ICRISAT

Sorghum Biofuels

Background

- The future of biofuels made from plant materials is of growing interest across the globe.
- Environmental benefits are a key outcome in developing or expanding **biofuel (1G/2G bioethanol, biogas**) production that can potentially reduce greenhouse gas emissions.
- Biofuels are carbon neutral at large, releasing carbon dioxide (CO_2) absorbed from the atmosphere by the crops used to produce them.
- The leading biofuel feedstocks are corn, sugarcane, and vegetable oils. The production of biofuels from these crops has raised concerns about the impact of rising commodity prices on the global food/feed system. Hence, policymakers are keen to explore other biofuel production resources, such as sweet sorghum, that do not compete directly with food/feed crops.
- Being a low-cost feedstock, sweet sorghum is expected to be an important driver for global biofuels. Implementing technologies that increase aboveground biomass yields and optimize lignin concentration can significantly increase bioethanol yields per ton of biomass harvested. This is expected to reduce biofuel production's economic cost and environmental impacts steadily.

ICRISAT's Capability

ICRISAT is well poised to significantly contribute to global efforts to increase biofuel production by co-designing, sharing, and scaling the technology and know-how with private/public partners and smallholder dryland communities.

Important milestones

- ICRISAT developed superior multi-purpose sorghum cultivars with high potential for aboveground biomass yields, stalk carbohydrates, and starch content, which are sought-after biofuel production metrics.
- ICRISAT has conducted 'Big Mill Tests' in sugar mills and has obtained encouraging results, i.e., sweet sorghum can complement molasses for meeting the ethanol blending targets of India.
- Available high biomass sorghum cultivars yielded 288 liters of ethanol per ton of dry biomass (i.e., 4000-6000 liter/ha), and sweet sorghum produced up to 3500 vs. 7000 liter/ha per year under single vs. double cycle management. This highlights sorghum's competitiveness vis-à-vis paddy straw and other traditional biofuel feedstocks.
- Pilot testing of high biomass sorghum in Numaligarh, Assam, India (where a 2G biofuel plant is being developed) showed that it could supplement bamboo as an ethanol feedstock. Sweet sorghum can also be integrated into the existing sugarcane industry to fill in the lean period of sugarcane crushing for year-round biofuel production.
- ICRISAT successfully incubated Rusni Distilleries Pvt. Ltd., a private sector company in India, that used sweet sorghum stalks as its feedstock for bioethanol production from 2005 to 2012.

The Way Forward

While ICRISAT's efforts have produced outstanding plant material with high brix (sugar content), fiber yields and other qualities, more research and development work is needed to:

- continuously improve the adaptability, yields, and quality of the products in newly developed sorghum varieties and hybrids, i.e., biofuel feedstocks
- streamline and mainstream the brown midrib (bmr) gene editing and fine-tune and test pyramided/ gene-edited high biofuel-yielding sorghum materials to share with private/public partners
- increase the shelf life of sweet sorghum stalks and juice (currently it has to be crushed and converted into syrup within 24 hours)
- reduce the negative trade-off between higher brix vs higher grain yield in order to develop superior dualpurpose biofuel sorghum ideotypes that are competitive for grain without compromising biofuel yields
- establish living labs as powerful 'Learning Technology Transfer Ecosystems', accounting for the entire biofuel value chains from 'Farm to Gas Station', with a particular focus on Asia and Africa
- scale up biofuel value chains while empowering stakeholders in drylands production environments and biofuels ecosystems.