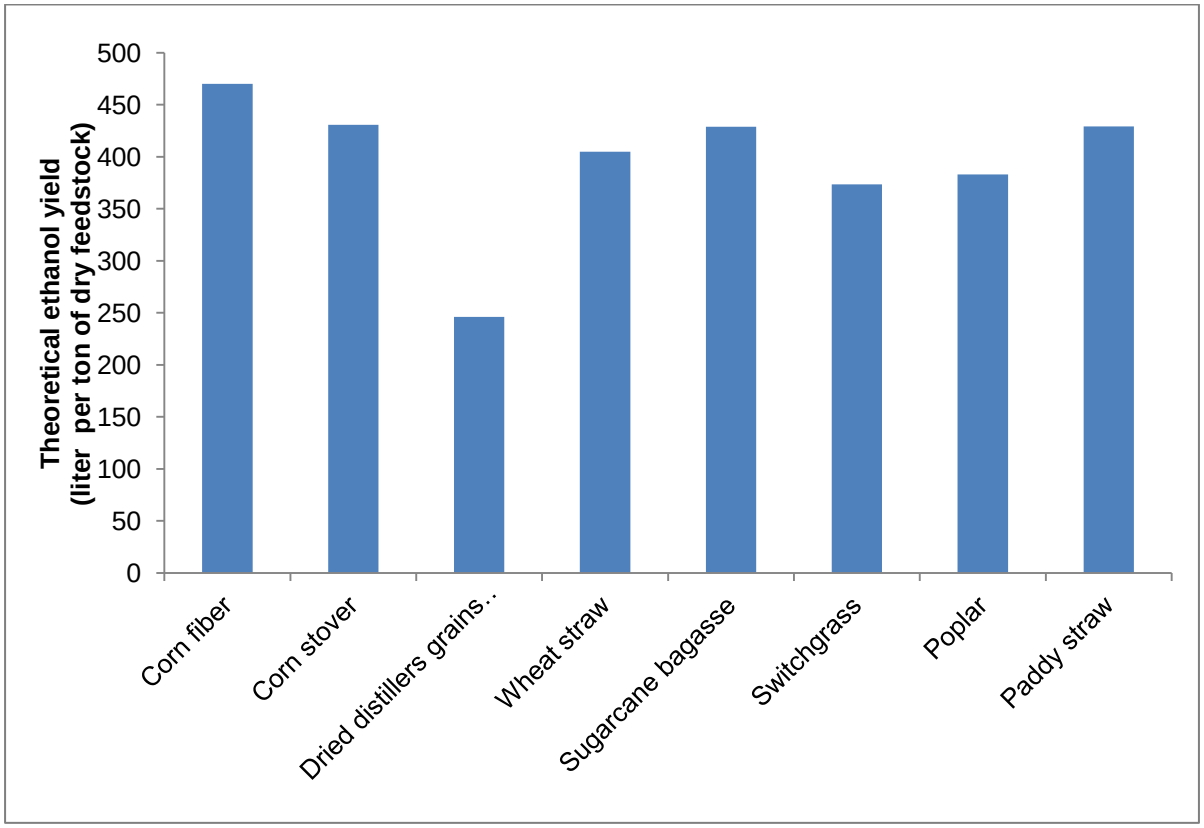
CDM-PoA registration process for Improved Biomass Cookstove



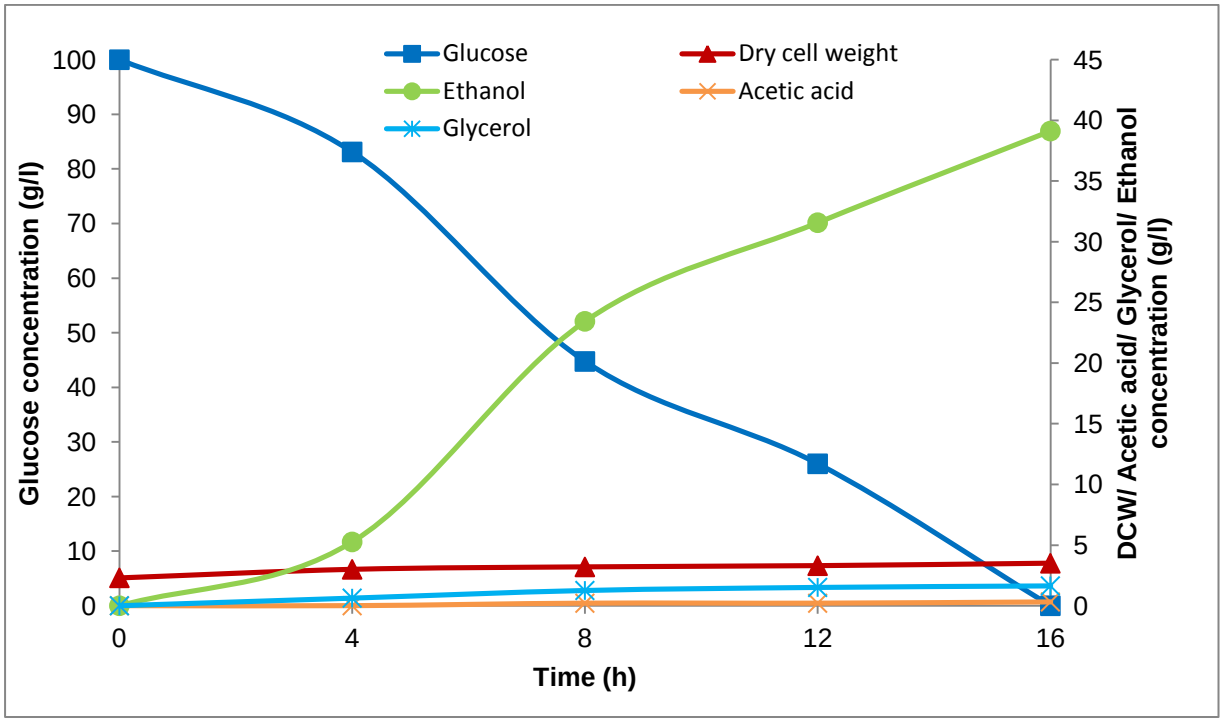
CPA Inclusion Process for Biomass Cookstove CDM-PoA



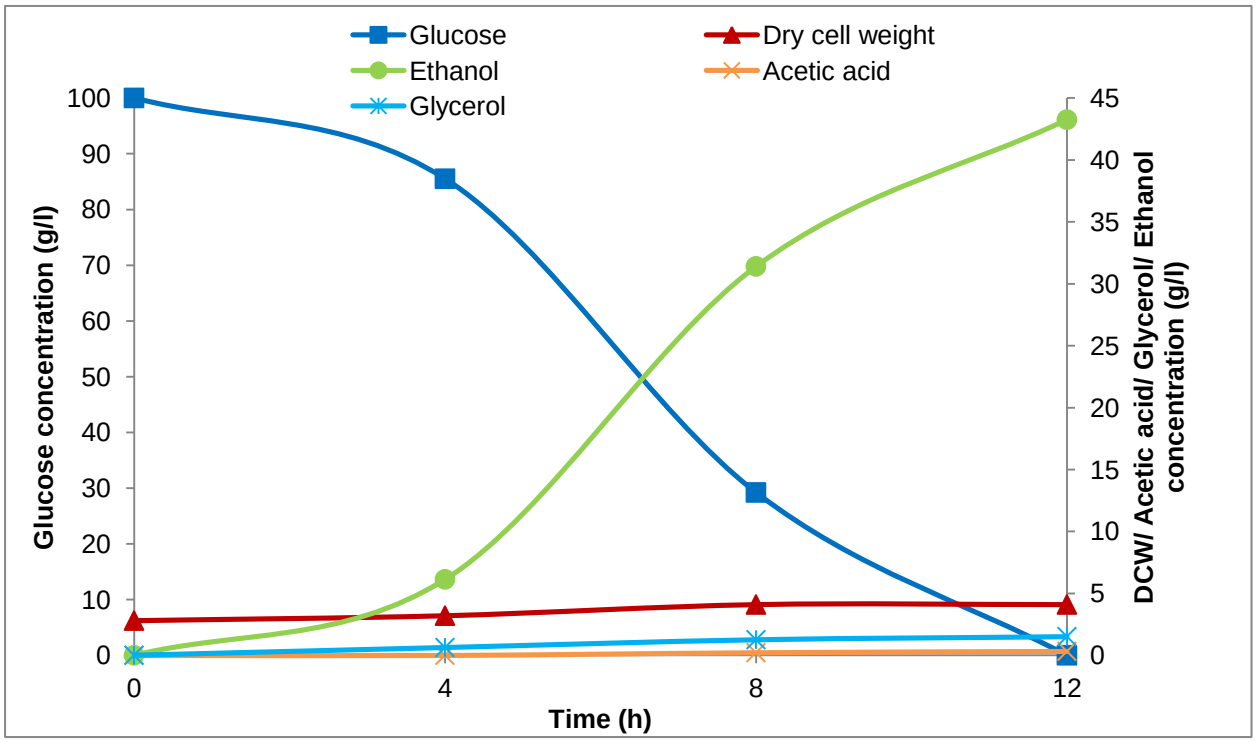
State-wise Agricultural Residue Generation and Available Surplus in India



Bioethanol Production Potential from Different Biomass Feedstocks

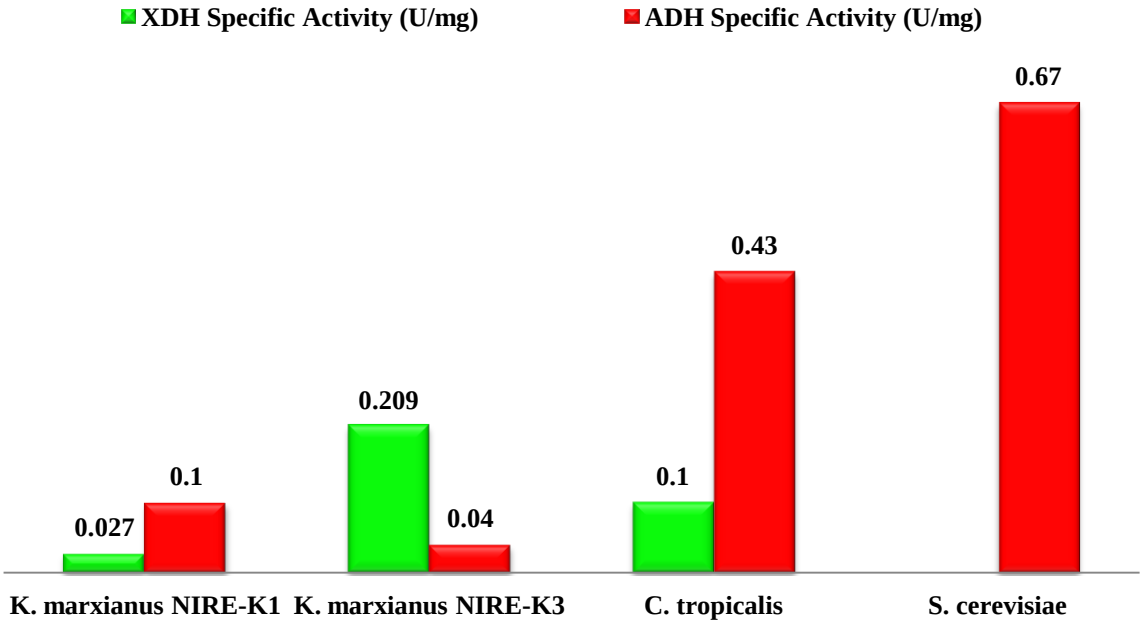


(A) *K. marxianus* NIRE-K1

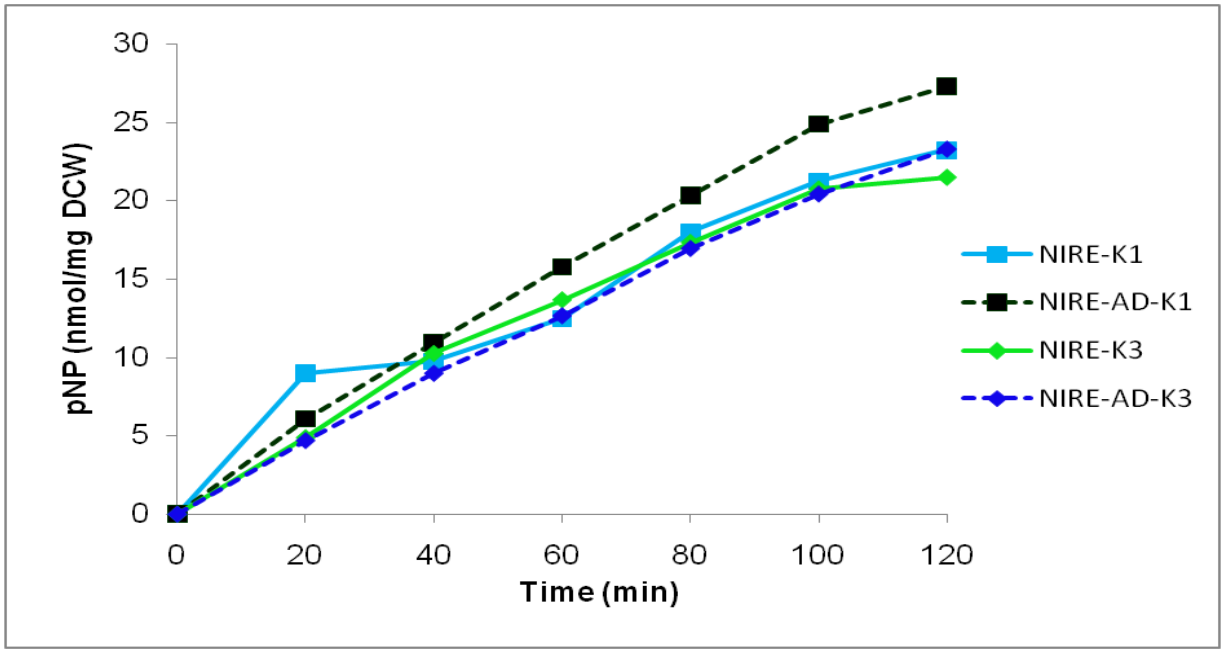


(B) *K. marxianus* NIRE-K3

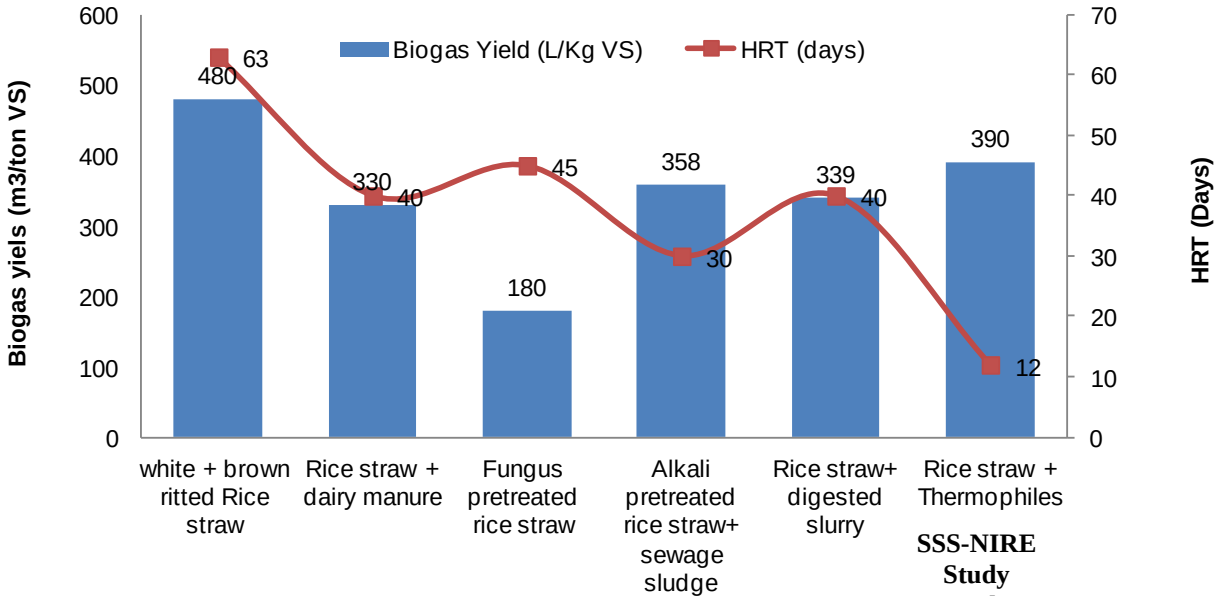
Fermentation Profile of Thermotolerant Ethanologenic Yeast *K. marxianus* NIRE-K1 and NIRE-K3 Developed at SSS-NIRE in a Bench-scale Bioreactor



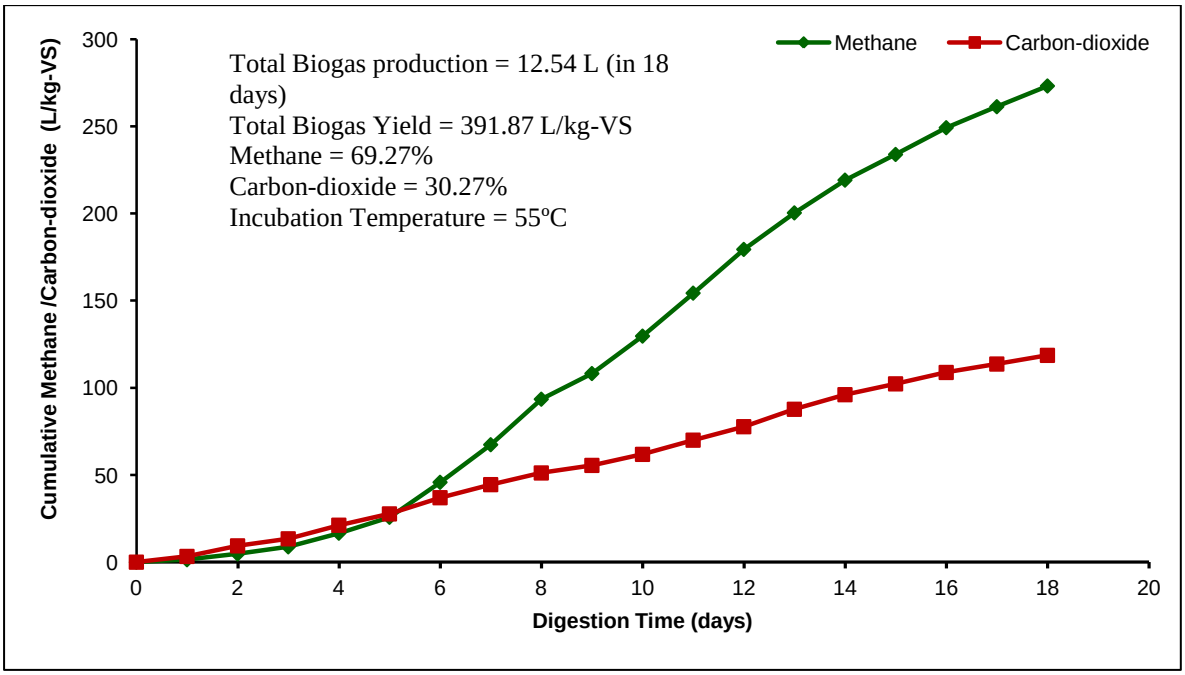
Specific Activity of XDH and ADH Enzymes in *K. marxianus* NIRE-K1 and NIRE-K3 Developed at SSS-NIRE with respect to Industrial Yeasts *C. tropicalis* and *S. Cerevisiae*



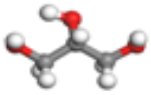
Assay for Xylose Transporter with Xylosidase Gene in Adapted and Wild Yeasts *K. marxianus* NIRE-K1 and *K. marxianus* NIRE-K3 Developed at SSS-NIRE



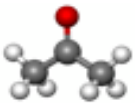
Biogas Production Potential from Rice Straw using Different Inoculums



Biogas Production from Rice Straw using Thermophilic Consortium Developed at SSS-NIRE



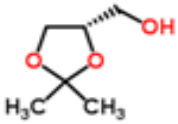
Glycerol
(a byproduct from biodiesel production)



Acetone

(25-55 °C, 1-5 h)

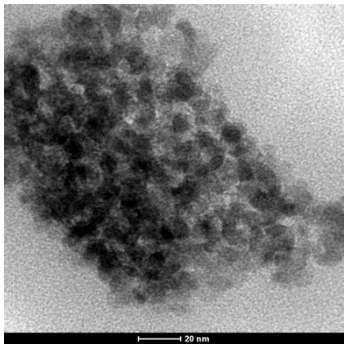
Solid-acid catalyst

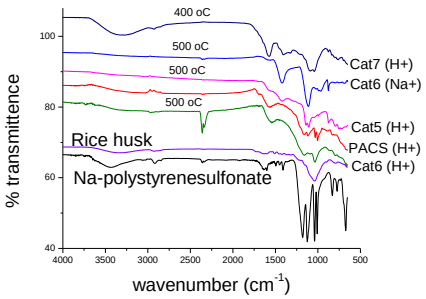


Solketal
Apllications as

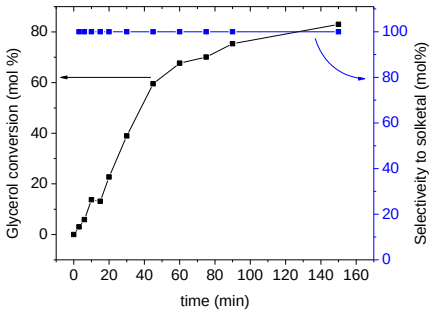
Fuel additive, solvent, chemical

(in the current market depending on purity commerical value of solketal is 25-60 times that of glycerol)





TEM image and FT-IR patterns of synthesized catalysts (selected)



Kinetics of glycerol ketelization under optimized conditions with the most active catalyst (30 °C, acetone: glycerol mole ratio of 6, 5wt% catalyst)

Features of the developed catalysts

- Acidity and catalytic activity comparable to H_2SO_4
- Derived from biomass sources (starch, rice-husk, deoiled cake etc)
- Mesoporous structure
- Reusability (potential for large scale application)

Process Development for Valorisation of Glycerol into Fuel Additive using Solid Acids

(Process optimization to achieve highest solketal yield and selectivity)

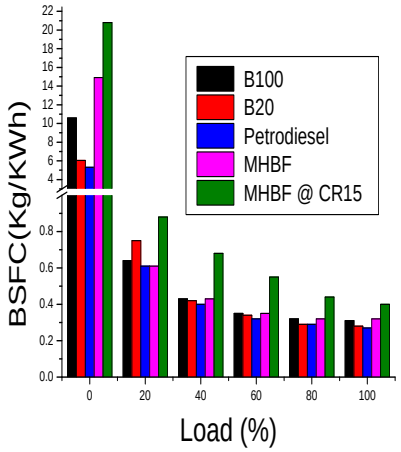
Biodiesel

Biofuels

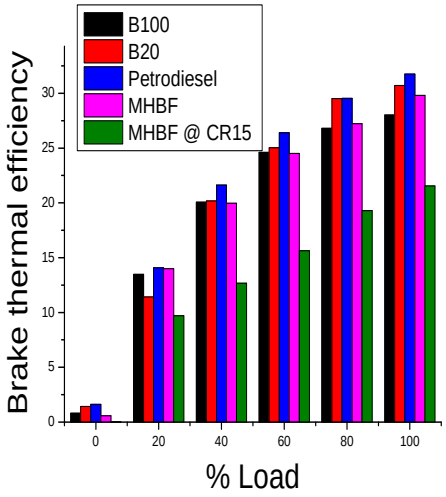
Green Diesel

Microemulsion Based Hybrid Fuel

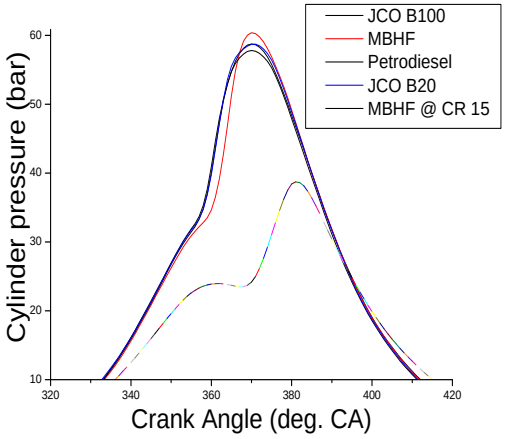
- BTE (%)
- ITE (%)
- BSFC (Kg/KWh)
- η_{mech} (%)
- BP (KW)
- CPmax Vs CA
- NHRmax Vs CA
- NO_x
- HC
- CO
- CO_2



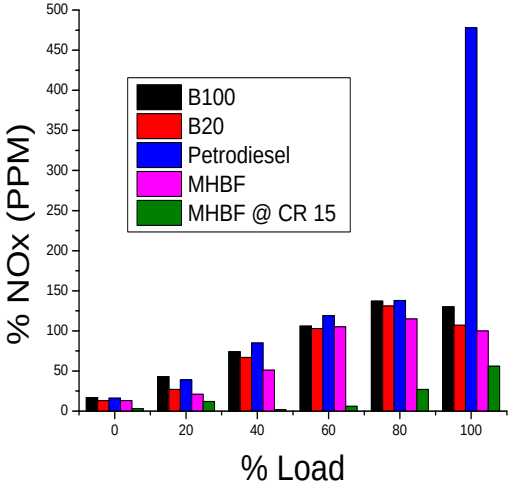
BSFC Vs Load



BTE Vs Load



Cylinder Pressure Vs Crank Angle



NO_x Vs Load

Testing facility of Biofuels in SSS-NIRE using VCR Compression Ignition Engine Test Rig.

3. INTRODUCTION

Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala is an autonomous Institution of the Ministry of New and Renewable Energy, Govt of India devoted to Bioenergy Research, Design and Development. The Governing Council under the Chairmanship of Secretary, MNRE has been directing and monitoring the activity of the Institute. The Institute has 10 nos. of sanctioned posts only, all of which are occupied at present. The Institute has prepared vision documents for research and created five research divisions including all aspects of biofuel and bioenergy research. The 16th meeting of the Governing Council approved the vision document and creation of 16 nos. of new scientific posts for smooth running of the R&D activities under different divisions. The proposal has been submitted for approval by the Ministry of Finance, and process has been initiated for advertisement. The Institute was certified by Intertek as an ISO 9001:2008, R &D institution.

4. 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 a knowledge based R&D Institution of high quality and dedication.
- To impart the training to professionals of bio-energy sector
- To provide the services and optimum solutions for the major stakeholders across the entire spectrum of the bio-energy sector.
- To support bio-energy sector in developing the knowledge for promoting new technologies.
- To develop Human Resources for the bio-energy sector at all levels.

OBJECTIVES

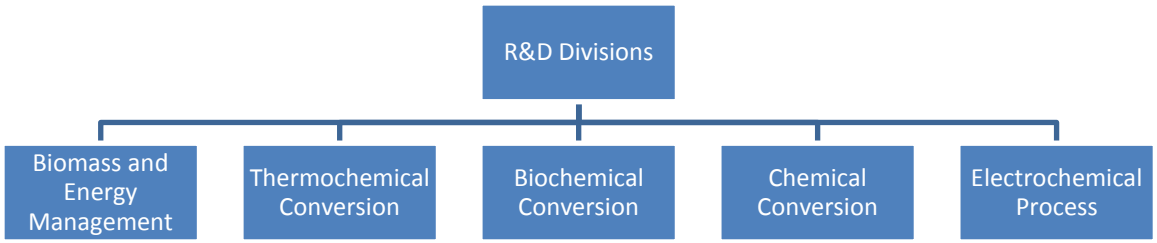
- To carry out and facilitate research, design, development, testing, standardization and technology demonstration eventually leading to commercialization of RD&D output with a focus on:
  a. Bioenergy, biofuels and synthetic fuels in solid, liquid and gaseous forms for transportation, portable and stationary applications; and
  b. 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).

5. 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).

6. CHARTER

With a view to manage, administer, direct and control the affairs of SSS-NIRE, 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.

7. 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 upto the boiling range 380 ^{0}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 etc. A few equipments are

in the process of procurement to complete the analysis facility as per ASTM or BIS Standards for green diesel and biodiesel testing.

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 equipments such as HPLC, Gas Chromatography, UV-vis spectrophotometer and Fibretech; Bioprocess laboratory contains the equipments such as Bioreactor (3.0 & 7.5 L), Refrigerated Centrifuge, Water Purification System, Lyophilizer, Microdisintegrator, Water Bath, Autoclaves, etc.; Microbiology laboratory contains 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 equipments such as Gradient PCR, Real Time PCR, Biophotometer, SDS-PAGE, 2-D gel Electrophoresis, Horizontal Gel Electrophoresis, Gel Documentation and Electroporation Unit.

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 equipments 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, CHNO analyzer, TGDTA, etc. have been procured and installed in the biomass characterization laboratory.

8. RESEARCH ACTIVITIES

8.1 Completed Projects

Biocrude Production: Hydrocracking of nonedible vegetable oil Completed-under review-2015, PI- Dr AK Sarma, SSS-NIRE, Kapurthala.

Hydrocracking of nonedible vegetable oil, in particular *Mesua ferrea* L (MFL) oil and *Jatropha curcas* L oil(JCO) having high percentage of free fatty acids were considered initially using alkali metal rich catalyst e.g., 1% Na_2CO_3, as per existing literature. It was found that at initial hydrogen pressure 7.5MPa, temperature 400 ^{0}C, the biocrude obtained in 1 hour reaction time, is very similar in properties to that of paraffinic crude oil. The true boiling point distillation recovery at 35-140 ^{0}C (gasoline) 15% wt.; 140-300 ^{0}C(Kerosene, ATF) 22 wt.%; 300-370 ^{0}C(Diesel, 14 wt.%); while 11wt.%, 370-482 ^{0}C paraffin wax. Moreover, the catalytic hydrocracking of JCO was also found satisfactory at 400 ^{0}C and such a lower pressure of 0.5 MPa H_2 using 1 wt% Na_2CO_3 as catalyst. During hydroprocessing about 12 wt. % gasoline, 21 wt. % kerosene, 15 wt. % diesel and 10 wt. % of slightly greenish in

color paraffin wax were obtained from JCO crude oil. In this case the total distillates recovery were observed to be more than 58 wt. % excluding the gas and loss of about 4 wt. %.

Economic evaluation of the process and products

The cost analysis of the biocrude obtained and the processed products were also required under the project. It was found from the literature survey that there was no such formula available for cost calculation for biocrudes and distillates. However for petroleum product the same is available. Because, the distillation process of biocrudes and petroleum crudes are analogous, the formulation applied for petroleum products cost evaluation could be used with little modification. The cost of the biocrudes obtained is primarily dependent upon the cost of the raw vegetable oil(Mesu ferrea L oil) and the hydroprocessing cost as expressed in equation (1). While about 35% of the oil cost is accountable as hydroprocessing cost as expressed in equation (2).

$$\text{Cost of crude oil per liter (C)} = \text{R} + \text{H (INR)} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where, R = Cost of raw oil per liter (INR)

Hydroprocessing cost per liter (H)

$$= 0.35 \times \text{R (INR)} \cdots\cdots\cdots\cdots\cdots\cdots (2)$$

The cost of the distillates can be calculated using equation (3) and equation (4) which are very much similar to the distillation products of petroleum crude oil.

$$\text{Total cost of light distillates (LD) per liter} = \text{D} + \text{T} + \text{D}' + \text{DM (INR)} \cdots\cdots\cdots\cdots (3)$$

$$\text{Total cost of heavy distillates (HD) per liter} = \text{D} + \text{T} + \text{D}'' + \text{DM (INR)} \cdots\cdots\cdots (4)$$

Distillation cost factor for light distillates (D')

$$= 0.10 \times \text{C(INR)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where, Distillation cost factor (D) $= 0.74 \times \text{C (INR)} \cdots\cdots\cdots\cdots (5)$

$$\text{Taxation cost factor (T)} = 0.11 \times \text{C (INR)} \cdots\cdots\cdots\cdots\cdots\cdots (6)$$

Distillation cost factor for heavy distillates (D'')

$$= 0.25 \times \text{C(INR)} \cdots\cdots (8)$$

Distribution and marketing cost factor (DM)

$$= 0.05 \times \text{C(INR)} \cdots\cdots (9)$$

Initially, the MFL seed oil was procured @ Rs. 15 per L and thus the cost of hydroprocessed biocrude was about Rs. 20 per L. Therefore, the cost of the biocrude distillates was found be very similar to the prevailing cost of petroleum crude oil distillates.

Two other previously reported catalysts for transesterification viz. MBCUS(Musa Balbisiana Colla underground stem Nanomaterials) and BBTPFS (Biomass based thermal power plants fly ash, mixture of oilseed husk and stalks were used as the feed stock of the power plant) were also employed to study the hydroprocessing activities with the vegetable oil. However, these two catalyst were found less efficient as compared to Na_2CO_3 (pure). Moreover, the hydroprocessing of waste cooking oil (WCO) into green hydrocarbons particularly green gasoline and green diesel and their performance evaluation using CI engine is also ongoing activity under chemical conversion division. In addition, the up-gradation of biocrude residue obtained from the hydroprocessing of vegetable oils with petrodiesel through co-processing is another thrust of this division. The optimization of process parameters for hydroprocessing of the vegetable oils using modified catalysts and their subsequent fractional distillation into renewable hydrocarbons and the evaluation of the fuel properties of the different fractions obtained as per ASTM and EN standards will be carried out in next phase.

Further, the biomass derived catalysts that were used earlier for tranesterification viz. MBCUS and BBTPFS were modified with the incorporation of Ni/Co/Mo salts in requisite quantity in order to enhance their catalytic activities. The synthesized catalysts were characterized with the help of advanced modern analytical tools like FE-SEM, TEM, XRD etc. at Institute Instrumentation Center, IIT Roorkee. Further study continues for modification of the catalyst, its effectiveness for various reactions etc. Research activities started for conversion of crude glycerine to value added fuel additive via organic synthesis route. In the first round of experiments it was found that 84% glycerine could be converted to solketal, an additive of petrol and diesel. The work is in progress.

8.2 Ongoing Projects:

- **Process development for bioethanol production from agricultural residues, Phase-I: Development of process for co-fermentation of hexose and pentose sugars of agricultural residues (PI: Dr. Sachin Kumar) (MNRE, Govt. of India)**.

MNRE funded research project on 'Process development for bioethanol production from agricultural residues, Phase-I: Development of process for co-fermentation of hexose and pentose sugars of agricultural residues' is undergoing since May 2012. The total cost of the project is INR 132.19 Lakhs for three years. Two thermotolerant yeasts namely NIRE-K1 and NIRE-K3 were isolated from the soil samples and screened for ethanol fermentation with high ethanol yield and ability to utilize both pentose and hexose sugars. Both the isolated yeasts have been identified by Microbial Type Culture Collection and Gene Bank, Institute of Microbial Technology, Chandigarh as *Kluyveromyces marxianus*. Both the strains have been found to be

distinct characteristics as genetically as well as functionally. Both *K. marxianus* NIRE-K1 and NIRE-K3 showed the diauxic growth on hexose and pentose sugars. Both the strains are able to utilize the sugars present in the crop residues including paddy straw after enzymatic saccharification at 45^0C.

A study was carried out for the optimization of medium components (yeast extract, di-potassium hydrogen phosphate, sodium di-hydrogen phosphate, magnesium sulphate, ammonium sulphate) using RSM using Design-Expert software Version 8.0 software for both the isolates *K. marxianus* NIRE-K1 and NIRE-K3 to increase ethanol production. Face-centered Central Composite Design (FCCD), with quadratic model was employed to study the combined effects of the salts. Dependent variable or response was maximum specific growth rate (h^{-1}) for optimization of growth. Equations were calculated with the statistical package (Stat-Ease Inc, Minneapolis, MN, USA) to estimate the response of the dependent variable. To validate the authenticity of software generated model, a confirmation experiment with duplicate set was performed under optimized concentrations of all the salts. The results were very close to the predicted value. Data indicates that the established model is reliable. The optimized media parameter (in g/L) for *K. marxianus* NIRE-K1 (yeast extract-4.3, di-potassium hydrogen phosphate-1.98, sodium di-hydrogen phosphate-0.15, magnesium sulphate-0.27, ammonium sulphate-1.9) and *K. marxianus* NIRE-K3 (yeast extract-2.78, di-potassium hydrogen phosphate-1.22, sodium di-hydrogen phosphate-0.18, magnesium sulphate-0.12, ammonium sulphate-1.97) have been obtained.

A comparative study was carried out between two thermotolerant yeast such as *Kluyveromyces marxianus* NIRE-K1 and NIRE-K3 and two mesophilic yeast such as Saccharomyces cerevisiae MTCC 170 and Candida tropicalis MTCC 230 through an assay showing xylose transporter for the transportation of xylose sugar. An assay was done at 5 ^{0}C temperature interval to know the optimized temperature using the xylose analog p-nitrophenyl-β-D-xylopyranoside (pNPX) to detect the expression of β-xylosidase activity in its intact, intracellular and extracellular cell. Out of all type of yeasts, S. cerevisiae MTCC 170 showed very little growth in xylose containing medium without any utilization of xylose sugar and further showed zero xylosidase activity with intact, extracellular and intracellular cells. All the strains showed optimized temperature for the highest xylosidase activity which was higher than that of the growth temperature (Table 1).

Table 1. Optimized temperatures of three types of yeast showing xylosidase activity

Strain	Cell Type	Optimized temperature (^{0}C)	pNP (nmol/mg DCW)
Kluyveromyces marxianus NIRE-K1	Intact	50	138
	Intracellular	50	1.54

	Extracellular	60	2.09
Kluyveromyces marxianus NIRE-K3	Intact	50	148.6
	Intracellular	50	1.76
	Extracellular	60	2.33
Candida tropicalis MTCC 230	Intact	45	85.56
	Intracellular	35	0.48
	Extracellular	35	1.66

The activity of xylose transporters for both the isolates has been carried out and comparison has been made between wild and adapted strains. A comparative study was carried out using adapted and wild cells of *K. marxianus* NIRE K1 and *K. marxianus* NIRE K3 through an assay showing xylose transporter activity. An assay was carried out using the xylose analog p-nitrophenyl-β-D-xylopyranoside (pNPX) to detect the expression of β-xylosidase activity in its intact cells. In general, pNPX is absorbed by the cell through transporter and is cleaved into p-nitrophenol (pNP) by xylosidase in vivo. The yellow compound pNP is then secreted and detected outside the cell. In this study, the intact cell xylosidase activity (the conversion rate of pNPX to pNP) of the strain was measured showing the expression of xylosidase gene. The amount of pNP secreted by the yeast cells showed time-dependent linearization even in 120 min. The result revealed that the intact cell activity of adapted *K. marxianus* NIRE K1 yeast was higher than wild yeast as 0.23 ± 1.26 and 0.19 ± 0.2 U (g DCW)$^{-1}$, respectively as shown in Fig. 1. Similarly, adapted cells of *K. marxianus* NIRE K3 yeast was higher than the wild one as 0.19 ± 0.02 and 0.18 ± 0.29 U (g DCW)$^{-1}$, respectively (Fig. 1). However, the wild and adapted cells of *K. marxianus* NIRE K1 showed 5.3 and 17.4% higher xylosidase activity than the *K. marxianus* NIRE K3 yeast cells.

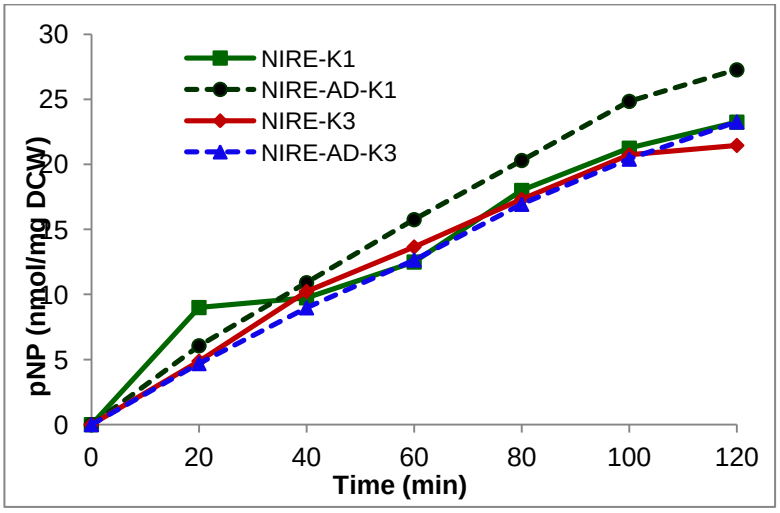


Fig. 1. Xylose transporter activity among adapted and wild isolates

- **Biogas production and utilization for heat and power generation applications using potential alternative feed-stocks (PI: Dr. Sachin Kumar) (MNRE, Govt. of India).**

A consortium of thermophiles was isolated from the soil samples. The thermophilic consortium of microbes was able to digest water hyacinth and crop

residue such as paddy straw anaerobically at 50-55^{0}C and able to produce with 60-65% methane composition. The consortium has been applied for the digestion of paddy straw and kitchen wastes anaerobically for biogas production in a temperature range between 50-55^{0}C. The paddy straw was digested in a short period of time i.e. 12-20 days as compared to conventional digestion with cow dung as 40-50 days for producing same amount of biogas. The biogas yield was found to be 350 L/kg of paddy straw with methane composition of 60%. The optimization of different conditions/operating parameters such as temperature, seed concentration, urea concentration, pH, solid loading, etc. is going on using RSM using Design-Expert software Version 8.0 software. The screening and identification of different bacteria in consortium is also going on.

- **Biomass Cookstoves Testing and Certification Center at NIRE, Kapurthala (PI: Dr. S. K. Tyagi) (MNRE, Govt. of India).**

A project entitled "Biomass Cookstoves Testing and Certification Center at NIRE, Kapurthala" has been sanctioned with an outlay of Rs. 97.908. The work in this direction has started with the main objective is to develop a Testing and Certification Center for the State of Punjab, Haryana, HP and J&K and also to carry out the basic RD&D activities in the area of biomass cookstove with higher efficiency besides, to provide necessary technical assistance to different stakeholders in this region of the country. The detailed objectives of the project are as follow:

i) Establishment of well-equipped laboratory facility for carrying out performance testing of biomass improved cookstove per latest BIS norms (August 2013).
ii) Development of standards and test protocols for cookstove and fuel.
iii) Technical assistance/testing to biomass cookstove stakeholders in the region.
iv) To conduct training on operation and maintenance for SNA's, NGO's, Project developers, Industry etc. engaged in the implementation and promotion of cookstove in consultation with MNRE.
v) To carry out random field performance monitoring and evaluation biomass cookstove including indoor air quality near the kitchen space in the consultation with MNRE.
vi) Any other activities assigned by MNRE.

The establishment of the testing and R&D facilities for improved biomass cookstove is completed and the design and development of low cost durable and locally acceptable biomass cookstoves is on-going.

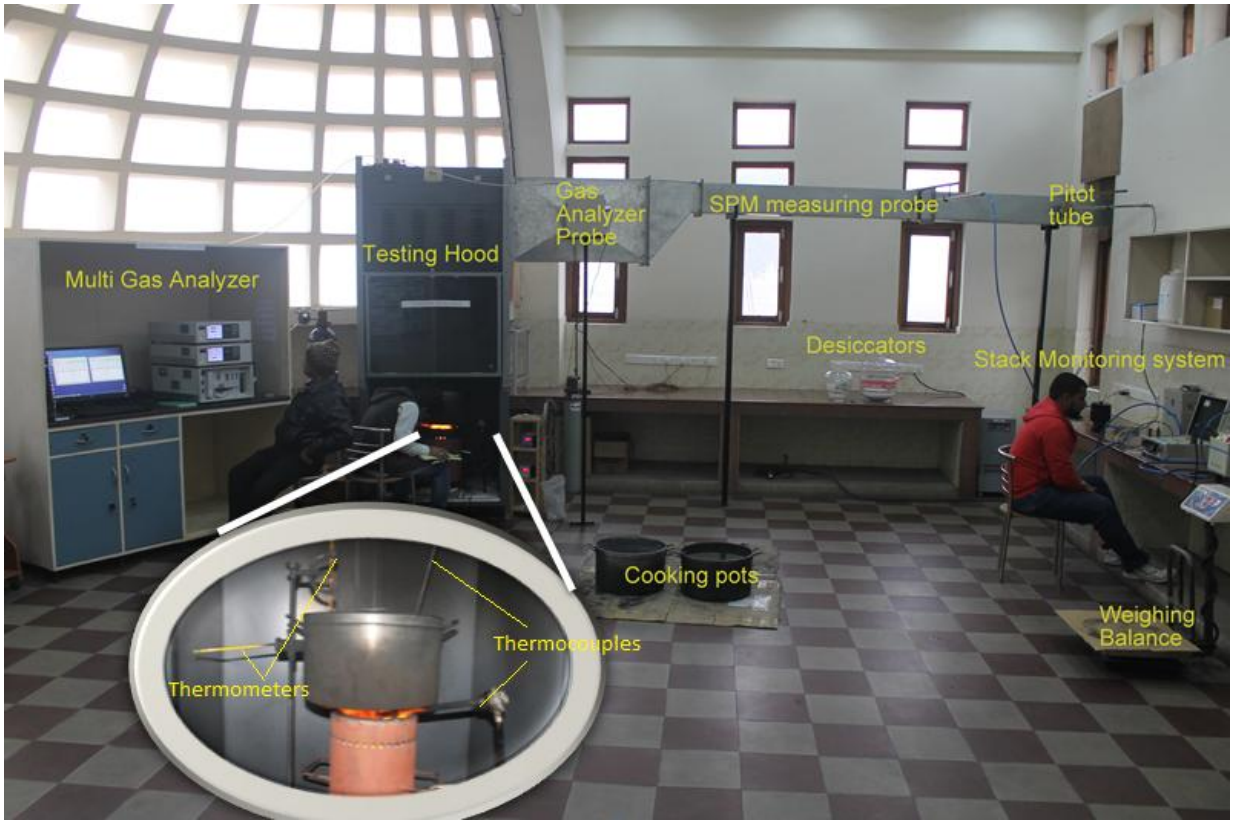


Fig 2: Biomass Cookstove Testing & Certification Centre at SSS-NIRE

8.3 Biodiesel Production Laboratory

The R&D activities on biodiesel production and application in CI engine for performance and emission characteristics using some other varieties of nonedible oil such as neem, moringaoleferia, bitter apricot and karanja were conducted. The experimental investigation under variable load condition with karanja biodiesel having B10 to B40 shows that B30 is most suitable blend for CI engine due to its high 1st and 2nd law efficiency. Also oxygen content in the blends helps in better combustion. Exhaust analysis also showed that emission profile with respect to CO is less as compared to other tested fuels. Further the performance of B30 is comparable to petroleum diesel in all respect at full load condition. However, with neem biodiesel B10 was found to be the best fuel with respect to emission at maximum compression ratio and at highest load condition. The other performance parameters were comparable to petroleum diesel.

Similarly, the biodiesel obtained from moringa oleifera seed oil showed properties that meet ASTM D 6751 and En14214 with respect to % conversion, flash point, density, viscosity, carbon residue etc. Performance of the engine at all compression ratios showed a nominal overall decrease in the brake power with increase in blend ratio. Brake power was higher at higher compression ratio. The brake thermal efficiency in the blends decreased with the increasing % biodiesel in the blend.

The biodiesel production and process optimization was carried out for bitter apricot oil. Biodiesel production and glycerol separation with this oil is very easy and could be achieved in a single step with alkali catalyst. The biodiesel obtained was also properly characterized for fatty acid composition, fuel properties and subsequent engine performance analysis upto B40. B10 and B20 blends showed highest 1st and 2nd law efficiency which is also higher than petroleum diesel at maximum compression ratio (1:18).

All these observations showed that neem, karanja, moringa and bitter apricot oil can be effectively used for biodiesel production and utilization at domestic level because these oilseeds are locally available in Punjab, Himachal and Haryana.

8.4 Power generation using algal fuel cell in a biorefinery approach

Water samples were taken from the Kanjli Lake, Kapurthala and neighbouring paddy fields. Some samples were also collected from soil, digs, stones, tanks within SSS-NIRE premises. These were inoculated into Erlenmeyer flasks with appropriate growth medium (BG11). The flasks were kept in culture racks under proper illumination and temperature. When growth was observed, serial dilution technique was employed for isolation of monoalgal cultures. Streaking and spreading was also done, wherever needed. To maintain the purity of cultures, appropriate dosage of different antibiotics were used. Cultures were observed under microscope regularly and some pure colonies were obtained as shown in Fig. 3. The algal strains isolated so far, are *Anabaena*, *Chlorella*, *Phormidium* and *Scenedesmus*. These were maintained in laboratory by proper sub-culturing. *Chlorella* was mass cultured up to 50L volume and the biomass was harvested as shown in Fig. 4. Biochemical characterization of this alga is in progress along with other isolated strains. The efforts are to isolate more strains which can prove to be beneficial for the experiment.

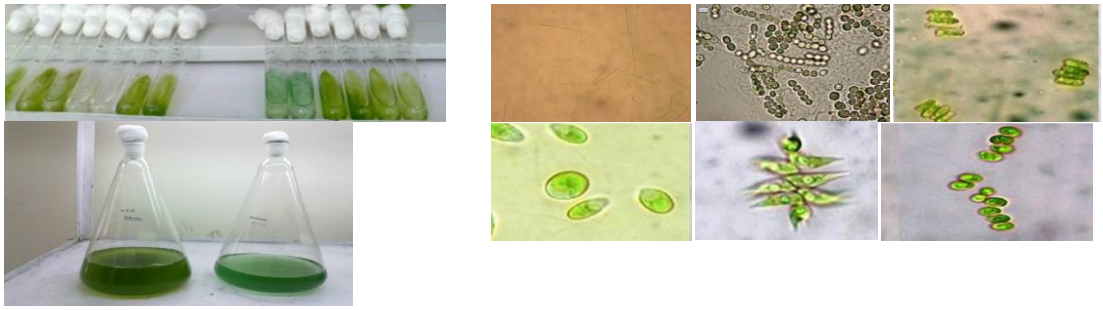


Fig. 3:Isolated algal species

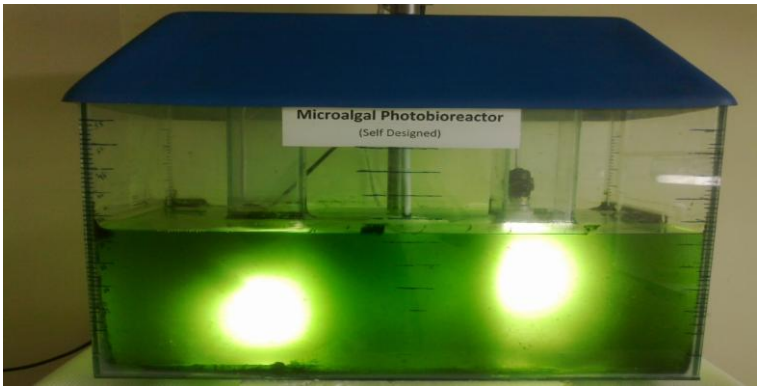


Fig. 4: Large scale production of algal species

8.5 Biomass Characterization and Generation of Database

Under this activity the variety of biomass samples such as Prosopis juliflora, Eucalyptus, Albizia procera, Melia sp., Pigeon pea (Arhar Dal), Mulberry sp. wood stalks and mixed variety of mango seeds have been characterized for macroscopic analysis including proximate analysis, ultimate analysis, determination of particle size, bulk density, calorific value, ash, fusion temperature, etc. and microscopic analysis including thermal properties, chemical kinetics, and mineral data, etc.

Proximate analysis data showed the moisture contents of biomass samples varied between 5 to 8% (by weight), and may be useful for Small Scale downdraft Gasifier as biomass feedstock. Volatile Matter of Melia wood stalk was found to be maximum (83.79 %) and it was observed lowest for (77%) mango seed. Maximum (16.32%) fixed carbon content was observed for mango seeds whereas Pigeon pea has the lowest (7.44%). Ash of biomass samples observed was in the range of 0.7 to 2.5%. The generation of database for different biomass is also in process for future RD&D activities.

8.6 Development of Biomass Gasifier Testing Centre

The comparison of three different biomass feed stocks has been investigated for 10 kW Downdraft Gasifier. The biomass feed stocks such as, mango seed, eucalyptus and melia wood stalks were selected. Mango seed was selected as it is a waste material available in abundance in India and also possesses high dry density, high HHV value and high fixed carbon content. Eucalyptus and Melia wood stalks are also selected because of their availability in bulk, high calorific value and comparatively low activation energies.

The gasifier system was operated as close as possible to the typical operation conditions with Mango seed, Eucalyptus and Melia feedstock as the fuel. The operation of Ankur WBG-20 gasifier was quite smooth and easily manageable with

minimum man power requirement. Steady state syngas composition for each feed stock was determined by GC.

An R&D project entitled "Establishment of Gasifier Testing & Certification Centre at NIRE, Kapurthala" is being prepared and likely to be submitted to MNRE for funding.

8.7 Dissemination of Cookstoves through Carbon Financing

The Program of Activities (PoA) on National Program on Improved Cookstoves in India along with the very first CPA (CPA1) was prepared in coordination with MNRE, GIZ, New Delhi and South Pole Carbon Consultant, New Delhi and submitted to UNFCCC and Gold Standard and finally registered and eligible for EUETS.

Furthermore, the Institute as the Coordinating and Managing Entity (CME) with technical support from GIZ, New Delhi has initiated the inclusion of more CPAs, out of 03 targeted for 2014-15, one from "Grassroot Trading Network for Women" as section 25 company under Self Employed Women Association (SEWA) Ahmadabad (Gujarat) has been matured by signing the required documents and they have disseminated more than 1000 nos. of cookstoves in the field. Few more are being encouraged and some has contacted through interactions during the meeting and presentations held at MNRE, New Delhi and BREDA, Patna and are likely to initiate the process in the near future.

9. COLLABORATION WITH OTHER ORGANIZATIONS

The Institute is having active R&D and academic collaboration with the following organizations:

1. Punjab Technical University, Jalandhar
2. National Institute of Technology, Jalandhar
3. Panjab University, Chandigarh
4. Punjab Agriculture University, Ludhiana
5. Tezpur University, Tezpur

International Collaboration in progress with

1. South Dakota School of Mines & Technology, USA
2. Cape Peninsula University of Technology, South Africa

Three B.Tech and one M.Sc and four M. Tech., students from NIT Jalandhar have completed their projects while, four Ph. D. students are working for their Thesis in collaboration with NIT, Jalandhar and PTU, Kapurthala.

10. IMPORTANT EVENTS

10.1 FIRST INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN BIOENERGY RESEARCH-2015:

The First International Conference on "Recent Advances in Bio-energy Research" ICRABR-2015 was organized by Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala during March 14-17, 2015. The conference was started with a scintillating inaugural function on March 14, 2015. Shri Upendra Tripathy, Secretary, MNRE inaugurated the event as Chief Guest by lighting up the lamp followed by Dr. B.S. Dhillon, Vice-Chancellor, Punjab Agricultural University, Ludhiana as Guest of Honour, Dr. N.P. Singh, Adviser, MNRE, Prof. B.S. Pathak, Former Director, SPRERI, Vallabh Vidhyanagar, and Shri Balour Singh, Director, PEDA, Chandigarh as Distinguished Guests whereas Prof. Y.K. Yadav, Director, NIRE presided over the conference as Chairperson.

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MNRE Union Secretary inaugurates ICRABR 2015

DP CORRESPONDENT
Kapurthala

Union government identified the need of bio-energy potential and the importance and necessity of renewal energy in present day context and Ministry of New and Renewal Energy has defined a road map from conversion from conventional energy to renewal energy and budgeted a great share for the same and especially in the field of Research and Design, these words were expressed by Upendra Tripathy, Secretary, Ministry of New and Renewable Energy, Government of India, while talking to *Daily Post*, he had been in Kapurthala to inaugurate the first International Conference on 'Recent Advance in Bio-energy Research (ICRABR-2015) on Saturday organised by SSS-NIRE, MNRE (GOI) was held at convention hall of Pushpa Gujral Science City Kapurthala.

He also stated that government under National Solar Mission planned for setting up of 15,000 MW grid connected solar power plant through NTPC Ltd.

In three phases and during first phase from 2014-15- 2016-16, 3000 MW solar energy will be produced through solar plants while in second phase from 2015-16 to 2017-18, 5000 MW and in third phase from 2016-17- 2018-19, 7000 MW energy through solar plants are targeted. He said that SSS, NIRE, Kapurthala going to play an important role in the coming few years for developing renewal energy in India.

Prof Y K Yadav, Director of SSS-NIRE highlighted the achievement of the institute so far in the area of Bio-Energy research and also stated the present scenario of resources available and need to move from fossil fuels to renewable resources. He pointed out the recent achievement in heterogeneous catalysis for conversion of waste oil and agricultural residue to valuable end products,

Prof B S Dhillon, Vice Chancellor, PAU, Ludhiana as Guest of Honour of the function pointed out that Brazil and USA are still playing the leading role in ethanol production and applications from agricultural crops residue. India has an enormous scope of production of bio-fuels from the surplus agricultural residue.

Besides different scholars in the field of bio-energy from India , foreign scholars including Dr Lalini Reddy of CPUT in South Africa, Dr Ibn Abubakar from University of Maiduguri in Nigeria, Dr Hanna Tashyreva from the National Academy of Science of Ukraine, Dr Vijay K Gupta from School of Natural Science, Discipline of Biochemistry in Ireland, also addressed the conference.

Also, a souvenir ICRABR was also released by the chief guest.

Union Secretary while addressing the conference on Saturday in Kapurthala. DP

India has an enormous scope of production of bio-fuels from the surplus agricultural residue

The prominent personalities among delegates from overseas were Dr Lalini Reddy, Cape Peninsula University of Technology, Cape Town, South Africa, Dr. Hanna Tashyreva, Zabolotny Institute of Microbiology and Virology of National Academy of Sciences of Ukraine, Kyiv, Ukraine and Dr. Baba Shehu Ibn Abubakar, University of Maiduguri, Nigeria. Other personalities present in the inaugural function were Prof. A.K. Jain, Former Director, NIRE and Dean, School of Environment & Earth Sciences, Central University of Punjab, Bathinda, Dr. D. K. Adhikari, Chief Scientist, Indian Institute of Petroleum, Dehradun, Dr. R.C. Ray, ICAR- CTCRI (Regional Centre), Bhubaneswar, Mr. Vasudeo Joshi, Praj Industries Limited, Pune, Dr. A.S. Mathur, IOC-DBT Centre, R&D Centre, IOCL, Faridabad, Dr. Bijan Choudhury, IIT Roorkee, Dr. P. Dhamija, Senior Director MNRE, Dr. V. K. Jain, Director, MNRE, Dr. Sachin Kumar, Organizing Secretary, ICRABR-2015, introduced the audience regarding the conference and emphasized on the objective of the conference. The vote of thanks was delivered by Dr. A.K. Sarma, Convener, ICRABR-2015.

कपूरथला/फगवाड़ा

जागरण सिटी

शहीदों को मिले भारत रत्न का सम्मान : नरेश पंडित

दैनिक जागरण

साइंस सिटी में रविवार को आयोजित समारोह के दौरान शामिल एनपी सिंह, प्रो. बीएस पाठक व अन्य सदस्य।

बायो फ्यूल के उपयोग से बढ़ेगी एनर्जी सुरक्षा

- साइंस सिटी में बायो एनर्जी पर अंतरराष्ट्रीय कांफ्रेंस का दूसरा दिन
- वक्ताओं ने बायो एनर्जी की उपयोगिता पर पेश किए विचार

जागरण संवाददाता, कपूरथला : हावर्ड यूनिवर्सिटी यूएसए के प्रो. राम गुप्ता ने बायो फ्यूल के जैविक पदार्थों से उत्पन्न होने वाले इथेनोल, बायो डीजल, हाइड्रोजन के विस्तृत रूपों पर प्रकाश डालते हुए कहा कि बायो फ्यूल का इस्तेमाल ट्रांसपोर्टेशन के रूप में करके हम वातावरण को दूषित होने से बचा सकते हैं। इससे ग्रीन हाउस गैस का प्रभाव कम होगा। ग्रामीण क्षेत्रों में लोगों को रोजगार मिलेगा और वातावरण को स्वच्छ रखने में मदद मिलेगी। इससे एनर्जी सुरक्षा भी बढ़ेगी।

प्रो.राम गुप्ता ने उक्त विचार सरदार स्वर्ण सिंह राष्ट्रीय अक्षय उर्जा संस्थान कपूरथला की तरफ से स्थानीय पुष्पा गुजराल साइंस सिटी में बायो एनर्जी पर आयोजित पहले अंतरराष्ट्रीय कांफ्रेंस को संबोधित करते हुए व्यक्त किए। इससे पूर्व इंडियन आयल कारपोरेशन फरीदाबाद के हेड एएस माथुर ने इथनोल में उपयोग होने वाली प्रकिया की लागत कम किए जाने के तरीकों पर प्रकाश डाला।

इंस्टीट्यूट आफ माइक्रवेल टेक्नालॉजी चंडीगढ़ के प्रिंसिपल व वैज्ञानिक डॉ. डीके साहू ने एल्गी के महत्व के संबंध में जानकारी देते हुए इससे उत्पन्न होने वाले विभिन्न बायो फ्यूल को रिन्यू करने से होने वाले लाभों के बारे में बताया। इस मौके पर वीडियो कांफ्रेंस के जरिए यूएसए के डाट माउथ कॉलेज आफ इंजीनियरिंग के प्रो. ली लेनट ने खाद्य सुरक्षा व उर्जा सुरक्षा के महत्व पर प्रकाश डाला। सरदार स्वर्ण सिंह राष्ट्रीय अक्षय ऊर्जा संस्थान के निदेशक प्रो. योगेंद्र कुमार यादव ने कहा कि बायो एनर्जी बहुत महत्वपूर्ण है।

पेट्रोलियम पदार्थों के अधिक उपयोग से वातावरण दूषित हो रहा है। वातावरण को सुरक्षित रखने के लिए 2017 तक 10 फीसदी लिक्विड फ्यूल एथनोल पैदा करने का लक्ष्य है। एथनोल को पैट्रोल में मिलाने से पैट्रोल का प्रदूषण कम होगा। इस एथनोल को पैदा करने के लिए हमारे पास 125 मिलीयन टन कच्चा माल उपलब्ध है और यह सारा कच्चा माल एग्रीकल्चर वेस्ट से प्राप्त होगा। दूसरे दिन तीन बराबर सेशन में अलग-अलग स्थानों से आए वक्ताओं ने अपने विचार पेश किए जिसमें जैविक प्रक्रम, रसायन, थर्मो केमीकल आदि पर चर्चा हुई। सेशन की अध्यक्षता डॉ. पीएस पाठक व साउथ अफ्रीका से डॉ. ललनी रेडी की ओर से संयुक्त रूप से की गई।

समारोह के दौरान बायो एनर्जी संबंधी जानकारी देते हुए एसएसए के निदेशक डॉ. योगेंद्र कुमार यादव व डॉ. वीसी पाठक

The plenary speeches were conducted after the inauguration function. The eminent speakers including Prof. B.S. Pathak, Dr. Lalini Reddy, Dr. Abubakar, Dr. Hanna Tashyreva, Prof. A.K. Jain, Dr. D.K. Adhikari, Mr. Vasudeo Joshi, Dr. A.S. Mathur, Dr. R.C. Ray, Dr. D.K. Sahoo, Prof. I.M. Mishra and Mr. Parikshit Dhingra delivered the plenary speeches. Two plenary speeches were conducted through video conferencing by Prof. Lee R. Lynd, Thayer School of Engineering, Dartmouth College, USA and Prof. Ram B. Gupta, School of Engineering, Virginia Commonwealth University, USA.

Prof. Pathak emphasised on the resources available and their characteristics for biofuels production in India. Dr. Lalini Reddy covered the renewable energy strategies adopted in South Africa. Dr. Abubakar targeted the status of bioenergy and its future in Nigeria. Dr. Tashyreva presented the application of aboriginal soil microbial communities for hydrogen production from food wastes in different continents. Prof. A.K. Jain covered the possible ways of biomass utilization for biofuels applications using decentralized energy systems. Dr. D.K. Adhikari explained the importance of aviation biofuels and technologies to convert renewable feedstock to green aviation fuels with a target to make it

sustainable and economic as compared to fossil based jet fuel. Mr. Vasudeo Joshi elaborated the role of Praj Industry in "Smart Biorefinery" for 2nd Generation Technology. Dr. A.S. Mathur emphasised on lignocellulosic ethanol and need for establishing cellulase production capabilities. Dr. R.C. Ray presented the prospects and limitations of the bioprocessing of sweet potato for bioethanol production. Dr D.K. Sahoo described the opportunities and challenges for bioethanol production from algal biomass. On the last day of the event, Prof. I.M. Mishra described the technological challenges in the biomass pyrolysis, whereas, Mr. Parikshit Dhingra emphasised on commercialized clean technologies and need for quick adoption. Prof. Lee R. Lynd presented his views through video and described the importance of land, food, and bioenergy in relation to the great challenges of our time. Prof. Ram B. Gupta beautifully shared his views through audio presentation and described the emerging technologies for biocrude, organic solar cells, renewable hydrogen via solar water splitting, electrical energy storage and flow batteries and emerging concepts like gasoline from coal with CO_2 sequestration and magnetic air conditioners.

8 कपूरथला/फगवाड़ा

अंतर्राष्ट्रीय सम्मेलन में वैज्ञानिकों ने पेश किए अपने-अपने विचार

■ कहा-भारत ऊर्जा की दुनिया का सबसे बड़ा चौथा उपभोक्ता

Fifteen technical sessions were conducted in three parallel sessions each day with the different themes such as Biomass & Energy Management; Thermo-chemical Conversion; Biochemical Conversion; Chemical Conversion; Electrochemical Processes; and Integrated/Waste to Energy. About ten invited speakers delivered their research findings and review papers. More than thirty participants read their findings through oral presentation whereas thirty eight participants through poster presentation.

About two hundred and eighteen abstracts were published in the souvenir under the different sections including 23 in plenary speakers, 15 invited speakers, 59 biochemical conversion, 50 chemical conversion, 16 biomass and energy management, 25 thermo-chemical conversion, 10 electrochemical processes, 6 waste to energy and 14 integrated systems. Due to rescheduling of the event, some of the speakers/participants could not manage their participation. However, about 10 invited speakers and 70 participants read their findings in oral and poster presentations. On the last day of event, one session was conducted for the formation of 'Bio-Energy Alliance'. During the session, the representatives of different organizations including academic and research institutions, universities, industries and foreign delegation were present and agreed with full support to originate Bio-Energy Alliance with the following objectives:

1. To provide a platform for all stakeholders, from policy makers to end-users, to interact and facilitate progressive supplementing and replacement of petroleum fuels by biofuels.
2. To make recommendations to different national and international funding agencies including government departments (both public and private sector) for allocation of funds for R&D in selected areas of bio-energy.
3. To encourage networking between R&D institutions and joint projects between R&D institutions and industries.
4. To bring to the attention of policy makers such issues which need to be addressed to facilitate the development/improvement of bio-energy and bio-fuel technology.

अजीत समाचार, जालन्धर

जिला व

सरस्वती पूजा के लिए दीप प्रज्वलित करते हुए संस्थान के डायरेक्टर डा. जोगिंदर यादव व सरस्वती वंदना दौरान उपस्थित वैज्ञानिक। (छाया : बजाज)

KAPURTHALA

प्रो: बी.एस. पाठक पूर्व डायरेक्टर सपरेरी को कांफ्रेंस दौरान सम्मानित करते हुए डायरेक्टर डा. जोगिंदर यादव उनके साथ स्वर्ण सिंह बोपाराय व उपस्थित वैज्ञानिक और गणमान्य। (छाया : बजाज)

कार्यक्रम को संबोधित करते हुए पूर्व सचिव केंद्रीय गैर रिवायती ऊर्जा मंत्रालय भारत सरकार स्वर्ण सिंह बोपाराय। (छाया : बजाज)

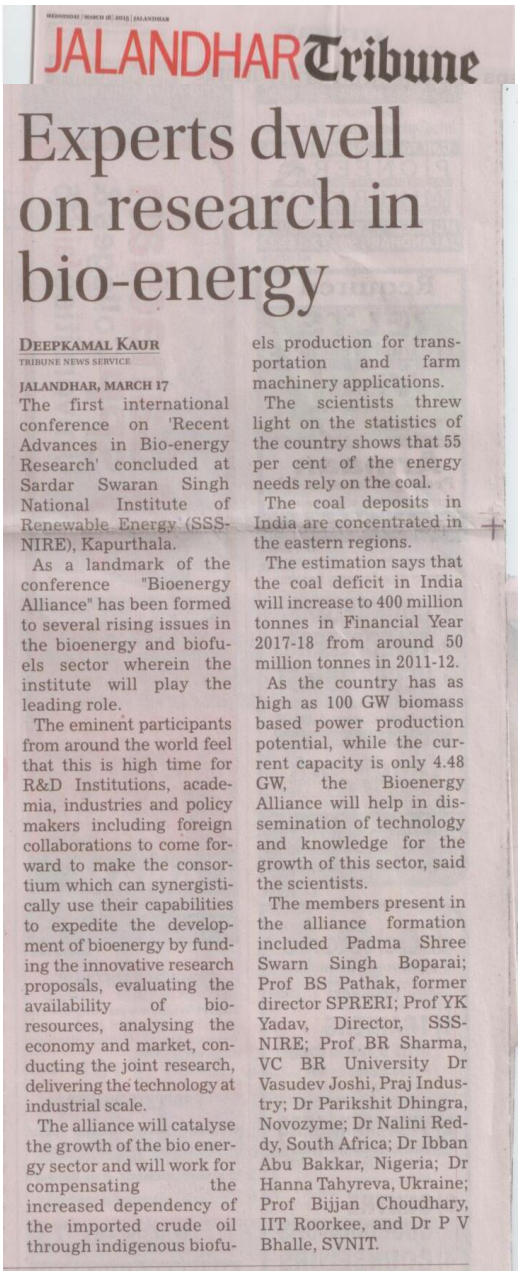
जैविक ऊर्जा से पंजाब में बिजली की कमी पूरी की जा सकती है : स्वर्ण सिंह बोपाराय

• बॉयोएनर्जी एलायंस की स्थापना से अंतर्राष्ट्रीय कांफ्रेंस संपन्न • पराली की समस्या के निजात के लिए ग्रुप बनाया गया : डॉ. यादव

5. To organize exchange visits of scientists and technology suppliers.
6. To organize round table and brain storming sessions/conferences/workshops, etc. on bio-energy.
7. To bring out bio-energy and bio-fuel news letter for wider dissemination and to create awareness.
8. To interact with other national and international organizations having similar objectives and programmes.

The conference was come to an end with the valedictory function under the Chairmanship of Dr. Y.K. Yadav, Director, SSS-NIRE. Padma Shri Sardar Swarn Singh Boparai, Former Secretary, MNRE as Chief Guest, Prof. Ved Raj Sharma, Vice-Chancellor, SBBS University, Jalandhar as the Guest of Honour and Prof. B.S. Pathak, Former Director as distinguished guest. Other dignitaries including Dr. Baba Shehu Ibn Abubakar, University of Maiduguri, Nigeria, Prof. I.M. Mishra, IIT Roorkee, Mr. Parikshit Dhingra, Novozymes South Asia Pvt. Ltd., Dr. Swaranjit Singh, IMTech, Chndigarh, Dr. R.C. Ray, ICAR- CTCRI (Regional Centre), Bhubaneswar, Mr. Vasudeo Joshi, Praj Industries Limited, Pune and Dr. Bijan Choudhury, IIT Roorkee were also present. All the invitees and participants shared their experiences during the conference and gave their feed-back, while appreciating the function as a grand success.

Finally, the Chairperson of the Conference Dr. Y.K. Yadav, Director, NIRE expressed his full satisfaction for the successful organization of the First International Conference on "Recent Advances in Bio-energy Research" (ICRABR-2015). He appreciated the hard work of the NIRE staff for making the necessary arrangements for the successful organization at the Institute. He also announced the organization of Second International Conference next year at the Institute.



JALANDHAR Tribune

Experts dwell on research in bio-energy

DEEPKAMAL KAUR
TRIBUNE NEWS SERVICE

JALANDHAR, MARCH 17

The first international conference on 'Recent Advances in Bio-energy Research' concluded at Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), Kapurthala.

As a landmark of the conference "Bioenergy Alliance" has been formed to several rising issues in the bioenergy and biofuels sector wherein the institute will play the leading role.

The eminent participants from around the world feel that this is high time for R&D Institutions, academia, industries and policy makers including foreign collaborations to come forward to make the consortium which can synergistically use their capabilities to expedite the development of bioenergy by funding the innovative research proposals, evaluating the availability of bio-resources, analysing the economy and market, conducting the joint research, delivering the technology at industrial scale.

The alliance will catalyse the growth of the bio energy sector and will work for compensating the increased dependency of the imported crude oil through indigenous biofuels production for transportation and farm machinery applications.

The scientists threw light on the statistics of the country shows that 55 per cent of the energy needs rely on the coal.

The coal deposits in India are concentrated in the eastern regions.

The estimation says that the coal deficit in India will increase to 400 million tonnes in Financial Year 2017-18 from around 50 million tonnes in 2011-12.

As the country has as high as 100 GW biomass based power production potential, while the current capacity is only 4.48 GW, the Bioenergy Alliance will help in dissemination of technology and knowledge for the growth of this sector, said the scientists.

The members present in the alliance formation included Padma Shree Swarn Singh Boparai; Prof BS Pathak, former director SPRERI; Prof YK Yadav, Director, SSS-NIRE; Prof BR Sharma, VC BR University Dr Vasudev Joshi, Praj Industry; Dr Parikshit Dhingra, Novozyme; Dr Nalini Reddy, South Africa; Dr Ibban Abu Bakkar, Nigeria; Dr Hanna Tahyreva, Ukraine; Prof Bijjan Choudhary, IIT Roorkee, and Dr P V Bhalle, SVNIT.

Recommendations

The following recommendations were noted based on presentations and discussions held during the conference by eminent scientists and academicians:

1. The total potential of biomass for bio-power is substantially higher than 100 GW. A number of policies, including Feed-in Tariff, Renewable Purchase Obligation, and financial incentives (capital subsidy, interest subsidy, etc.), have been developed to promote bio-power. Although these served to trigger bio-energy development to some extent, the sector still faces problems. Only about 4.48 GW of bio-power capacity including cogeneration has been realized to date. The recommendation of the conference is that the technology evolution and investment opportunities must be spread among the stakeholder and Industrialist.

2. Over 150 million tonnes of surplus biomass, mostly crop residues, are burnt each year creating serious air pollution and causing loss of organic matter. This biomass is a valuable store of bio-energy and should be utilized to supplement the country's energy supply.

3. Proper geographic mapping of biomass production, collection and storage, characterization, supply, potential applications for power generation etc needs to be carried out. The premiere Industrialists of the country should take interest for biofuels production and power generation from these surplus agro-residues.

4. India is highly dependent on import of petroleum to meet the needs for transport and fraction fuels like alcohol. Biodiesel, bio-oil and other products having diesel and gasoline like characteristics. The surplus biomass should be preferably used for producing transport and fraction fuels.

5. India has a 5% ethanol blending mandate at present. Although National Bio-fuel Policy established in 2009 set an ambitious target of 20% blending for both ethanol and biodiesel by 2017, interest in India in biofuels - jatropha plantation in particular - appears to have died down to a large extent because of a number of factors. Thus new dimensions of rethinking in these issues and formulation of new panes such as installation of new plants for conversion of loose lignocellulosic biomass to bioethanol are urgently felt necessary.

6. Considerable R&D work has been done to develop technology for converting biomass to fuels. This activity need to be straightened on priority to expedite the development of economically viable and environment friendly technology of bio-fuel production.

7. In the biodiesel front Jatropha mission is not really successful in all the regions of the country due to climatic variations and environmental factors such as soil quality, proper agriculture knowledge etc. The conference recommends that all types of non-edible vegetable oils, waste fry oil, bio oil obtained from pyrolysis of biomass and algae have to be promoted as per availability in different regions of the country for liquid fuel substitution.

8. To achieve the above, a network of R&D institutions and industries should be formed to make simultaneous progress in all components, from biomass logistics to final product (biofuels) testing.

9. To facilitate fast progress and successful implementation of a time bound programme of development of bio-energy technologies, government should announce a Bio-Energy Mission with mandate to give desiccation to the programme and monitor its progress.

10. Thrust areas of R&D for liquid biofuels production, hydrogen generation, electrochemical processes using biochemical and chemical means for the next generation fuels were highlighted and recommended for transportation sector. New routes for generation of aviation fuel will certainly motivate the young generation.

10.2 TRAINING PROGRAMS ORGANIZED

a. National Training Program under Chemical Conversion

युवा वैज्ञानिकों को व्यावहारिक प्रशिक्षण का अनुभव प्राप्त करने के लिए प्रोत्साहित किया जाना चाहिए : प्रो. यादव

तीन दिवसीय राष्ट्रीय प्रशिक्षण कार्यक्रम में मौजूद प्रो. यादव व अन्य वैज्ञानिक। (दाएं) कार्यक्रम में मौजूद उपस्थितगणों के साथ वैज्ञानिक। - भास्कर

स्वर्ण सिंह राष्ट्रीय अक्षय ऊर्जा संस्थान ने तीन दिवसीय राष्ट्रीय प्रशिक्षण कार्यक्रम करवाया

भास्कर न्यूज़ | कपूरथला

नवीन एवं नवीकरणीय ऊर्जा मंत्रालय भारत सरकार के संस्थान स्वर्ण सिंह राष्ट्रीय अक्षय ऊर्जा संस्थान कपूरथला की ओर से गैर खाद्य वनस्पति तेलों से जैव इंधन के उत्पादन और लक्षण वर्णन की प्रक्रियाओं पर तीन दिवसीय राष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।

इस व्यवहारिक प्रशिक्षण कार्यक्रम का उद्घाटन भाषण में बताया कि वर्ष 2013-14 में भारत में करीब 158 मिलियन मीट्रिक टन पेट्रोलियम का इस्तेमाल किया। इसमें से करीब 83 प्रतिशत क्रूड का आयात किया गया। दूसरी और भारत में प्रति वर्ष 640 मिलियन टन बायोमास उपलब्ध है जिससे जैव इंधन का उत्पादन किया जा सकता है। अगर उपयोगी तरल और ठोस इंधन के रूपांतरण के लिए उपयुक्त प्रौद्योगिकी का औद्योगिकरण किया जा सके। क्योंकि देश में 20 प्रतिशत तरल जैव इंधन के विकल्प के लिए एक महत्वाकांक्षी योजना तैयार की गई है, जिसमें जैव इंधन का पेट्रोलियम आधारित इंधन के साथ इस्तेमाल किया जा सकता है। इससे गैर खाद्य वनस्पति तेल के व्यापार में निश्चित रूप से समय की मांग के साथ बढ़ौतरी होगी।

प्रो. यादव ने कहा कि युवा वैज्ञानिकों को व्यावहारिक प्रशिक्षण का अनुभव प्राप्त करने के लिए प्रोत्साहित किया जाना चाहिए। जिससे कि यह युवा वैज्ञानिक जैन इंधन के उत्पादन और इसके लक्षण वर्णन के क्षेत्र में अनुसंधान गतिविधियों में अपना योगदान कर सके।

इस प्रशिक्षण कार्यक्रम के आयोजक डा. एके सरमा ने प्रशिक्षण कार्यक्रमों के उद्देश्य विस्तार से बताते हुए कहा कि यह कदम देश में संसाधन विकास को सुविधाजनक बनाने और अंत में जैन ऊर्जा प्रौद्योगिकीय के क्षेत्र में विकास करने के लिए लिया गया है। इस प्रशिक्षण कार्यक्रम में देश के विभिन्न हिस्सों से आए हुए वैज्ञानिकों,शिक्षाविदों,एमटेक और पीएचडी अनुसंधान विद्यार्थियों ने हिस्सा लिया। कार्यक्रम के दौरान लक्षण वर्णन में विशेष रूप से आवश्यक परिष्कृत विश्लेषणात्मक उपकरणों और तकनीकों जैसे गैस क्रोमेटोग्राफी,फ्लैश सह आग बिंदु परीक्षक,घनत्व मीटर,ऑक्सीकरण स्थिरता इकाई,विज्ञान संबंधी विस्कोमीटर,टीबीपी आसवन इकाई और टीटरोमेट्रिक विधियों,इंजन और उत्सर्जन निरुपण आदि का सफलतापूर्वक प्रदर्शन किया गया। प्रशिक्षुओं ने प्रयोगशाला में काम करने और उपकरणों को संभालने के अनुभव पर प्रशिक्षण प्राप्त किया।

कार्यक्रम के दौरान जैव इंधन के क्षेत्र में काम कर रहे प्रख्यात वैज्ञानिकों द्वारा तीन विशेष व्याख्यान दिए गए। डा. थलंडा भास्कर वरिष्ठ वैज्ञानिक आईआईपी देहरादून कार्यक्रम के मुख्य वक्ता थे और अपनी प्रस्तुतियों में बताया कि कैसे थर्मोकैटलीटिक रूपांतरण की प्रक्रिया हमारे भविष्य के लिए बायोमास से तरल इंधन के उत्पादन के लिए उपयोगी है।

डा. आरएस ब्रिज ने सविस्तार अपना भाषण प्रस्तुत करते हुए कहा कि कैसे आंतरिक दहन इंजन लोकोमोटिव और कृषि क्षेत्र में इंजन के लिए जैव इंधन के संभावित उपयोगों के बारे में विस्तार से प्रकाश डाला। पंजाब केंद्रीय विश्वविद्यालय के डीन प्रो. एके जैन ने जैव इंधन रूपांतरण प्रौद्योगिकीय और भविष्य की पीढ़ी के लिए संभावित अनुप्रयोगों पर सामान्य भाषण दिया। प्रशिक्षण कार्यक्रम के समापन समारोह में संत लोंगोवाल इंस्टीट्यूट आफ इंजीनियरिंग और प्रौद्योगिकी,पंजाब के निदेशक प्रो. सुनील पांडे मुख्यातिथि थे।

उन्होंने जैन ऊर्जा के क्षेत्र में संस्थान में इस तरह के विश्व स्तर के लिए अग्रिम अनुसंधान सुविधाओं के विकास के लिए एसएसएस नीरे संस्थान के वैज्ञानिकों के प्रयासों की सराहना की। रसायनिक रूपांतरण के तहत अनुसंधान और तकनीकी टीम ने प्रयोग शालों में जैन इंधन की मौजूदा उत्पादन और लक्षण वर्णन प्रौद्योगिकीय का प्रदर्शन किया।

इस प्रशिक्षण में समापन दिवस समारोह के दौरान प्रतिभागियों ने संतोष दिखाया और कहा कि एसएसएस नीरे में जैविक ऊर्जा पर अनुसंधान विश्व स्तर का है और व्यावहारिक रूप से उपकरणों की जो कार्यप्रणाली देखने का अवसर मिला वो केवल उन्होंने किताबों में देखा था।

A three day National Training programme, on "Practical hands for processes of bio-fuel production and characterization from non-edible vegetable oils " was organized during March 19-21 January, 2015 at the Institute. Practical hands on training for lab scale production of bio-diesel and basic characterization techniques were imparted to scientists, academicians, M.Tech. & Ph.D. research scholars. During the programme, sophisticated analytical equipments and techniques required particularly for characterization of liquid bio-fuels like gas chromatography, flash cum fire point tester, density meter, oxidation stability unit, kinematic viscometer, TBP distillation unit and titrimetric methods, engine and emission characterization etc. were displayed and demonstrated successfully. The trainees gained hands on experience by working in the laboratory and handling the equipments. Three numbers of expert talks were delivered by eminent scientists working in the area of biofuels during the training programme. Prof. Yogender Kumar Yadav, Director, SSS-NIRE, delivered an inaugural speech and stated that our country produced 220.765 MMT petroleum distillates and 158.197MMT were used. About 83 % of the Crudes were imported. On the other hand India has about 640 MMT biomass available annually for biofuel production, if appropriate technology for conversion to useful liquid and solid fuels can be industrialized. Because the country

has an ambitious plan to substitute 20% liquid biofuels to that with petroleum based fuels, non-edible vegetable oil market will definitely rise in the demand of time. Prof. Yadav stated that young scientists should be encouraged to gain practical hands on experience so that they may contribute in research activities in the field of bio-fuel production and its characterization. Dr. A.K. Sarma, Organizing Secretary of the training programme elaborated objective the training programmes and stated that this step is taken to facilitate Human Resource Development and finally the development in the field of bio-energy technologies in the country. Dr. Thalanda Bhaskar, Senior Scientist, IIP Dehradun was the keynote speaker of the program and delivered presentations how thermo-catalytic conversion process is useful for generation of liquid fuels from biomass for our future. Dr. R. S. Bharj presented an elaborative speech how internal combustion engine works analogy to human body ad potential uses of biofuels for engine in locomotive and agricultural sector. Prof. A.K. Jain, Dean Central University of Punjab delivered general speech on bio-fuel conversion technologies and potential applications for future generation. Prof. Sunil Pandey, Director, Sant Longowal Institute of Engineering and Technology, Punjab was the Chief Guest of the valedictory function. He appreciated the efforts of the scientists of SSS-NIRE for developing such world class advance research facilities at the Institute in the field of bio-energy. The research and technical team under the chemical conversion demonstrated the existing production and characterization technologies of bio-fuel in the laboratories and personally interacted with research scholars particularly from IIT, Roorkee, SLIET, Longowal, Delhi Engineering College, NIT, Jalandhar, Kurukshetra University, and GNDU, Amritsar. He appreciated the involvement and the interest shown by the scientists, academicians and research scholars in this training programme. During the closing day function of this training the participants had shown their satisfaction and narrated that the research facilities at SSS-NIRE are of world class and they got the opportunity to practically see the working of the equipments which they saw only in the books.

b. National Training Program under Biochemical Conversion

A one week National Training Program on Hands on Analytical and Molecular Techniques 'Biomass based Bio-refineries: An Emerging Incentive for Advanced Biofuels and Value-added Products' was organized during 23-27 February, 2015. The training course was inaugurated by Prof. M.K. Surappa, Director, Indian Institute of Technology Ropar as the Chief Guest and under the chairmanship of Prof. Y.K. Yadav, Director, Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala on 23rd February, 2015. Prof. Yadav informed that Petroleum based fuels meet about 95% of the requirement for transportation fuels, and the demand has been steadily rising. The country need to produce the alternative fuels in the form of biofuels such as ethanol, butanol, biodiesel using the different biochemical and chemical techniques to meet out the growing need of clean transportation fuel for the country.

बायोमास के महत्व व उपयोग पर प्रकाश डाला

• सरदार स्वर्ण सिंह राष्ट्रीय अक्षय ऊर्जा संस्थान में कार्यशाला आयोजित

• जैव ईंधन का उत्पादन वैकल्पिक ईंधन के रूप में करें : डॉ. यादव

Prof. Surappa appreciated the scientists of the Institute and the Ministry of New & Renewable Energy, Govt. of India for creating such a wonderful centre of excellence in the field of bio-energy. He expressed his full satisfaction on such initiatives taken by the scientists and technical staff of the Institute. He stressed that every nation needs clean energy in one way or the other way for its sustainable development as the conventional energy sources are fast depleting and creating environmental pollution. Such training centres will enhance the research capabilities of the young scientists and would help in the quality research in the field of bio-energy and bio-fuels.

Objective of this training was to facilitate and train the academicians, researchers and young scientists/fellows working in biochemical conversion technologies for advanced biofuels and processing units for useful applications and to develop competent human resources and researchers in the field of advanced biofuels. The institute is having state-of-art research facilities in bio-energy and this training will provide the opportunity to exchange the ideas and expertise among the young and active researchers at national level.

Dr. Sachin Kumar, Coordinator of this training course informed that the faculty members and research scholars from different Institutions and Universities around the country are actively participating in the national training program. For this training 20 researchers were selected from NIT Rourkela, DTU Delhi, JNTU Hyderabad, Sardar Patel University, Gujrat, Anna University, Tamil Nadu, Periyar University, Tamil Nadu, University of Madras, Tamil Nadu, Thapar University, Punjab, Banasthali University, Rajsthan, Dayalbagh Institute, UP, Moolji Jaitha College Jalgaon, Maharashtra, Pt. Ravi Shankar Shukla University Raipur, Chhattisgarh, R D University Jabalpur, MP, JP University, Solan. The program will cover hands on analytical and molecular techniques and presentations by the expert scientists in the field of bio-energy followed by the demonstration of the production and characterization technologies in the laboratories and the personal interactions. Dr. S. K. Tyagi introduced the chief guest to the participants and Dr. A. K. Sarma extended vote of thanks.

10.3 Vigilance awareness week observed at SSS-NIRE:

Vigilance Awareness Week 2014 concluded recently at SSS-NIRE Kapurthala a function held at conference hall of the Institute. Prof. Yogender Kumar Yadav, Director of the Institute was present as the chief guest on this occasion. The programme started

with an intensive oath taking on Vigilance Awareness Theme on 27th October, 2014 and banners and posters were displayed on

"Honesty is the best policy",
"Corrupt Derail- Honest Prevail",
"Corruption is Anti Development",
Polluted by Corruption leads to our Destruction",
"Corruptions robs us all"

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 3rd November, 2014 in the conference hall. Prof. Yadav 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. Prof. Yadav also emphasized that the Institute has taken initiative to become a plastic free green campus within this year. Thus everyone 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.

10.4 Swachh Bharat Abhiyan

The activities under Swachh Bharat Abhiyan is continuously observed in almost all the Saturdays where, all the scientists and staff of SSS-NIRE including research fellows actively participate in the cleaning drive of the Institute. The Swachh Bharat Abhiyan was started in Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala on 25th of September, 2014 and on 2nd October 2014 at 9.30 AM under the guidance of Prof. Y.K. Yadav, Director, SSS-NIRE the pledge taking ceremony for Swachh Bharat Abhiyan was taken by all the staff of the Institute. All the staff members gathered again in the Conference hall for hearing the encouraging speech of the Honourable Minister of Power, Coal and Renewable Energy Sh. Piyush Goyal from 11.30 AM to 11.45 AM. The entire campus was divided into seven different zones and the teams were formed for each zone to execute the duties assigned to team members for cleanliness drive in the Institute. All the employees of the Institute proceeded for their designated places in the

campus to participate in the Swachh Bharat Abhiyan. Finally the staff members and their families joined for lunch in the campus after the campaign.

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

DAILYPOST

DAILY POST

NATION
DELHI GOVT TO BUILD TOILETS IN 700 SLUM CLUSTERS P7

SPORTS
CALIFORNIA EAGLES DEFEAT PUNJAB THUNDER 63-52 P11

DAILY LIFE
ALL FOR CHANGE P1

PUNJAB
GOVT TO LAUNCH SCHEME FOR TOILET RURAL AREAS: BADA

SSS-NIRE launches cleanliness drive

DP CORRESPONDENT
Kapurthala

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), Kapurthala (An Autonomous Institution of MNRE, GOI) launched a cleanliness drive campaign on Sunday to prove their pledge taken on October 2 on Mahatma Gandhi's birth anniversary, to clean offices, including toilets, roads and taking a pledge – as part of National Campaign.

Prof (Dr) Yogender Kumar Yadav, Director, SSS-NIRE, began his day by paying tribute to Gandhiji and taking pledge for making India Clean according to Mahatma Gandhi's dream. SSS-NIRE Officials led by Dr S.K. Tyagi, Scientist E of the Institute adopted each for the task to clean Roads, Housing Complex, Hostel Block, Office Premises, Laboratories in the Campus after taking the pledge for "Swachh Bharat" on Sunday morning.

Union Minister of Ministry of New and Renewable Energy Piyush Goyal through video conference also joined the campaign and spoke about the need to keep cleanliness around working place and surrounding areas.

Dr Yadav said that 'Swachh Bharat Abhiyaan' will go a long way and would focus on awareness about cleanliness in the Institute and rural areas in the vicinity of Campus. He also emphasised on different aspects of cleanliness besides activities like cleaning of houses and other premises to the officials and staff of the Institute. He said that the technologies of biomass utilisation for energy generation would also be demonstrated during the campaign and people will be motivated to use biogas plants.

Dr Yadav said that the Institute is working on bio-energy to develop best technologies, which will help to generate electricity and keep the rural areas sanitised and would be economically beneficial to the people.

In his message to all staff of the Institute on of Gandhi Jayanti, Prof Yadav said: "I call upon every Indian to do his utmost to make a success of the 'Swachh Bharat Abhiyaan' launched by the government to ensure hygiene, waste management and sanitation across the country."

He also called upon every staff of the Institute to work hard to achieve the goal of cleanliness by 2019 - the 150th birth anniversary of Mahatma Gandhi and reminded what believed that cleanliness is next only to godliness.

Press Release of cleanliness drive under Swachh Bharat Abhiyan at SSS-NIRE

10.5 Hindi Divas and Pakhwada:

The Institute observed Hindi Divas and Pakhwada from 14th-28th September 2014. The program was coordinated by Hindi Officer, Dr. Abhishek Gupta. Prof. (Dr.) Yogender Kumar Yadav, Director of the Institute chaired the function.

Observance of Hindi Divas & Pakhwara; (left) Director General, SSS-NIRE delivering speech; (right) audience

11. PATENTS, INNOVATION, CULTURE AND GENE PUBLISHED/DEPOSITED

- Sanjeev Mishra, A. K. Sarma, *Acutodesmus obliquus* strain NIREMACC01 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene and internal transcribed spacer 2, complete sequence; and 28S ribosomal RNA gene, partial sequence.
- Sanjeev Mishra, A. K. Sarma, *Chlorella pyrenoidosa* strain NIREMACC02 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene and internal transcribed spacer 2, complete sequence; and 28S ribosomal RNA gene, partial sequence, GenBank: KJ507207.1
- Kumar S, Arora R, Behera S and Sharma NK, *Kluyveromyces marxianus* NIRE-K1 ITS and D1D2 domain of ribosomal RNA gene, partial sequence. Accession No. KP405925; deposited on Jan 06, 2015.
- Kumar S, Arora R, Behera S and Sharma NK, *Kluyveromyces marxianus* NIRE-K3 ITS and D1D2 domain of ribosomal RNA gene, partial sequence. Accession No. KP405926; deposited on Jan 06, 2015.
- Kumar S, Arora R and Behera S, Deposited *Kluyveromyces marxianus* NIRE-K1 in MTCC under Budapest Treaty, Deposition no.: MTCC 5933, Nov 2014.
- Kumar S, Arora R and Behera S, Deposited *Kluyveromyces marxianus* NIRE-K3 in MTCC under Budapest Treaty, Deposition no.: MTCC 5934, Nov 2014.

12. PUBLICATIONS

E-BOOK

1. "Recent Advances in Bio-energy Research" 2014 edited by Dr. Sachin Kumar, Dr. A.K. Sarma, Dr. S.K. Tyagi, Dr. Y.K. Yadav, ISBN No.978-81-927097-2-7 at SSS-National Institute of Renewable Energy, Kapurthala, India.
2. AK Sarma, (2015). Biodiesel Production from Mesua ferrea L and Pongamia glabra Vent ISBN-9783659438646, Lap Lambert Pub. House, Germany, 1-113.

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1. Kumar P, Aslam Md, Singh N, Mittal S, Jha MK, Bansal A, Sarma A K, (2015). Characterization, activity and process optimization with a biomass-based thermal power plant's fly ash as a potential catalyst for biodiesel production, RSC Advances, 5, 9946-9954.(IF 3.71)
2. Aslam Md, Kothiyal N C, Sarma A K(2014). True Boiling Point Distillation and Product Quality Assessment of Biocrude obtained from Mesua ferrea L. seed oil via Hydroprocessing, Clean Technologies and Environmental Policy, Doi: 10.1007/s10098-014-0774-z.
3. Behera S, Singh R, Arora R, Sharma NK, Shukla M and Kumar S (2015) Scope of algae as third generation biofuels. Frontiers in Bioengineering and Biotechnology 2:90. doi: 10.3389/fbioe.2014.00090.

INTERNATIONAL/NATIONAL CONFERENCES

1. Mahajan R, Kaur H, Rao R, Kumar S. Pre-treatment of paddy straw to improve biogas yield. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.
2. Arora R, Behera S, Sharma NK, Singh R, Kumar S. Bioprospecting thermostable cellulosomes for efficient bio-fuel production from lignocellulosic biomass. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.
3. Behera S, Arora R, Sharma NK, Kumar S. Biohydrogen production from organic wastes: an overview. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.
4. Sharma NK, Behera S, Arora R, Singh R, Kumar S. Potential role of xylose transporters in industrial yeast for bioethanol production: a perspective review.

First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.

5. Singh R, Kumar S. Biogas production from water hyacinth using thermophilic consortium. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.

6. Shukla M, Kumar S. Integrated algal biorefinery: a promising solution for sustainable development of mankind. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.

7. Bhatnagar VS, Sharma NR, Kumar S. Pretreatment of paddy straw for enhanced saccharification. First International Conference on 'Recent Advances in Bio-energy Research' (ICRABR-2015), Mar 14-17, 2015 at SSS-National Institute of Renewable Energy, Kapurthala, India.

8. Singh R, Yadav YK, Kumar S. Bio-Prospecting Novel Thermophilic Consortium for Biogas Production from Paddy Straw. 2nd International Conference on Frontiers In Biological Sciences (InCoFIBS-2015), Jan 22-24, 2015 at National Institute of Technology, Rourkela, Odisha, India.

9. Arora R, Behera S, Sharma NK, Singh R, Yadav YK, Kumar S. Biochemical Conversion of Rice Straw (*Oryza sativa L*.) to Bioethanol using Thermotolerant isolate K. marxianus NIRE-K3. EBAS-2014, Nov 14-15, 2014 at LPU, Jalandhar, India.

10. Kumar S, Bioenergy: current status and future perception in India. 2nd U6 Consortium International Conference, Sep 6-10, 2014 in the Cape Peninsula University of Technology, Cape Town, South Africa.

11. Kumar S, Biochemical Conversion Technologies for the production of biofuels. Symposium on Recent Advances in Biotechnology for Food and Fuel, Nov 19-20, 2014 at TERI, New Delhi.

13. LECTURE DELIVERED/MEETING ATTENDED

- Prof. Y.K. Yadav was invited as Key-Note speaker at the National Seminar on Sustainable Energy Generation-Current Scenario at Punjab University, Chandigarh on 21st March, 2015
- Prof. Y.K. Yadav attended the Re-Invest 2015, 1st Renewable Energy Global Investment Promotion Meet & EXPO at New Delhi on 15th to 17th February, 2015

- Prof. Y.K. Yadav attended the meeting regarding preparation of the White Paper and Paddy Straw Utilization and Management at Chandigarh on 29th January, 2015.
- Prof. Y.K. Yadav attended "Make in India" Workshop organized by CII at Vigyan Bhawan, New Delhi on 29th December, 2014.
- Prof. Y.K. Yadav attended the conference of Principal Secretaries/Secretaries of States/ UTs of Renewable Energy Departments and heads of SNAs at Jacaranda Hall, New Delhi on 17th December, 2014.
- Prof. Y.K. Yadav attended Standing Committee on Energy (2014-15) meeting – Examination of the subject "Encouraging Local Renewable Energy Manufacturing Base in India with special reference to Solar Energy", at New Delhi on 05th December, 2014.
- Prof. Y.K. Yadav attended 2nd Governing Council Meeting of NISE on dated 25th November, 2014 at MNRE, New Delhi.
- Prof. Y.K. Yadav was invited as speaker on "India Clean Cookstove Forum 2014" at New Delhi on 11th November, 2014.
- Prof. Y.K. Yadav attended first meeting of the Expert Committee on Renewable Energy Act for India at MNRE, New Delhi at MNRE, New Delhi on 07th November, 2014.
- Prof. Y.K. Yadav attended 23rd GC Meeting of SSS-NIRE at MNRE, New Delhi on 31st October, 2014.
- Prof. Y.K. Yadav attended 9th Finance Committee Meeting of SSS-NIRE at MNRE, New Delhi on 25th September, 2014.
- Prof. Y.K. Yadav attended meeting/presentation of the representatives of the MNRE before the standing committee on Energy at New Delhi on 23rd September, 2014.
- Prof. Y.K. Yadav attended conference of Principal Secretaries of various states of Renewable energy Departments and Heads of SNAs at MNRE, New Delhi, on 17th September, 2014.
- Prof. Y.K. Yadav attended 34th Governing Council Meeting of NIWE on dated 12th September, 2014 at MNRE, New Delhi.
- Prof. Y.K. Yadav attended the National Workshop on Unnat Bharat Abhiyan at IIT, New Delhi on 07th September, 2014 at MNRE, New Delhi.
- Prof. Y.K. Yadav attended the 37th Governing Body Meeting of Pushpa Gujral Science City on 11th September, 2014 at Chandigarh.
- Prof. Y.K. Yadav attended 33rd Governing Council Meeting of NIWE (C-Wet) on dated 15th July, 2014 at MNRE, New Delhi.

- Prof. Y.K. Yadav delivered a talk on "Innovation and Futuristic Trends in Advance Manufacturing & Nanotechnology" at D.A.V. Institute of Engineering & Technology (DAVIET), Jalandhar on 07th July, 2014.
- Prof. Y.K. Yadav attended conference of State Principal Secretaries/Secretaries dealing with Renewable energy and the Heads of State Nodal Agencies for Renewable Energy at New Delhi on 10th June, 2014.
- Prof. Y.K. Yadav delivered a keynote address on, "Renewable Energy Technologies and Energy Conservation Methods" at Rayat – Bahra Ropar Campus on 09th June, 2014.
- Prof. Y.K. Yadav attended 22nd GC Meeting of SSS-NIRE at MNRE, New Delhi on 26th May, 2014.
- Prof. Y.K. Yadav attended AMARE International Workshop at Hydrabad on 20th May, 2014.
- Prof. Y.K. Yadav attended first weekly Operational Review Meeting (ORM) at MNRE, New Delhi on 09th April, 2014.
- Dr S. K.Tyagi attended the meeting on 23rd January, 2015 at IIT Delhi to discuss various issues related to Testing Centre and Presentation on Cookstoves R&D Project Progress called by MNRE.
- Dr S. K.Tyagi attended a one day workshop in Patna, Bihar on 3rd Feb., 2015 for interaction with the SNAs and SRLMs of the five States of Jharkhand, Bihar, Andhra Pradesh, Madhya Pradesh and Chhattisgarh, as directed by MNRE
- Dr S. K. Tyagi attended the meeting on Modalities and Implementation of Unnat Chulha Abhiyaan (UCA) and its Linkage with CDM on 04th August, 2014 at MNRE.
- Dr S. K. Tyagi presented the National CDM PoA on Improved Cookstoves in India in the Unnat Chulha Abhiyaan of MNRE during the one day stakeholders workshop at MNRE, New Delhi on 28th August, 2014.
- Dr S. K. Tyagi attended the training on "Functioning and Maintenance of Solar Radiation Recourse Assessment Station" during 2-3 June, 2014 at National Institute of Solar Enery (NISE) Gurgaon.
- Dr S. K. Tyagi attended Stakeholders Consultation Meet regarding second CPA inclusion in the cookstove CDM PoA at GNTfW during 18-19, April, 2014 in Ahmedabad.
- Dr A.K. Sarma participated in the 2 days R &D conclave on Renewable Energy, held in Vigyan Bhawan New Delhi, on August, 2014.
- Dr. A.K. Sarma Delivered Keynote speech in a national conference held at Rayat Institute, sponsored by PTU on June, 2014.

- Dr. Sachin Kumar delivered the keynote speech in 2nd U6 Consortium International Conference in the Cape Peninsula University of Technology, Cape Town, South Africa on Sept. 09, 2014.

14. AWARDS & HONOURS

- Prof Yogender Kumar Yadav, received World Renewable Energy Pioneer Award (WREN PIONEER Award, 2014) from the World Renewable Energy Council/ Network, United Kingdom for his global contributions in the field of renewable energy, at Kingston University, London, UK on 4th August, 2014.
- Dr A. K. Sarma has been awarded Honorary Membership: International Society for Sustainability and Development, Japan, Membership ID: M141654.
- Dr Sachin Kumar selected as a scientific committee member for 'International Conference on Energy, Environment and Climate Change (ICEECC 2015)' on Jul 8-9, 2015 in the University of Mauritius, Mauritius.
- Dr Sachin Kumar selected as a technical committee member for International Conference on 'Biofuels and Bio-energy: International Conference and Exhibition' during Feb 23-25, 2016 jointly organized by MANIT, Bhopal with WEENTECH, Coventry University, UK.
- Ms Richa Arora, SRF has been awarded First Prize in oral presentation for the paper entitled, "Biochemical Conversion of Rice Straw (Oryza sativa L.) to Bioethanol using Thermotolerant isolate *K. marxianus* NIRE-K3" presented in EBAS-2014 during Nov 14-15, 2014 at LPU, Jalandhar, India.

15. ABROAD VISITS/CONFERENCES/WORKSHOP/TRAINING

- Prof. Y.K. Yadav visited UK to receive World Renewable Energy Pioneer Award (WREN Pioneer Award 2014) from World Renewable Energy Council/ Network, UK and made an invited presentation "Recent Developments and Perspectives of Renewable Energy in India" at the World Renewable Energy Congress *XIII* during August 3-8, 2014 held at Kingston University, London, United Kingdom.
- Dr. S. K. Tyagi and Dr. Sachin Kumar visited Uganda for Study-cum-exposure tour during 20-26 July, 2014 to study the constraints and barriers in the operationalization of CDM Cookstove PoA.
- Dr. Sachin Kumar visited Cape Peninsula University of Technology, Cape Town, South Africa to deliver the keynote speech at International Conference during Sept. 06-10, 2014.

16. 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. About 50 Books and 50 Scientific Journals have been purchased for Documentation Centre in this FY.

17. PROGRESS OF CONSTRUCTION

The following construction activities were done during 2014-15:

a) Construction of road connecting to Common Facility Block

b) Construction of road connecting to Hostel Block to Sub Station.

c) Construction of Meter Room for Installation of 992.80 KVA Electricity Load Extension.

d) Renovations/Painting for campus houses.

18. HORTICULTURE ACTIVITIES

With a 'GO GREEN" motto, SSS-NIRE follows an integrated approach towards development of Forestry & horticulture by paying attention technically as well as institutional issues and targeting social causes as global warming etc to support the horticulture and silviculture. More than two hundred ornamental and forestry plants have been planted during the year. Around the campus office, hostel block, housing 3500 sq mtr area has been developed with selection no. 1 and Korean grass. The Institute has also purchased the necessary fertilizers, machinery and agricultural tools for the development of campus to meet the objectives of GO GREEN campus.

Bamboo and Jatropha for biofuel applications

Bamboo plantation: Near about 300 bamboo saplings were planted along the boundary wall near Jatropha field. In the year 2011 the Bheema bamboo saplings were provided by Ms/ Grow More Pvt. Ltd. Bangalore based company. Bamboo plants are growing at a good pace and many plants have attained the height of 20-24 feet. The foliage of bamboo plants is also lush green in colour. Diameter of bamboo trunk is also healthy. Sprouting of new bamboo saplings takes place in each season. Sprouting of new bamboo from the plants are looked very healthy.

Jatropha plantation

In continuation to the decision taken in the FY 2013-14, about 1000 jatropha plants were studied under extreme care with proper water supply and fertilizer for growth, seeding and maturation. Experts from Punjab State Agriculture Department were also consulted. It was confirmed that the agro-climatic condition of Kapurthala, is not suitable for economic production of jatropha seeds.

19. 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.

- 19th Purchase committee meeting was organized on 26th August, 2014 at SSS-NIRE.
- 20th Purchase committee meeting was organized on 5th February, 2015 at SSS-NIRE.
- 9th Finance Committee meeting was held at MNRE on 25th September, 2014.
- 22nd Governing Council Meeting was held at MNRE on 26th May, 2014.
- 23rd Governing Council Meeting was held at MNRE on 31st October, 2014.
- Administrative Meetings were held at SSS-NIRE on 12th August, 2014, 18th September, 2014, 9th October, 2014, 14th November, 2014, 7th January, 2015.
- Bio-Energy Alliance Meeting was held at SSS-NIRE on 17th March, 2015.

Other Administrative meetings during the year.

- A meeting regarding submission of UC and SoE was held on 12th August, 2014.
- A review Committee Meeting was held on 18th September, 2014.
- Progress Review Committee Meeting was held on 7th January 2015.
- Administrative meeting regarding ICRABR-2015 was held on 6th February, 2015.
- MOU (Memorandum of Understanding) has been signed between SSS-NIRE and PAU (Punjab Agriculture University).
- Certificate of ISO (International Organization for Standardization) has been renewed after ISO audit held on 24th January, 2015.
- 3rd Standing Technical Committee meeting was organized in October 2014 at SSS-NIRE.

20. ANNUAL AUDITED ACCOUNTS FOR THE FINANCIAL YEAR 2014-15

The annual audited accounts of the Institute for the year 2014-15 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) 2282829,2212471
(R) 2282830
(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 31.03.2015 and Income & Expenditure account for the year ended 31.03.2015 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 31.03.2015 and

(ii) In the case of the Income & Expenditure account, of the Income and Expenditure of its accounting year ending on 31.03.2015.

For K. Bhagat & Co.
Chartered Accountants
Mem. No. 519528
Partner

Place : Jalandhar City

Dated : June 25, 2015

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 2015

(Amount in Rs.)

PARTICULARS	SCHEDULE	31st MARCH, 2015	31st MARCH, 2014
A. CAPITAL FUND AND LIABILITIES			
Corpus/Capital Fund	I	229,779,413.00	151,235,530.00
Reserve & Surplus	II	409,075,344.88	403,439,782.23
Current Liabilities & Provisions	III	19,801,286.50	10,154,229.40
TOTAL		658,656,044.38	564,829,541.63
B. ASSETS			
Fixed Assets	IV	297,606,229.00	314,243,464.40
Current Assets. Loans & Advances	V	135,039,557.38	98,366,532.23
Investment (Corpus Fund)	VI	226,010,258.00	152,219,545.00
TOTAL		658,656,044.38	564,829,541.63
Contigent Liabilities And Notes on Accounts	VII		

For SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

As per our Audit Report Attached

FOR K. BHAGAT & CO.
Chartered Accountants

Mem. No. 510528
Jalandhar

Partner
Firm Reg. No.- 006797N

Place: Jalandhar
Date: 25.06.2015

Administrative-cum-Accounts Officer

Director

Chairman

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 31.03.2015

(Amount in Rs.)

PARTICULARS			31st MARCH, 2015
INDIRECT INCOME			
Grant Received from MNRE during the year			
for Salaries	13,000,000.00		
for General Expenses	107,000,000.00		120,000,000.00
Interest Received from Saving/MOD a/c			9,141,201.15
Sponsorship Received			195,000.00
Licence Fees			51,719.00
Tender Fees			26,900.00
Registration Fees			360,500.00
Hostel Fees			532,410.00
Other income			8,430.00
	TOTAL	**A**	**130,316,160.15**
INDIRECT EXPENSES			
Salaries			7,260,033.00
Consumable Laboratory Workshop Exp.			1,796,487.00
Audit & Legal Fees			87,130.00
Advertisement			70,959.00
Depreciation			34,573,315.00
Electricity & POL			2,495,443.00
Horticulture Expenses			157,879.00
Insurance Exp.			18,144.00
Meeting, Seminars, Workshop & Conference			1,503,882.00
Office/Guest House Exp.			74,667.00
Printing & Publications			64,947.00
Refreshment			152,437.00
Rentals, Hiring of Prof. Services			10,325,476.00
Repair & Maintenance			288,061.00
Stipend			1,956,804.00
Stationary (Including Software Exp.)			304,377.00
Telephone & Internet Exp.			330,036.50
Travelling Exp.			438,187.00
	TOTAL	**B**	**61,898,264.50**
Surplus Transfer to Reserve & Surplus		**A-B**	**68,417,895.65**

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

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR 2014-15

	RECEIPTS		31st MARCH, 2015	31st MARCH, 2014
A.	**OPENING BALANCES**		**237,000,373.74**	**196,621,619.03**
	Cash in Hand		2,912.00	28,913.00
	Bank Balances			
	In Saving A/c		345,919.16	17,908.15
	In Deposit A/c		88,658,952.88	196,923,074.18
	In Current A/c		217,330.70	221,940.70
	Investments		147,466,375.00	-
	Interest Accrued on FDR (Incl. TDS)		5,532,838.00	
	Add: Cheque deposited but not credited		13,625.00	5,000.00
	Less: Cheque issued but not presented		(5,240,533.00)	(575,941.00)
	Stamps		2,954.00	724.00
B.	**GRANT RECEIVED**		**122,752,000.00**	**92,700,000.00**
	Bio- Diesel Production Project		-	-
	Bio- Mass Power Project		-	-
	From Govt. of India		120,000,000.00	80,000,000.00
	Bio Crude Project		-	1,700,000.00
	ICRISAT Project		-	-
	NREP Project		-	-
	Bio- Mass Cook Stove Project		-	6,000,000.00
	Bio- Ethenol Project		-	5,000,000.00
	Bio-Gas Production Project		2,452,000.00	
	Bio Mass Energy Tech. Project		300,000.00	
C.	**INTEREST RECEIVED**		**24,267,825.15**	**14,205,020.21**
	On Saving/Bank Deposits		9,141,201.15	14,205,020.21
	Interest on FDR Corpus		15,126,624.00	-
D.	**OTHER INCOME**		**2,103,003.00**	**430,864.00**
	Security Deposit		-	695.00
	Tender Fees		26,900.00	86,450.00
	Licence Fees		51,719.00	54,035.00
	Hostel Fees	532,410.00		39,000.00
	Less: Receivable	36,956.00	495,454.00	
	EMD		965,000.00	168,000.00
	Registration Fees		360,500.00	-
	Sponsorship		195,000.00	-
	Misc. Income		8,430.00	82,684.00
E.	**OTHER ADJUSTMENTS**		**2,100,020.50**	**6,167,118.40**
	Expenses Payable/Creditors Outstanding During the Year		1,449,484.50	4,333,797.40
	Advances of Last Year Adjusted During the Year		650,536.00	1,833,321.00
			388,223,222.39	**310,124,621.64**

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 2014-15

	PAYMENTS	31st MARCH, 2015	31st MARCH, 2014
A.	**PAYMENT MADE AGAINST FUNDS FOR VARIOUS PROJECTS**		
	Out of Capital Grant		
	Revenue Expenditure	**27,324,949.50**	**25,454,047.50**
	Expenditure During the Year	61,898,264.50	61,774,946.50
	Less: Depreciation	(34,573,315.00)	(36,320,899.00)
	Capital Expenditure	**17,936,079.60**	**35,173,506.40**
	Fixed Assets	17,936,079.60	35,173,506.40
	Out of Grant for Projects	**2,064,074.00**	**3,192,288.00**
	Expenses Under Bio- Diesel Poject	-	2,383,420.00
	Expenses Under Bio- Ethenol Project	625,556.00	537,014.00
	Expenses Under Bio Mass Cookstove Project	609,105.00	-
	Expenses Under Bio- Crude Project	668,729.00	271,854.00
	Expenses Bio-Gas Production Project	160,684.00	
B.	**OTHER PAYMENTS**	**5,736,133.40**	**9,304,406.00**
	EMD Refunded	932,500.00	-
	Prepaid Expenses	1,383.00	
	Advance Given During the Year	725,717.00	5,199,247.00
	Expenses Payable/Creditors of Pre. Year paid During the Year	4,076,533.40	4,105,159.00
C.	**CLOSING BALANCES**	**335,161,985.89**	**237,000,373.74**
	Cash in Hand	19,869.00	2,912.00
	Bank Balances		
	In Saving A/c	39,323,218.44	345,919.16
	In Deposit A/c	75,875,415.75	88,658,952.88
	In Current A/c	204,458.70	217,330.70
	Investments	219,736,210.00	147,466,375.00
	Interest Accrued on FDR (Incl. TDS Recoverable)	7,426,953.00	5,532,838.00
	Add: Cheque deposited but not credited	10,005,000.00	13,625.00
	Less: Cheque issued but not presented	(17,429,139.00)	(5,240,533.00)
	Stamps	-	2,954.00
		388,223,222.39	**310,124,621.64**

For SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

As per our Audit Report Attached

FOR K. BHAGAT & CO.
Chartered Accountants

Partner
Firm Reg. No.- 006797N

Place: Jalandhar
Date: 25.06.2015

Administrative-cum-Accounts Officer

Director

Chairman