

**6<sup>th</sup> IAPSIT International Conference-IS 2018**  
**“Sugar Crops Improvement, Biotechnology, Bio-refinery and Diversification:**  
**Impacts on Bio-based Economy”**  
**at Udon Thani, Thailand from 06-09 March 2018**

The world sugar markets are moving towards a very exciting phase with ample transformational opportunities. The impressive economic growth at the global level, especially in the Asian and South East Asian nations is an important driver for the development of agro-based industries, including the sugar industry in these nations. The various challenges like the depleting natural resources, decreasing productivity, increasing cost of production, climate change and associated problems necessitate a shift towards more sustainable production and management strategies. A bio-based economy can be an answer to these challenges, with its immense potential to generate a gamut of crop-based products with improved, cost-effective, sustainable and innovative technologies.

**About IS-2018 :**

Sugarcane being an important crop in many of the Asian and ASEAN nations and a very suitable candidate for diversification options, sugar industry can be the trial-blazer for a sugarcane-based bio-economy, esp., in the sugar producing countries. Diversification is the key for the sugar industry in the Asian continent as a whole, with the potential for co-generation, biofuel production, generation of ancillary products like chemicals, pharmaceuticals, bio-based paper, packing material, bagasse and molasses, animal feed, biofertilizers, sugarcane based textiles and detergents etc., apart from the main products, sugar and sweeteners. With this idea in mind, the 6<sup>th</sup> IAPSIT International Conference was organized on the theme of **“Sugar Crops Improvement, Biotechnology, Bio-refinery and Diversification: Impacts on Bio-based Economy”**. The Conference was jointly hosted by the Thailand Society of Sugar Technologists (TSSCT), Kasetsart University, Bangkok, Thailand Sugar Planters’ Federation, International Association of Professionals in Sugar and Integrated Technology (IAPSIT), The Unity of Thailand Sugarcane Planters, The North-Isan Sugarcane Planters Association, The United Association of Thai Sugarcane Planters and the North Eastern Sugarcane Planters’ Federation. South East Asian region is emerging as a promising hub for bio-based products and technologies, with feedstock availability and government support favouring the bio-based product generation.

Thailand is a major sugar producer of South East Asian region, and one among the few net sugar exporting countries of the world. It has a share of 15% of the global sugar exports and is the second largest sugar exporter after Brazil. Thailand accounts for approximately 7 % of the global sugar production. By 2020, Thailand expects to produce 13.0 million tons of sugar with a sugar consumption of 3.7 million tons. Also, the country is an important partner in the bio-based economy initiatives, with a utilization of ~40% of the sugarcane produced for bio-based products. Thus, it was very apt that Thailand was chosen as the venue for the 6<sup>th</sup> IAPSIT International Conference.

Udon Thani, approximately 560 kms from Bangkok is an important regional hub connecting the North Eastern parts of Thailand with the rest of the country, and is also the

gateway to Laos. This province is home to one of the earliest Bronze-age Civilizations. The region is culturally very diverse and rich, with its own speciality art and handicrafts and is famous for handwoven silk, “Kid” textile, pottery etc. It has many tourist attractions with a lively night-life. Several recreational activities like rafting, fishing, overnight camping and waterfall hiking etc., apart from shopping for traditional and modern articles are an inevitable part of a visit to this Province. Several local tourist attractions like historical museums, monuments, waterparks etc., make Udon Thani a suitable scenic tourist destination to be explored, along with the scientific deliberations.

The venue of the conference was Hotel Charoen, situated approximately 2.5 km from Udon Thani Airport. It is located near the Central Plaza and also to some of the historic landmarks like Udon Thani Rajabhat University and Udon Thani Provincial Museum. The scenic surroundings and the tastefully decorated interiors offered the right ambience for a comfortable stay for the delegates. The beautifully decorated Expo Area and the well equipped halls of the venue provided an ideal environment for the scientific deliberations. **Around 200 delegates from 22 countries** participated in this scientific gathering devoted to sugar crops, integrated industries and sugar industry-based bio-economy.

### **IS 2018- Inaugural Sessions:**

The arrival of the delegates and their registration commenced from 5<sup>th</sup> March 2018. There was a grand Delegate Reception along with The Exhibition Inauguration Ceremony at the Udondusadee Convention Hall on 5<sup>th</sup> March 2018, at 6 pm. Mr. Teerachai Sankaew, Chairman and Advisor of the North Eastern Cane Planters' Association, Thailand, welcomed the delegates to Udon Thani and this was followed by Opening Remarks by Mr. Kitti Choonhawong, President of TSSCT and Chairman of IS 2018, The significance of the Conference was touched upon by the speaker in his remarks. The delegates were treated to a variety of gastronomic delicacies, including specially prepared sugarcane juice. The participants from various parts of the globe had a memorable time catching up with each other, simultaneously having a glimpse of the exhibits that were displayed by the various organizations. The Exhibition area consisted of stalls put up by many organizations/companies viz., MitrPhol Group, Bangkok, New Holland Agriculture, Bangkok, CropTech Asia, Bangkok, Rivulis, Australia, Smartkasetyon Co., Ltd., Thailand, Syngenta, Bangkok, Kacha Agricultural Chemicals Co., Ltd., Thailand, Saksiam Group, Thailand, SKYVIV Co., Ltd., Thailand, Bruker Optik GmbH, Singapore, Brevini Co. Ltd., Thailand, Thai Agency Engineering Co., Ltd., Thailand, Kulin Formosa Technology Co., Ltd., Thailand and The Global Canesugar Services Pvt. Ltd., India.

The Inaugural Ceremony was held on 06<sup>th</sup> March 2018 in the Udondusadee Convention Hall. The programme started with a cultural extravaganza by a troupe of dancers, depicting the stories from the religious scriptures like Ramayan. The performance was mesmerizing, leaving the audience spell-bound in a dream world for almost an hour. This was followed by the formal inaugural session. The Governor of Udon Thani Province, Mr Watana Puttichat, gave his welcome speech and welcomed all the delegates to Udon Thani for this important conference. He expressed his gratitude to the organizers for having selected Thailand and in particular, the Province of Udon Thani for hosting the International

Conference IS 2018 which, he emphasized, has a lot of contemporary significance. He wished the Conference a grand success. This was followed by address by Dr Yang Rui-Li, President IAPSIT where he spoke about the importance of a sugar industry-based bio-economy and its present-day significance. Dr Sushil Solomon, Vice Chancellor, Chandra Sekhar Azad University of Agricultural and Technology (CSAUA&T), Kanpur, India and the Secretary, IAPSIT presented a report on the importance of the IS 2018 and role of IAPSIT towards the holistic improvement of sugar and integrated industries in the developing countries, with special emphasize on Asian/South East Asian nations. He also briefed about the activities of IAPSIT during the past 14 years.

Dr Kitti Choohawang, Conference Chairman and the Chairman, Thailand Society of Sugar Technologists (TSSCT) briefed about the Conference and extended a warm welcome on behalf of the Conference Secretariat and TSSCT. Mr Cherdpong Siriwit, Chairman, Advisory Board of Conference Organizing Committee also gave his remarks. The Conference was formally declared open by the beating of drum by the Governor, Udon Thani Province. This was followed by the release of the Conference publications. Some of the distinguished workers in sugar industry from the different parts of the world were felicitated. This included My Kitti Choohawang, Mr. C. Siriwit, Mr.T. Sankaew, Mr Nitin Deshpande from Pune, India and Dr GSC Rao, Global Canesugar Services Pvt. Ltd., India

### **Technical Programme :**

The inaugural ceremony was followed by a group photo session of all the participants and a coffee break. This was followed by a key note lecture during the forenoon session. The remaining three key note sessions were held during the morning of 07<sup>th</sup> and 08<sup>th</sup> March 2018. The Technical sessions were held currently, from the afternoon of 06<sup>th</sup> March and these continued till the forenoon of 08<sup>th</sup> March. The interactive poster session was held on 08<sup>th</sup> March afternoon, after the conclusion of the Oral presentations.

### **IS 2018 : Keynote lectures :**

**The first keynote lecture by Dr Klanarong Sriroth, MitrPhol, Thailand,** was on **“Biotechnology in Sugar Industry”**. The Session was chaired by Dr Li Tao-Yang from China and Dr DP Singh from India. Dr Sriroth talked about the three disruptions faced by sugar industry today, *viz.*, climate change, saccharophobia and solar energy Vs co-generation and electric vehicles Vs flexi-vehicles. He discussed ways and means to overcome these disruptions. Diversification towards other bio-based products and use of biotechnology for the production of varied products were discussed. Use of biotechnological tools like genome editing, CRISPR etc., for developing GM sugarcane with disease resistance, enhanced N<sub>2</sub> fixation, cold tolerance, for production of bio-stimulants, production of other bio-based products like alcohols, biodiesel, jet fuel, acids, saccharides, animal supplements etc., and the many number of patents that are being filed in this area of sugarcane research were briefed. Such strategies should act as means to overcome these present-day challenges faced by the global sugar industry.

The deliberations on 7<sup>th</sup> March 2018 started with two keynote lectures in the Meeting Room 1(Lao Charoen Sri). In the **first keynote lecture** of the day, Dr Wen-Chieu Lee from National Cheng Chung University, Taiwan spoke about the “**Production of Xylo-oligosaccharides as value added products from sugarcane bagasse**”. **Dr Denizart from Brazil chaired the session**. The scope of utilizing hemicelluloses in bagasse for production of high-value added compounds like xylo-oligosaccharides (XOS), which have high market potential as pharmaceuticals was brought out in the lecture. The use of alkaliphilic *Bacillus halodurans* having xylanase-encoding *xyn45* has been effective in converting the xylan from sugarcane bagasse to form XOS. The use of recombinant *E.coli* overexpressing *xyn45* gene, cultivated by fed-batch fermentation has been found to be very effective in converting the xylan to XOS from sugarcane bagasse, rice straw, corn cob etc. The second keynote lecture by Dr Manoj Srivastava from Global Canessugar Services Pvt. Ltd., India dealt with the comparison of cane management system in outgrowers and block farming. Both the systems have their own merits and demerits and the choice of the system to be adopted need to be based on the situation and the demands.

The session for the third day on 8<sup>th</sup> March started with a keynote address on “**Green energy for Indian sugar industry : A step towards social, economic and environmental sustainability**” by Prof. Narendra Mohan, Director, National Sugar Institute, India. Dr. Narendra Mohan initiated his talk, with the challenges faced by the sugar industry in India, the most important among these being sustainability. He emphasized that green energy is one of the most efficient ways for sustainable development of the industry. The share of green energy in the energy matrix needs to be increased. With the sugar industry gradually moving towards “Energy Industry”, the complete utilization of all the by-products like bagasse, molasses, ethanol etc., will help earn a higher revenue. Many of these “non-renewable energy sources” are still undergoing large scale commercial development, but some technologies like sugarcane ethanol for clean green fuel is already being put to use at a commercial scale. The concept of Sugarcane biorefinery with the complete utilization of sugarcane biomass is the technology of the near future. Use of alternative sources of feedstock like cassava, sugar beet etc., is also important for profitability and sustainability of the sugar industry.

### **IS 2018 : Technical Sessions & Interactive Poster Session :**

**The Technical Sessions** were held from the afternoon of 06 November 2018. Two Technical Sessions were held concurrently. The Session I was on “**Sugar Production and Protection Technologies and Mechanization of Farms**” and this continued through all the three days. A concurrent **Session IV** was held on “**Sugar-energy matrix in developing countries, sustainability issues, marketing national policies and integrated industries**” on 06 March. The **Session II** held on 07 March, 2018, dealt with “**Sugar Crops Improvement, breeding & biotechnology**”. The **Session III** was on “**Sugarcane harvesting, processing, value addition and stewardship of environment**” and this was held on 07<sup>th</sup> and 08<sup>th</sup> March 2018.

The Technical Session I on “**Sugar Production and Protection Technologies and Mechanization of Farms**” was initiated from 1.30 pm on 06<sup>th</sup> March 2018 at Meeting Hall

1. This session continued through all the three days, till 08<sup>th</sup> March. Chairman of the session was Dr RKF NgKee Kwong from Mauritius and Prof. Duli Zhao from China. There were 19 presentations in this session including the lead papers and oral presentations. Ten of the presentations related to Plant protection strategies in sugar crops and the rest dealt with Crop production and mechanization aspects. Some of the Oral presentations included those dealing with plant protection regulations with special reference to India, management strategies for diseases and pests like white leaf disease, stem borers etc., risk management of pests and diseases in the changing cropping scenarios, use of normalized vegetation index for estimating yield and yield components, intercropping for doubling sugarcane growers' income, improved management practices including water saving techniques for enhancing sugarcane production and productivity apart from other aspects. The importance of prophylactic measures for prevention of diseases and pests incidence was brought out through some of the papers presented in the session.

The **Technical Session II on “Sugar Crops Improvement, Breeding & Biotechnology”** was held on 07<sup>th</sup> March 2018 at Meeting Hall 1. The session covered the genetics, breeding, and biotechnology of sugar crops. The session was chaired by Dr. YB Pan, USDA-ARS, Florida, co-chaired by Dr. NV Nair, Ex-Director, Sugarcane Breeding Institute, India and was coordinated by Dr. M. Swapna from India. A total of 11 papers were presented including two lead papers. Dr YB Pan from USDA-ARS in his lead paper talked about the application of molecular markers in sugarcane germplasm studies, with specific reference to new germplasm with *Saccharum spontaneum* cytoplasm. This included a new Energy cane variety Ho 02-113. The new germplasm is available for use, after signing an MTA with the USDA. The sugarcane improvement programs in India were described in detail by Dr. NV Nair, former director of Sugarcane Breeding Institute, Coimbatore, India. A well developed sugarcane varietal development programme involving the Sugarcane Research Institutes under ICAR, the State Agricultural Universities, State departments etc., with the active support and involvement of the All India Co-ordinated Research Project (AICRP) on Sugarcane was described in detail. Utilization of the *Saccharum* spp. hybrids and related genera and other strategies were discussed. The lead lectures were followed by nine oral presentations on various aspects of sugarcane improvement. The topics varied widely from conventional breeding strategies to use of high throughput SNP arrays.

Dr Islam from BSRI, Bangladesh talked about the development and utilization of SNP markers and their utilization to map SCYLV genes. The conventional breeding strategies taken up for sugarcane varietal development with adaptability, productivity and non-flowering trait were discussed by Dr SB Patil from Sugarcane Research Station, Mandya, India. Dr M. Swapna from IISR, India, in her presentation showed that ample variation for sugar content still exists in the populations arising from commercial crosses. Use of Interspecific hybrids as an attractive option for introgression of novel genes into the adapted genetic background was also suggested. Dr MN Premachandran from India, in his presentation described the utilization of genetic resources available at Sugarcane Breeding Institute, India, including Inter Generic Crosses. *Erianthus* x *Saccharum spontaneum* with

upto six backcrossings gave rise to near-commercial clones with *E. arundinaceus* cytoplasm. Biotechnological strategies with special reference to plastid transformation for sugarcane improvement were the topic of presentation by Dr. Mustafa from Pakistan. Identification of unigenes for sucrose metabolism through RNA-Seq analysis and proposition of a simple module for sucrose metabolism was described by Dr Huang from GXAAS, China. Dr Yang Rui-Li from China talked about functional endophytic nitrogen fixing bacteria detection through meta-transcriptomics. Dr Y. Tansumos from MitrPhol, Thailand gave an overview of the sugarcane varieties in MitrPhol area and the future trends. Currently, Mitr Phol focuses on both sugar and high fibre traits and mechanization especially for harvesting and breeds new varieties for water logged areas. Dr. Chatsurachai from Mitr Phol, Thailand talked about the genetic variation of yeast genes involved in ethanol production from sugarcane molasses. Comparative sequence analysis of the genes from some of the isolated yeast strains identified the most significant variations to be present in the *adh1* gene in the substrate binding site. Thus, all these presentations dealt with the application of sugarcane improvement strategies that can result in an improvement in the different bio-based products from this crop.

The **Technical Session III on Sugarcane harvesting, processing, value addition and stewardship of environment**” was held concurrently on 07<sup>th</sup> March. The session was chaired by Dr. K Siroth from Thailand and Prof. Narendra Mohan from India and co-chaired by Dr. Robert Quirk from Australia and Dr. Wirat Vanichsriratna. The topics for the presentations covered a wide range, from biocomposting for zero-liquid discharge in distilleries, production and techno-economic evaluation of several bio-based derivatives from sugarcane bagasse and other products, including their processing, utilization of microbes from sugar mills for food and feed applications, application of expert system for sugar process improvement in sugar mills, use of cutting-edge technologies for sugar mill modernization, mechanization in sugarcane agriculture with special reference to harvesters and facilitating a smooth transmission from manual field management to mechanization etc., to name a few.

The **Technical Session IV on “Sugar-energy matrix in developing countries, sustainability issues, marketing national policies and integrated industries”** was held on 06 March from 2 pm in the Meeting Room 2 (Mookamantri). The Session was chaired by Dr. Kitti Choonahawong, Thailand Society of Sugarcane Technologists, Thailand and was co-chaired by Dr MC Gopinathan from Solidarid, India. The Co-ordinators were Prof. Son Chu-Ky from Vietnam and Dr. Munish Kumar, from India. There were four lead lectures and three oral presentations. Dr Keerthipala, Director, SRI, Sri Lanka talked about the public and private sector management of sugarcane industry in Sri Lanka. The utilization of mill capacity under both the public and private sector mills is very low, i.e., less than 50%. The sugar production and sugar recovery is also very low in both the sectors. The authors suggested public-private partnership or fully private management with strict regulations to revive the sugar industry in Sri Lanka. Dr Tanapon Chaisan, Kasetsart University, Thailand gave an overview of the sugar industry in Thailand and the by-product utilization in the industry. Thailand, an important sugar producing and exporting country, produces around 10 million tons of sugar. By 2025, the Thai sugar industry expects to produce around 48 million

tons of bagasse. Co-generation from bagasse and other diversification options are already being taken up by the industry. Still the efficiency of the industry with respect to sugarcane as well as sugar production need to be improved through various strategies like introduction of new high yielding high sugar sugarcane varieties. Dr. M.C. Gopinathan from Solidarid, India talked about “Sustainable sugar production and the challenges faced by small holder sugarcane farmers”. Disruptive climatic changes, water crisis and the volatile markets and other challenges have enhanced the significance of sustainability as a national as well as global agenda. With the sugar production, consumption exports etc., increasingly shifting towards the developing countries, the various initiatives for a sustainable and profitable sugar industry continue to evade the small holders. The small holders need affordable and adaptable solutions to the emerging issues, like improved productivity and profitability, access to improved technology, finance and risk mitigation, value-chain partnerships with trust, transparency, commitment etc. Future strategies should take into consideration, these aspects also. Dr.S.Solomon, Vice-Chancellor, CSAUA&T, India, gave an overview of the sugarcane based bio-products and industries in Asia and South East Asia. The Asian countries including South East Asian region being important sugar producers, the sugar industry in these nations need to be the frontrunners in utilizing the opportunity for a sugar industry based bio-product production and utilization at a commercial scale. This, in turn, is an essential strategy for sustainability and profitability of the sugar industry of the region. Thailand has undertaken a major 10 year plan of Bio-economy hub programme having an investment of 11.3 billion. The other Asian countries including India and China have also initiated sugar-industry based bio-products production programmes. Much more need to be done in this regard. The various challenges need to be overcome by the countries of this region so that the sugar industry in the Asian region can be the flag-bearers in the global march towards bio-based economy.

The Interactive Poster Session was held on 8<sup>th</sup> March 2018 from 1PM-3 PM. The posters were presented in four sections corresponding to the Technical Sessions. Dr. S. Solomon from India was the Chairman and Dr. Manoj Srivastava from India co-ordinated the Session. A total of 35 posters were presented from all the four technical Sessions- 22 posters under Session I, 8 posters under Session II, 4 posters under Session III and one in Session IV. The contents ranged from the use of conventional practices to the latest techniques in sugar crops production, improvement and management.

### **The Grand Finale:**

The valedictory session was held at 4 pm on 8<sup>th</sup> March at the Udondusadee Convention Hall. It was chaired by Dr Yang Rui-Li, President IAPSIT and was co-ordinated by Dr S. Solomon, Secretary, IAPSIT. Dr. S. Solomon welcomed the delegates to the Session and gave a quick brief about the Conference. He expressed his thanks to the entire team for all the support. This was followed by presentation of reports by the chairmen/co-ordinators of the various sessions. A brief report of the presentations and the recommendations that came out of the deliberations were presented for each session. The Best Poster Awards for the posters the different Sessions were presented. The First prize was bagged by the poster on comparison of Fly ash from different sources for use as adsorbent by Ngasan *et al.*, from MitrPhol, Thailand. Kumpan *et al.*, from MitrPhol got the second best poster award for their

poster on antioxidant phenolic extracts from sugarcane bagasse. The poster on analysis of Nitrogen fixation efficiency in sugarcane using  $^{15}\text{N}$  natural abundance by Ting et al., from GXAAS, China bagged the third award. Dr HP Singh and his team from India were awarded a consolation award for their poster on intercropping in sugarcane. Distinguished Scientists Awards were conferred on various researchers viz., Dr. Hoopa Hanboonsong, from Khon-Khei University, Thailand, Dr. M. Swapna from ICAR-Indian Institute of Sugarcane Reserach, India and Dr HG Prakash from Chandra Sekhar Azad University of Agriculture & Technology, Kanpur, India for contribution in their respective areas of sugarcane research. Prof. W Svasaard, Prof. W. Vanichsiratna, Prof. P. Weerathaworth, Prof. P. Sukyayi, Dr. S Uraicheun from Thailand, Prof. Narendra Mohan and Dr. DP Singh from India, Dr Duli Zhao from USA, Dr Li Tao-Yang from China, and Dr Son Chu-Ki from Vietnam received the Certificate of Appreciation. Dr. S. Solomon, Secretary, IAPSIT was conferred with the IAPSIT Leadership Award. Some of the participants gave their feedback about the Conference. While congratulating the organizers for the successful conduct of the event, they expressed the hope that the discussions during the Sessions would help in chalking out a blue-print for the development of a bio-based economy with the sugar industry showing the way. This, they hoped will be specifically relevant to the Asian region including the ASEAN nations. Overall, the delegates had an excellent opinion about the Conference. Dr Yang-Rui Li, President of IAPSIT and the Organizing Secretary of IS 2014 gave the concluding remarks and expressed his gratitude to the delegates and all others who had made the event a huge success. He expressed his hope that the suggestions and recommendations will help the global sugar and integrated industries to develop and evolve. The formal closure of IS 2018 was declared by the President, IAPSIT. The session concluded with a vote of thanks by Dr GP Rao, Publication Editor, IS 2018.

The evening of 8<sup>th</sup> March saw a gala Farewell Dinner with a very colourful and memorable cultural performance by the Thai artistes, at the Hotel Swimming pool zone. The dancers with their colourful costumes and well rehearsed and co-ordinated movements gave an enthralling performance which captivated the attention of the audience. The participants got a taste of exquisite Thai cuisine with a variety of mouth-watering dishes.

It was not “all work and no play” for the delegates at the Conference. After the Technical Sessions, the delegates visited the various temples, museums and also the village tourist locations famous for handicrafts and handmade products. Many participants visited the Red Lotus Sea in the Lake Nong Han. They also took maximum advantage of the opportunity to visit the market places and “to shop till they drop” for their favourite items. The shopping spree continued on all the days with the participants getting a taste of the various traditions and culture of Thailand in general and of Udon Thani in particular.

#### **Field Visits :**

On the concluding day of the conference, i.e., 9<sup>th</sup> March, there was a field visit to the Erawan sugar factory and Erawan Sugar Research and Development Centre. The officials at Erawan factory extended a warm welcome in a traditional manner and this was followed by introductory remarks. After a visit to the handicrafts stalls that displayed various items, and

also to the sugarcane fields, the delegates enjoyed a sumptuous meal. The visit to the R& D Centre was held in the afternoon. The R&D Centre showcased the commercial varieties released from government sectors like CSB08-108, LK92-11, conventional breeding plots including those for Energy canes derived from conventional breeding techniques, surface and sub-surface drip irrigation, sugarcane tissue culture plantlets being hardened in special nursery etc., apart from the various machinery used for sugarcane cultivation that were displayed.

The field/factory visit marked the formal conclusion of the Conference IS 2018. The delegates bid farewell to each other and to Udon Thani, looking forward to meet again during the 7<sup>th</sup> IAPSIT Conference at the next venue.

### **The main recommendations that emanated from the deliberations are listed below**

- Promoting germplasm exchange among institutions /countries for introgression of novel gene combinations into the existing genetic background., with a simultaneous emphasis on improvement for biomass along with sugar yield.
- Introgression of *Erianthus* genes for biomass/energy canes. Introduction of cytoplasm from *S. spontaneum* and other wild species.
- Intensifying the application of bio/nanotechnological tools to enhance the efficiency of breeding process for sugar/sweeteners as well as other products.
- Manipulating the specific metabolic pathways in the crop for enhanced production of chemicals, biomolecules, pharmaceuticals and other derivatives from bagasse, molasses etc., thereby, realizing the concept of sugarcane as a biofactory.
- Microbial engineering and identification of suitable microbial consortia for lignin/cellulosic degradation.
- Complete utilization of all the by-products, viz., bagasse, molasses, press mud and other products by the sugar industry, to ensure higher revenues for the industry.
- Use of alternate feed stocks like cassava, sweet sorghum , sugar beet etc., along with sugarcane, for bio-ethanol production/cogeneration
- Modernization of sugar industry with state-of-the-art technological interventions for better utilization of by-products, and establishment of sugarcane /bagasse-based biorefineries.
- Government incentives should be provided to sugar industry for facilitating a need-based shift to bio-based products.
- Small-holder friendly strategies to overcome the present-day challenges faced by the sugar industry
- IT-based expert systems for cane production in the field and process improvement in the mill, for improvement in quantity and quality of the products.
- Enhanced public funding and investment in R&D efforts, including infrastructure, for bio-based products/technologies, to facilitate the development of cost-effective, better and novel products and technologies for a bio-based economy.
- Clear-cut government policies with respect to strategies like GM crops, since genetic manipulations will have a significant role in development of bio-based products.

- Development and effective management of “Bio-economy Clusters” within the region among the sugarcane growing ASEAN nations.
- Facilitating adequate infrastructure, investments, trained human resource and exchange of research personnel well-trained in the related technologies, among the countries.
- Initiatives by IAPSIT for linkage and networking among the countries, organizing capacity building programmes and exchange of personnel.