

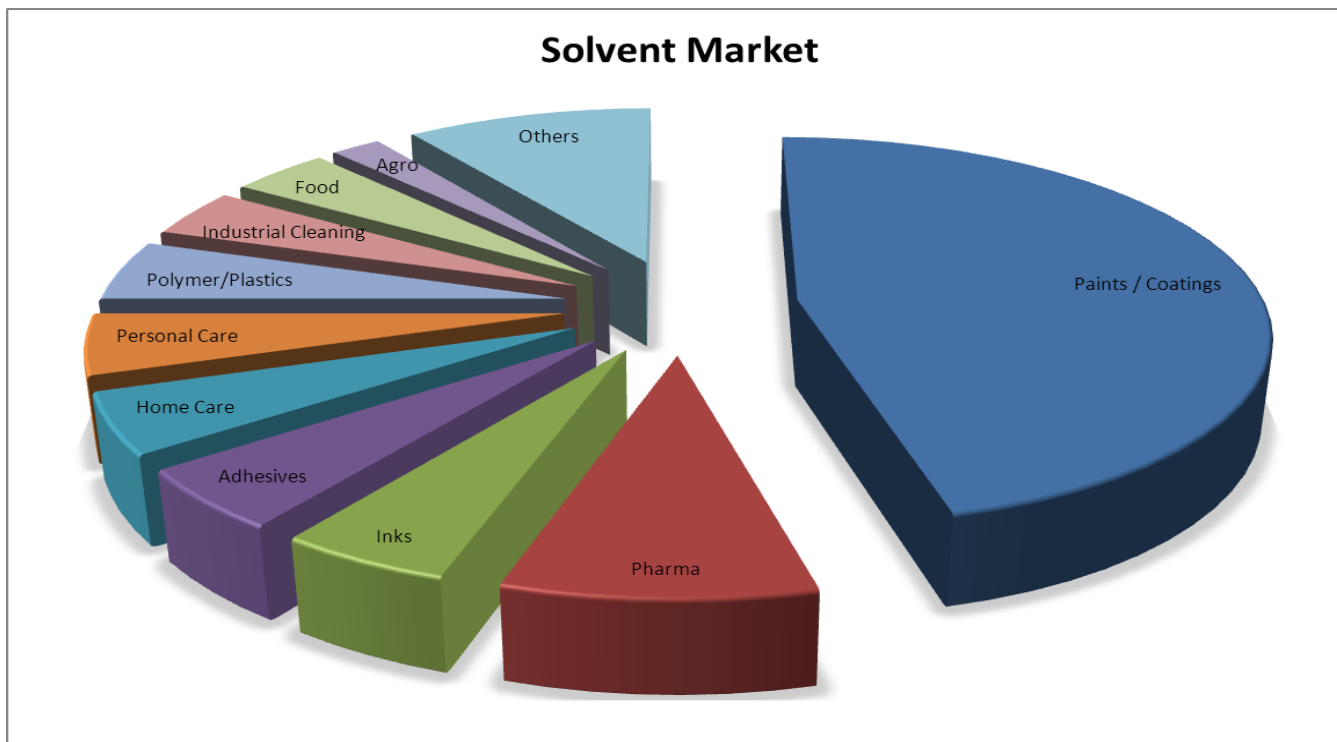
OPPORTUNITIES FOR BIO-BASED GREEN SOLVENT

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Solvents

- Chemical substances that can dissolve, suspend or extract other materials
- Can serve various functions – extraction, purification, medium for reaction, coating, cleaning, energy control.....
- Used in different industrial segments



Need for alternate source

- The Global Solvent market is in order of 20 MMT and , in terms of value is worth tens of billion of US dollars annually.
- Key driving industries - Paints & coatings, cosmetics & pharmaceuticals
- Primary source of Solvent - Petroleum feedstock
- It is estimated that solvent use accounts for 50%-80% of mass utilized in a typical chemical operation and create many environmental concerns.
- Perfect solvent is not available - trade-off between efficiency, cost and environmental impact
- Regulations and Organizational preferences .
- Legislation-Such as In Europe recently imposed REACH legislation.

What are Green Solvents?

- Chemicals manufactured using fermentation route /renewable resources
- Minimize the use and generation of hazardous substances
- They meet the goal to minimize environmental impact
- **Therefore They are – A sustainable Option**

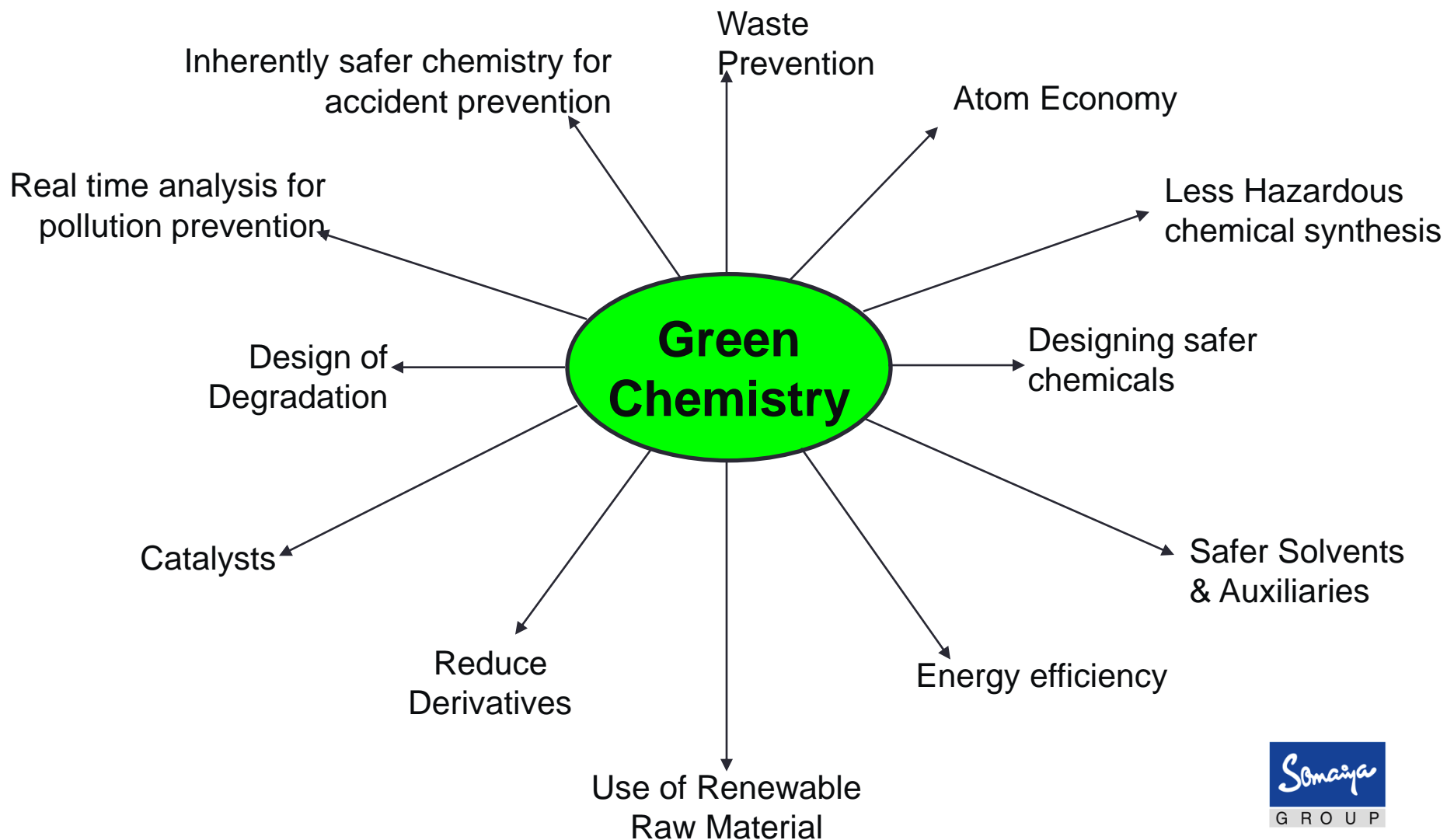


Green solvent opportunities

- The green solvents market would replace $\sim 1/4^{\text{th}}$ of the total global consumption of solvents by 2020
- The green solvents market have witnessed a moderate growth in the past few years and is likely to continue so in the in the coming years
- Green solvents have made rapid incursions into a variety of end-use segments such as printing inks, coatings, pharmaceuticals , adhesives, food processing and cleaning products.
- **This is in sync with Green Chemistry Principles**



Principles of Green Chemistry



Use of Renewable Raw Material

- A natural resource that can replenish itself over time

- **Renewable Raw-materials**

- Agricultural
- Forestry



- **Examples of renewable agricultural raw materials which are used across industries -**

- Cellulose
- Starch
- Sugar
- Oils

About Godavari Biorefineries Ltd (GBL)



- GBL through its journey of 78 years has created a well integrated sugarcane processing complex & has become a leading manufacturer of Sugar, Ethanol, Organic Chemicals, Power & Bio -Fertilizers.
- GBL is actively pursuing the goal of creating a unique Biorefinery using green & renewable sugarcane as a feedstock.
- GBL is involved in production of various agricultural products & sugar manufacturing since 1939, started producing ethanol from 1961, has launched a cogeneration unit in 2002, and is selling carbon credits since 2007.

GBL'S Milestones



- No.1 Processor for Sugar at a Single Location.
- Processing 2 – 2.5 Million Tons of Sugarcane per year.



- Power plant capacity 50 MW.



- Leading manufacturer of Beverage Grade Ethanol & Anhydrous Ethanol used in blending with gasoline.



- Produces various chemicals using Ethanol as feedstock.
- Among top 10 producers of Ethyl Acetate in the world
- GBL's Chemical Unit is an Export Oriented Unit (EOU).

About Somaiya Group

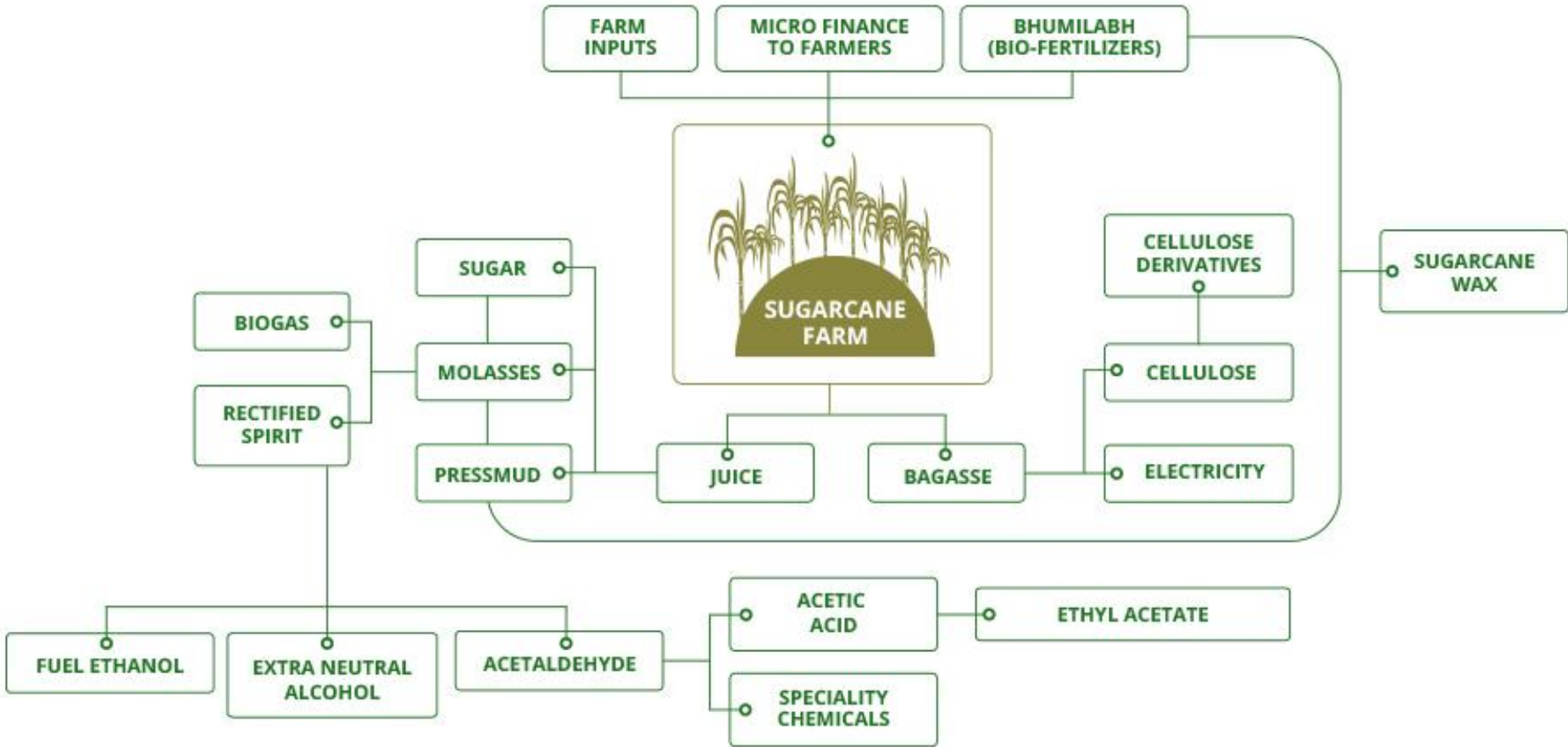


Somaiya group established in 1939 is one of the oldest and well established industrial houses in India and has diversified interest in:

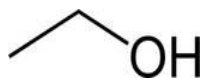
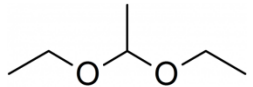

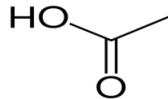
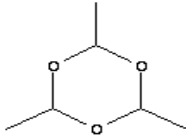
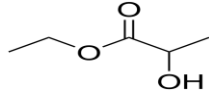
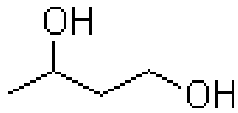
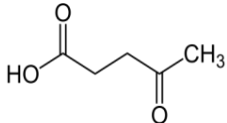
- Sugar
- Ethanol
- Bulk Organic Chemicals
- Specialty Chemicals
- Agriculture & Agricultural Research
- Renewable energy
- Education
- Healthcare
- Printing and Publishing
- Food Processing



GBL's Value Chain



GBL – Solvents from renewable resource

- Ethanol 
- Acetaldehyde diethyl acetal 
- Ethyl Acetate 
- Acetic Acid 
- Paraldehyde 
- Ethyl Lactate 
- 1,3-Butanediol 
- Levulinic acid and esters 

Ethanol



- **Renewable solvent**

Molasses \longrightarrow Ethanol

- **Fermentation Reaction**

- **Properties & Applications**

- Low toxicity and pleasant odour
- Possesses bactericidal and fungicidal activities
- Can be found as a solvent in numerous oral liquid formulations and OTC medicines
- Can be used as an extraction solvent in herbal medicinal products
- Has applications in the personal care industry, paints, coatings, printing inks, flavour and fragrance industries

Ethyl Acetate

- **One of the most popular Solvent**

Molasses \longrightarrow Ethanol \longrightarrow Ethyl Acetate

- Esterification reaction



- **Properties & Applications**

- Low toxic and possesses fruity odour
- Widely used as a solvent for API manufacturing
- Used in agrochemical, personal care & Fragrance industries
- In paints act as an activator or hardener
- As a solvent it is pretty harmless to the environment and human beings

Ethyl Lactate

- **A renewable Solvent**

Molasses \longrightarrow Lactic Acid \longrightarrow Ethyl Lactate

- It's an important organic ester
- Biodegradable solvent with excellent properties and low toxicity being produced by lactic acid aqueous solution and ethanol, via an esterification process



Ethyl Lactate



- **Attractive Solvent Properties**
 - ✓ Biodegradable
 - ✓ Easy to recycle
 - ✓ Non-corrosive
 - ✓ Non-carcinogenic
 - ✓ Non-ozone depleting
 - ✓ Low volatility, toxicity & flammability
 - ✓ Superior miscibility in polar and non-polar mediums
- **Commonly used in the Personal care, electronics, Paints & coatings industry**
- **Potentially has many other applications**

1,3-Butylene Glycol

- **Solvent for variety of applications**

• Molasses \longrightarrow Ethanol \longrightarrow Aldehyde \longrightarrow 1,3-BG



- COSMOS certification (100 % Natural origin)

- **Properties & Applications**

- Practically odourless, viscous
- Hygroscopic liquid of low toxicity
- Possesses anti-microbial property by itself which contributes to the preservation of cosmetics against spoilage by micro-organisms
- Intermediate in the manufacture of polymeric plasticizers

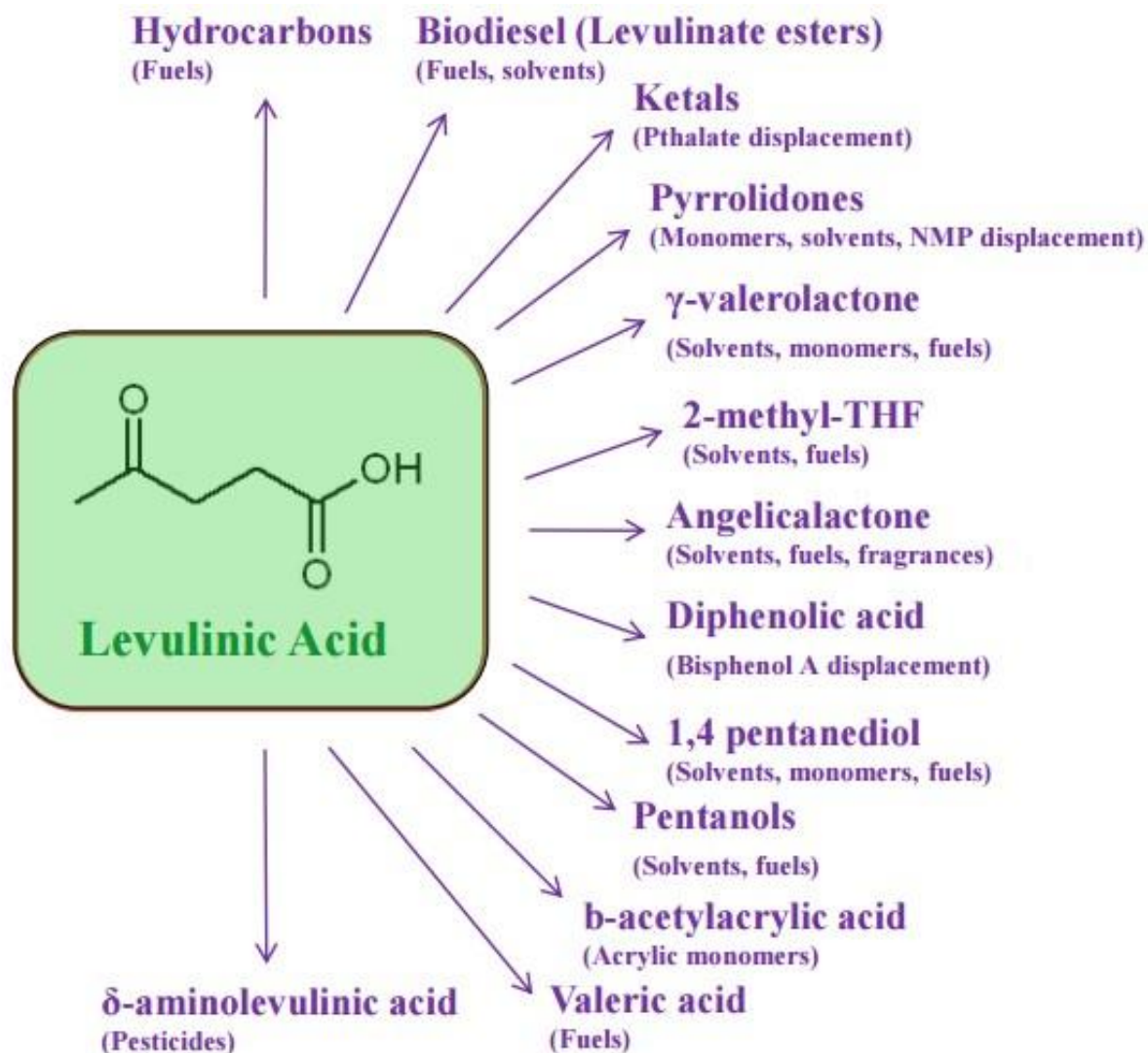
Green Acetals



Green Alcohols + Green Acetaldehyde \longrightarrow Green Acetals

- Acetals can be used to replace Toluene, Benzene, Xylene and dichloromethane
- Used in sectors - Coatings, Inks, Adhesives, Cosmetics, Pharmaceuticals, Agrochemicals & potentially in any sector
- Advantages - High solvent power, variable evaporation rates & polarity

Levulinic Acid as a platform



Ethyl Levulinate

- ***Biodegradable solvent***

Molasses \longrightarrow Levulinic acid \longrightarrow Ethyl Levulinate

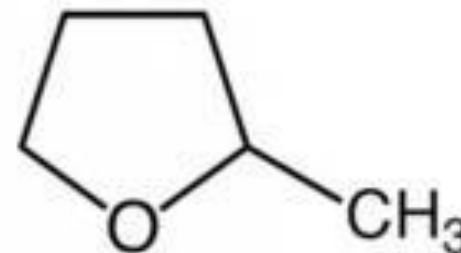
- It's an important organic ester
- Low toxicity being produced by levulinic acid aqueous solution and ethanol, via an esterification process
- Used in the fragrance industry
- Considered as future biodegradable fuel

Other Solvents



2-Methyltetrahydrofuran (2MeTHF)

- Derived from renewable Source
- Guarantees superior versatility, efficiency and reactivity in Grignard and organometallic reactions.
- It is an aprotic solvent (not miscible with water)
- Better ecocompatibility
- Non-irritating



Other Solvents

Bio- Methanol

Bio- Butanol

Levoglucosenone

Dimethyl iso sorbide



Conclusion



- *There is no universal green solvent and the best options are based on cost, environmental benefits and other relevant factors.*
- *Need for Green bio solvent :*
 - *Economically feasible to produce*
 - *Cost appealing to consumers*
 - *Give our Environment a break*

How many of you would be willing to pay 2-3 times more for Bio-solvent because they were “environmentally friendly”?