EU-India Advanced Biofuels Conference

New Delhi, India

3rd March 2018

Decarbonizing the Indian fuels sector using domestic resources

CSIR – Indian Institute of Petroleum

Key Success Factors of Alternate Fuels

- Performance / Acceptability - Does it work?
- Scale and supplies – Can we get enough whenever and wherever needed?
- Cost – is it affordable relative to incumbent? If not, who bears the difference?
- Adaptability to existing infrastructure – Does money have to be spent to make it work?
- Sustainability – Does it mitigate environmental impact? Is the Net Energy Ratio favourable?

India – Fuel Carbon Imports (approx)

Commodity	Import, MMT/yr	% C	Imported C, MMT/yr
Crude Oil	220	85%	190
Coal	200	75%	150
Natural Gas	15	77%	11.6

Demand Side Response

- Reduce energy requirement (enhance efficiency)
- Reduce carbon requirement (non-carbon energy e.g. solar, wind, geothermal)

Supply Side Response

Find about 350 MMT of domestic carbon (on current basis) to replace our fuel carbon imports

Need energy security solutions that ALSO reduce GHG Emissions

Tree Borne Oils and Algae:
Uncomfortable Questions

For bio-jet deployment, at least 100 tons per day of oil is needed

What guarantees of supply would be provided?

What could be the long term contracted price for the oil?

Tree-borne oilseeds e.g. jatropha

1. How much yield can we isolate per acre of land?
2. What soil conditions, agronomic practices and water supply are needed?
3. In how many years would the plants mature and reach this output?
4. How will infestations and seasonal variations affect mortality and yield?

Algae

1. How large a pond or coastal lagoon is required? (Recently reviewed project: 20 acres per ton per day)
2. How will we protect the raceway pond from predatory contamination?
3. How will we remove all the water at a reasonable cash/energy spend?

Jatropha and algae have not delivered. How do we get enough lipids?

Scalable options for lipids

- Today: ONLY Food value chain by-products
  - Used Cooking Oil
  - Palm Stearin; other edible oil refining co-products
  - Fats/oils from slaughterhouses, poultry, fisheries
- EMERGING
  - Tree borne oils (regional TBOs, not just jatropha)
  - Rotation crops (carinata; early success in Punjab)
- FUTURISTIC
  - Microbial oils
  - Dairy and sewage fats

GREEN FUEL

BIODIESEL TO BE MADE FROM USED COOKING OIL

30 LAKH TONNES
Projection of how much used cooking oil manufacturers can get

50 LAKH TONNES
Consumption of biodiesel per annum by 2030

12 LAKH TONNES
Installed manufacturing capacity of biodiesel in India

73,000 TONNES: Manufacturing capacity of biodiesel in Gujarat

6,000 PUMPS
Selling B-5 blend (5% Biodiesel + 95% diesel) in India

350 DEPOTS
is the targeted number of collection centres for used edible oil in India by January 2019

Source: Biodiesel Association of India

RECYCLING WASTE

- **Heating** and **re-heating edible oil increases** the **value** of **total polarized compound** (TPC)
- An amendment to the Food Safety and Standards Authority of India (FSSAI) Act implemented from July 1, says, **edible oil** with TPC value **beyond 25% is unsafe** for human consumption
- **Used edible oil with TPC >25% can be used to produce biodiesel**

Used Cooking Oil based Biodiesel Now Commands a Premium

RUCO Express - Dehradun

Launched with Food Safety and Standards Authority of India (FSSAI) and NGO Partner SDC Foundation

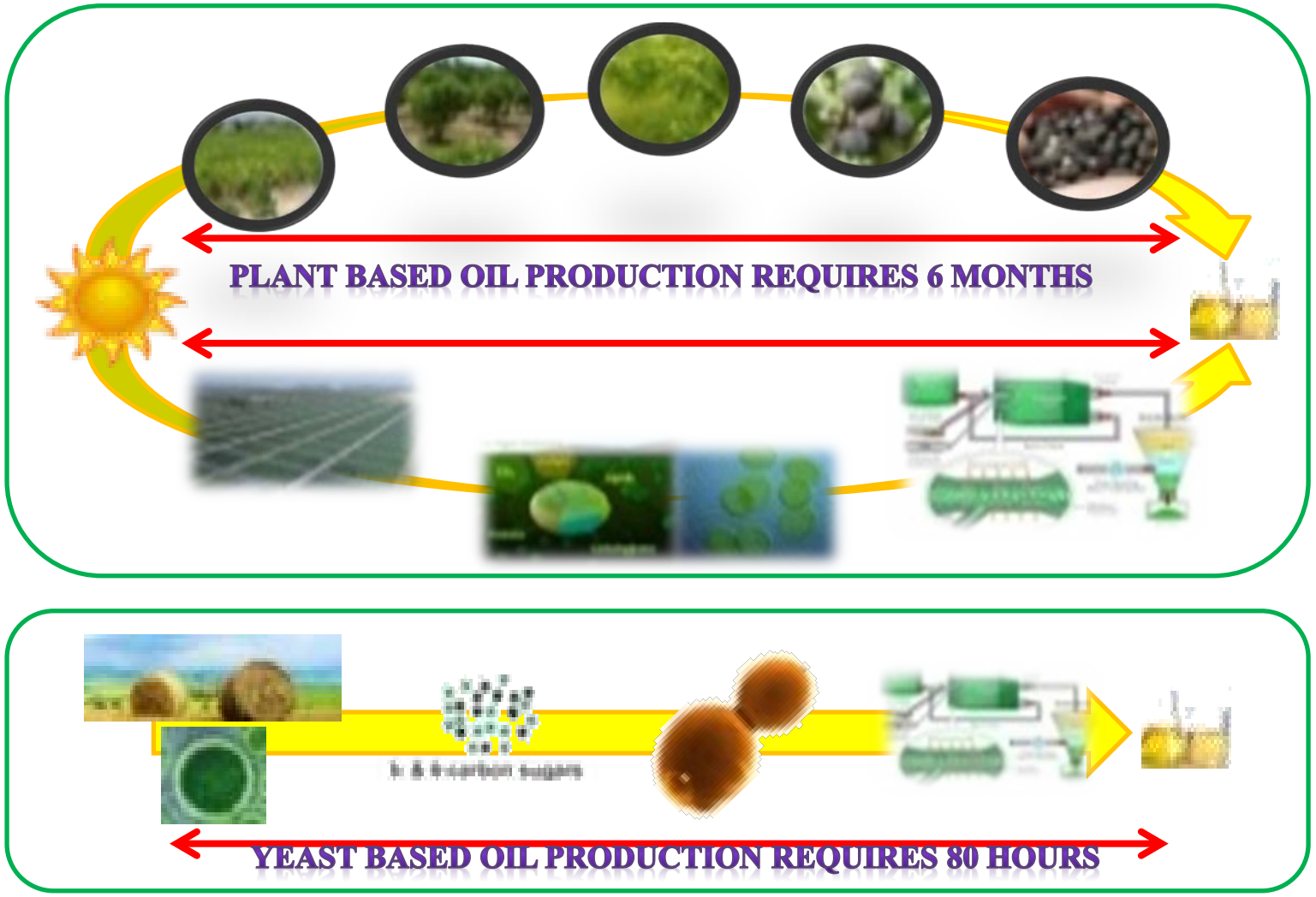
In 3 months from launch

~ 20 participating F&B Outlets

~ 1000L per week

(>50 KL per year)

Microbial SCO:
Oleaginous Yeast Lipids



Carbon economies for oil production from oleaginous yeasts

- Maximum theoretical conversion
  100 g glucose ⟶ 33 g Tri- Acyl Glycerol (TAG)
  (Ratledge, 2014.)

- Highest practical conversion
  100 g glucose ⟶ 17-20g TAG

- Most microbes are not able to obtain maximum theoretical yield due to diversion of flux towards other metabolites.

Tuning the carbon flux to improve the lipid production in oleaginous yeast *Rhodotorula sp.* RMIIPL32

Using C5 sugars (2G ethanol by-product) instead of C6

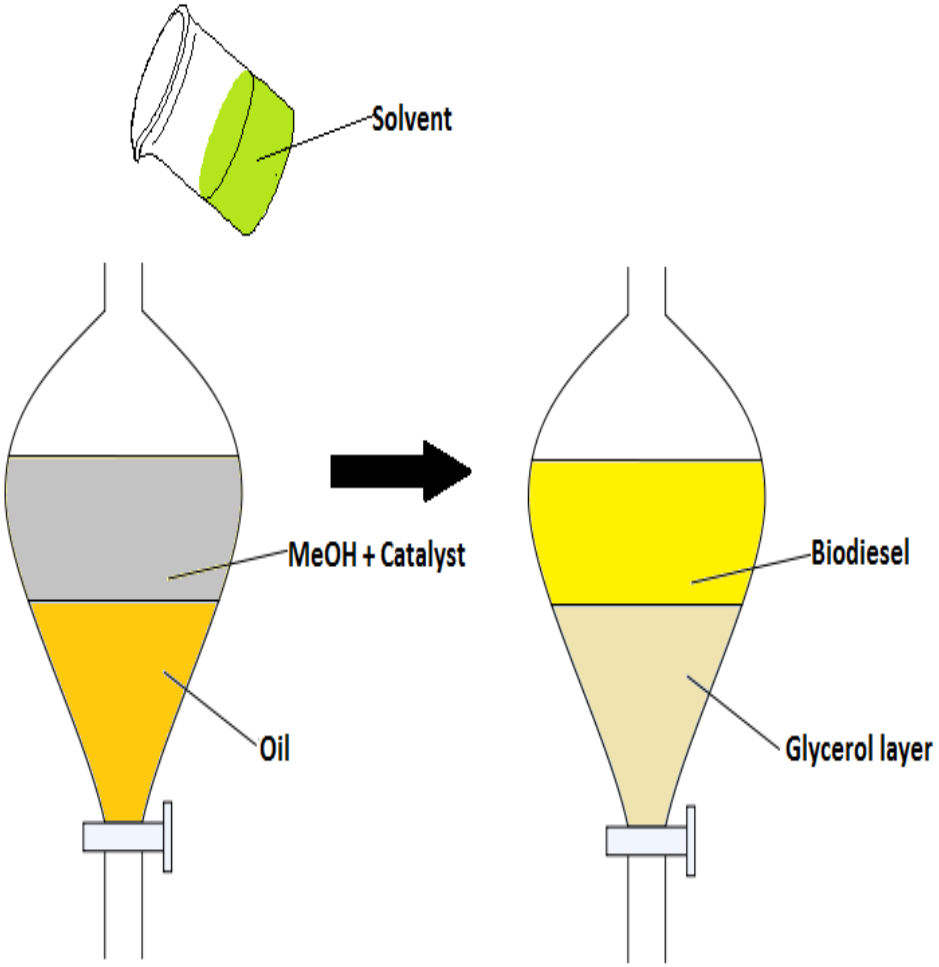
- **Biomass yield 0.268 g/g of xylose consumed**
- **Lipid yield 0.17 g/g of xylose consumed**
- **Fat coefficient of 17.54% w/w on consumed sugar basis**

Fatty acid composition of SCO from RMIIPL32

#	Fatty acid	Short-hand designation	%(w/w)
1	Capric Acid	**C10:0**	4.76
2	Lauric Acid	**C12:0**	6.31
3	Myristic Acid	**C14:0**	5.76
4	Palmitic Acid	**C16:0**	19.75
5	Stearic Acid	**C18:0**	2.76
6	Oleic Acid	**C18:1**	48.69
7	Linoleic Acid	**C18:2**	4.74
	Total Saturated fat		**40.88**
	Total Mono unsaturated fat		**48.92**
	Total Polyunsaturated fat		**4.99**

Microbial Lipids could Alter India's Lipid Supply Chain for Biofuels

CSIR- IIP Room Temperature Biodiesel Process



- ✓ Ambient catalytic conditions
- ✓ No heating or mechanical stirring
- ✓ After separation of glycerine, FAME biodiesel purified by water wash/distillation.
- ✓ Especially suitable for small scale distributed operations
- ✓ Can be used as distributed sourcing for bio-jet/HVO plants
- ✓ "Drop and drive" rural community model enabled

Vision: 1 bbl/day biodiesel, 50,000+ locations across India

"Make and use": Minimize carbon footprint of transporting biofuels

Comparable with one petroleum refinery diesel unit

Waste Plastics to Fuels and Chemicals
CSIR-IIP- GAIL Technology

Petrochemicals (500 ml)
(Benzene,Tolune, Xylenes) + LPG

Gasoline (700 ml)
+ LPG

Option-1

Option-2

Option-3

Diesel (850 ml)
+ LPG

1 Kg waste (PE+PP)

- Exclusive production of either ***gasoline or diesel or aromatics*** along with ***LPG*** from polyolefinic wastes (e.g. HDPE, LDPE, PP etc)
- Liquid fuel meeting Euro IV/VI specifications., Aromatics rich in BTX

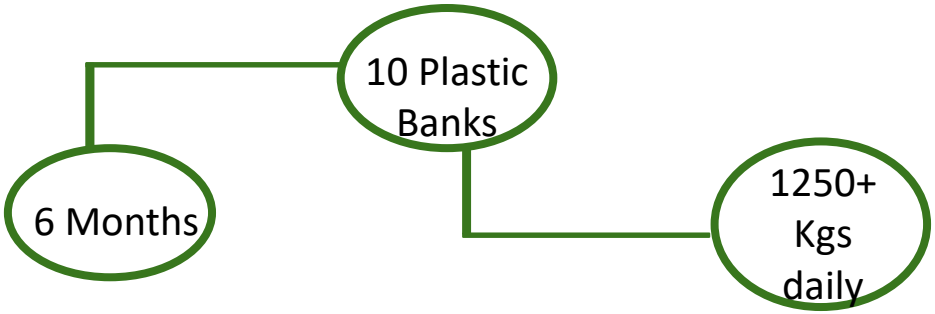
Social Development
for Communities
FOUNDATION

PLASTIC BANKS

An innovative and community driven
plastic supply chain model
in
Dehradun, Uttarakhand

Plastic Bank – The Concept

- Innovative and community oriented plastic waste collection model
- Encourages communities to know their waste better
- Supports segregation, collection, transportation and recycling
- Engages communities and stakeholders like bulk waste generators, urban local bodies etc.
- Spurs community driven behaviour change and social action



Plastic Wapsi Abhiyan

- Dehradun Smart City Limited launches Plastic Wapsi Abhiyan at 20 government schools
- ~5,200 students from class 6 to 12
- Creates the framework for segregation, collection and documentation
- Recognizes top performing schools and students
- Rewards high plastic collection institutions and individuals
- Recycles plastic waste from the community at the CSIR-IIP facility
- Civil society organization SDC Foundation curates the campaign






CSIR-IIP and SDC Plastic Banks of Dehradun

ESS ELL Honda

Drishti Eye Institute

In Conclusion...

- Biofuels and Alternate Fuels have taken much longer than anticipated to fulfill their promise
- Scalability has been the primary constraint
- Increased focus on waste carbon supply chains enhances chances of successful projects
- A concerted effort along the value chain with strong institutional and committed local partners, supported by conducive policies, is making a visible difference

*Man and Nature must **coexist in harmony**; the alternative is **not sustainable***