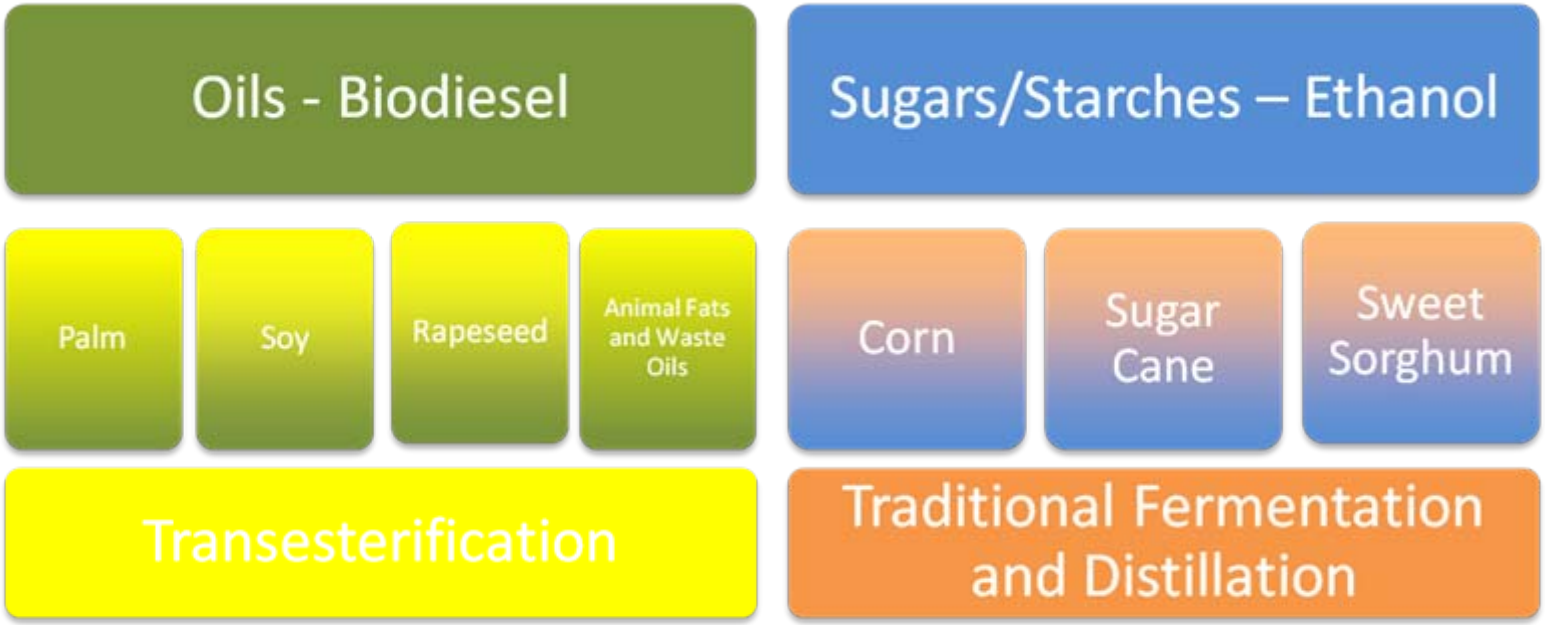
What's Next for Biodiesel: The Future of Feedstocks and Technology

6th Annual Global Oils and Fats Forum

October 6, 2009

Current Biofuels Situation



Perception (not always reality) of incompatibility with fueling infrastructure.

Oxygentated fuels which have a lower energy density than petroleum. Nonetheless, both have proven valuable as an addition to the fuel supply.

Current process technologies produce fuels which are not applicable in certain segments such as aviation fuel.

Sustainability issues continue to plague the industry.

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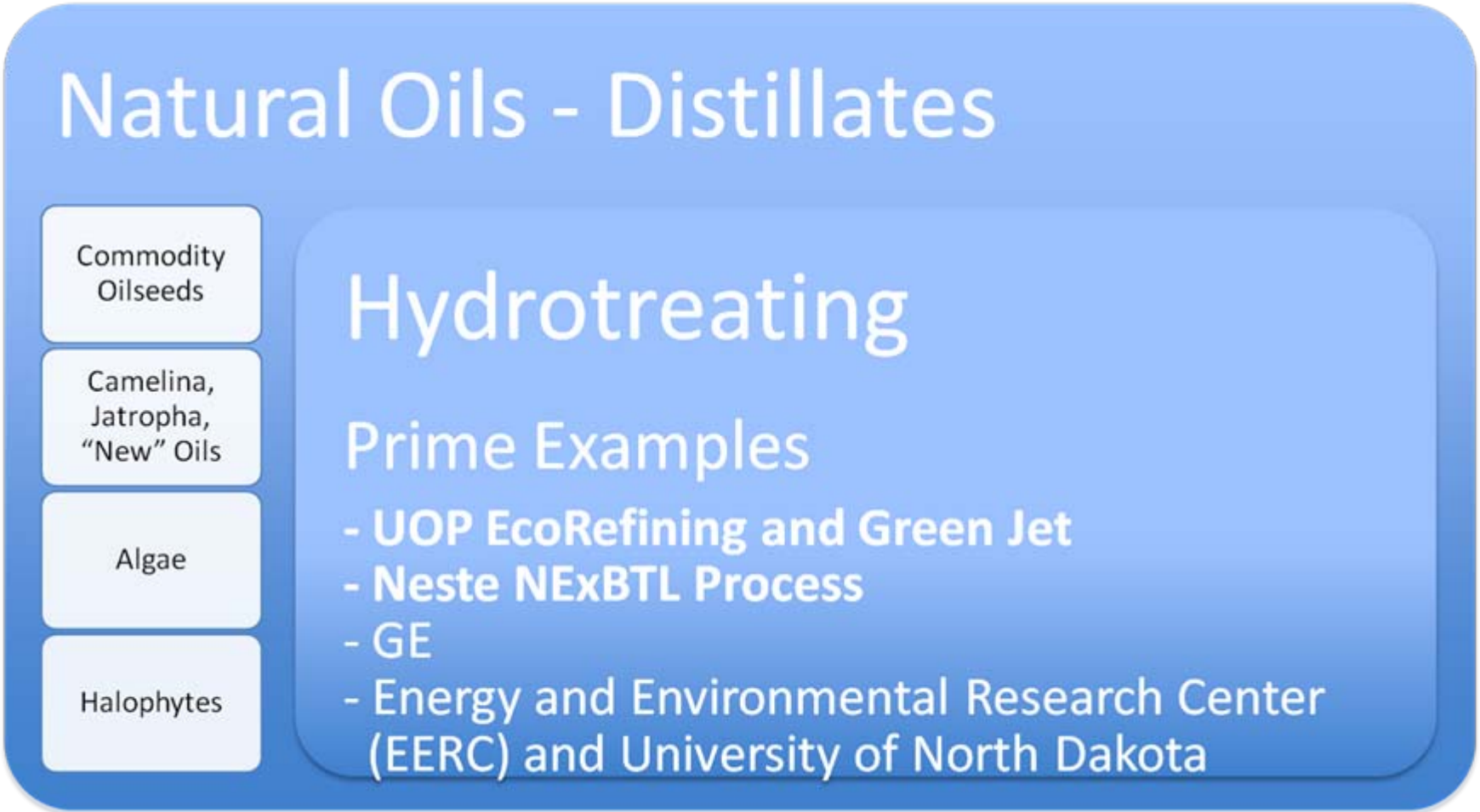
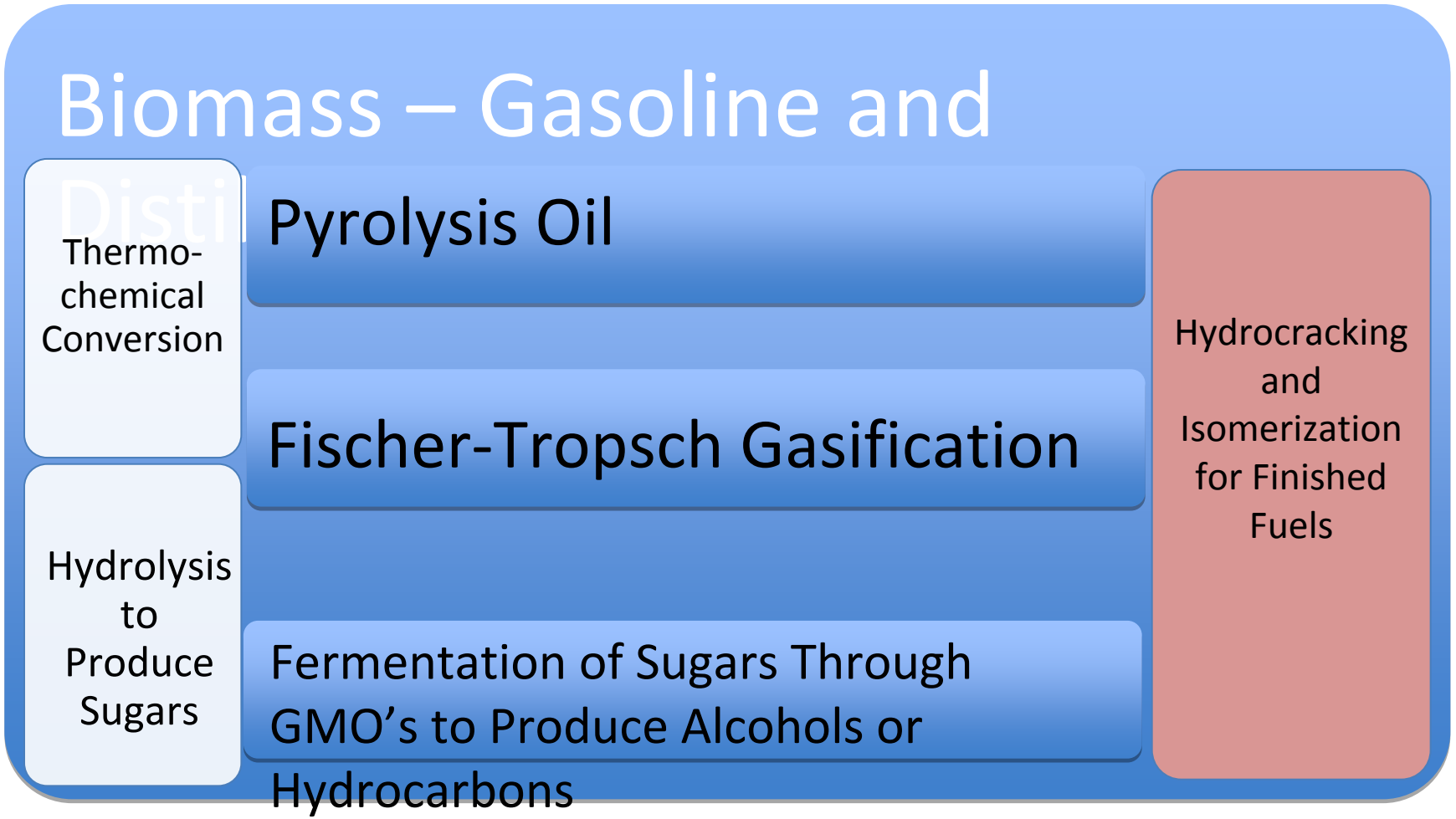
Next Generation Feedstock and Processing



Next Generation Feedstock and Processing



Biomass Potential for Palm

Palm industry has caught the attention of researchers due to its high biomass yield.

- Shell, Fiber and EFB represent over 80 million tons of biomass yearly.
- Palm Fronds represent over 45 million tons of biomass per year. After replanting, trunks could be as much as 10 million tons per year.
- Currently only about 10% of the biomass is used commercially (though most is used as part of integrated plantation management).
- Biomass is already centralized

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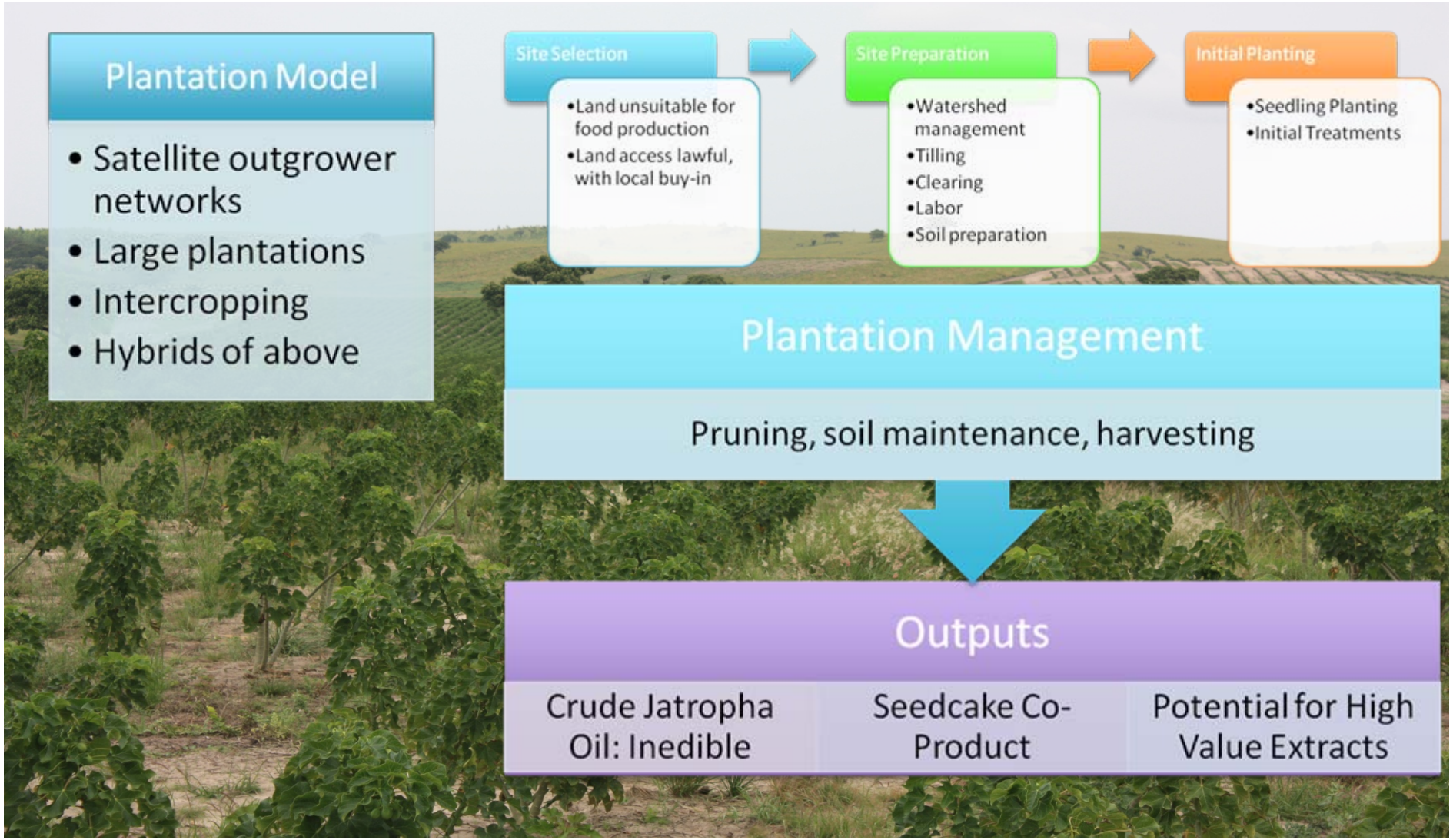
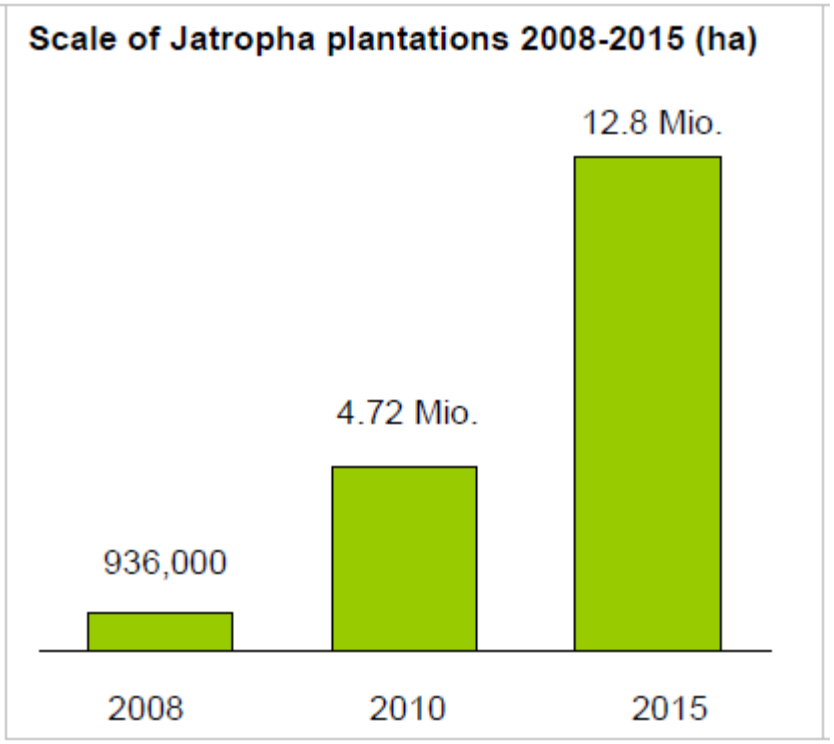
Jatropha Overview



Jatropha – Present and Future Scale



Source: *GEXSI Global Market Study on Jatropha Final Report to WWF* May 8, 2008

Sub-Scale

- Largest plantations <20k hectares
- Most <2 years old
- Seed more valuable for planting. No commercial oil production.

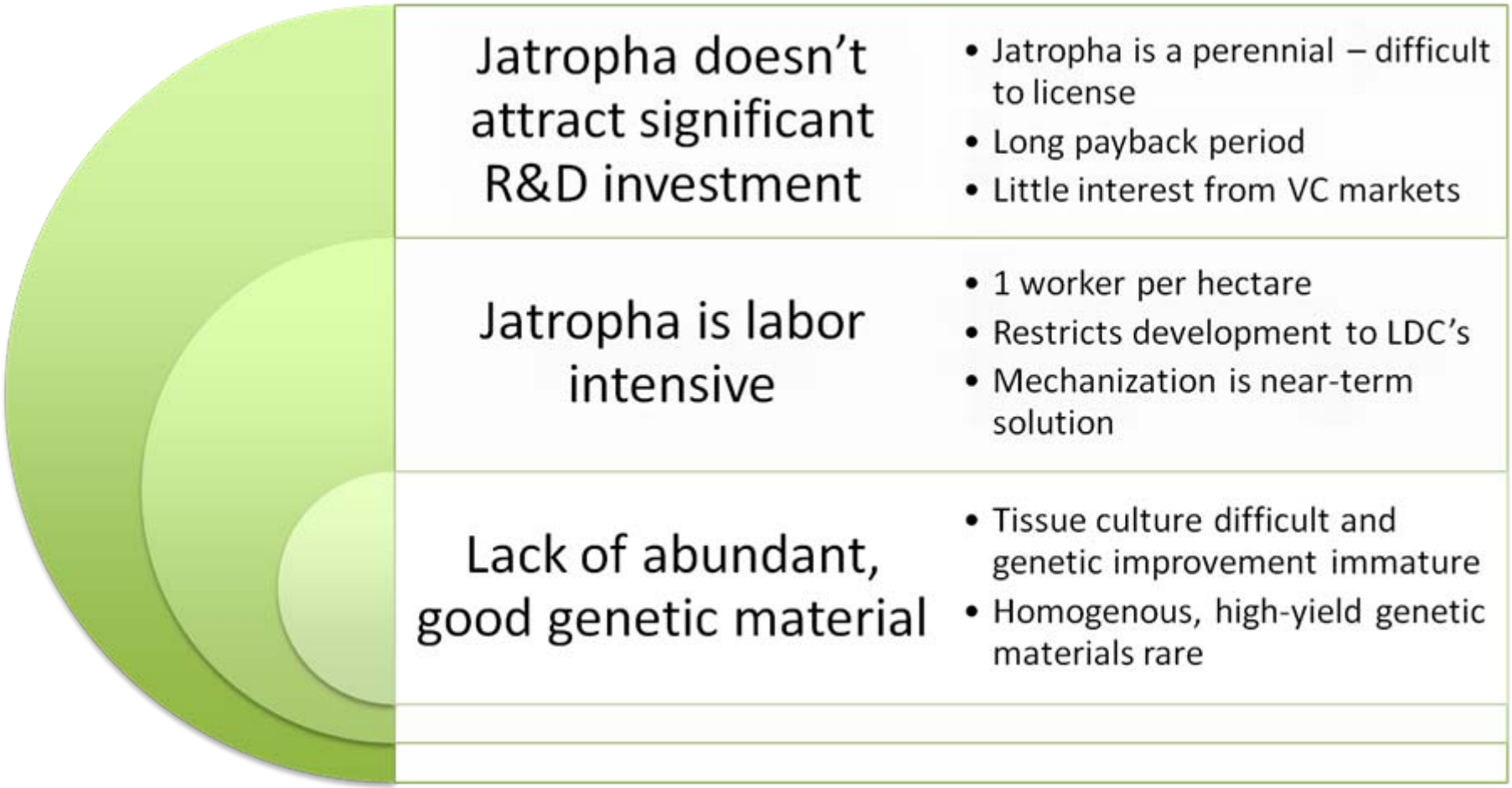
Mixed Plantation Models

- Large contiguous plantations now underway
- Out-grower networks will play central role in scaling industry

Sustainable Planting

- GEXSI study finds only 1.2% of lands with competitive food production
- Study finds only .3% of plantings were previously primary forest, only 5% secondary forest

Barriers to Scaling of Jatropha Industry



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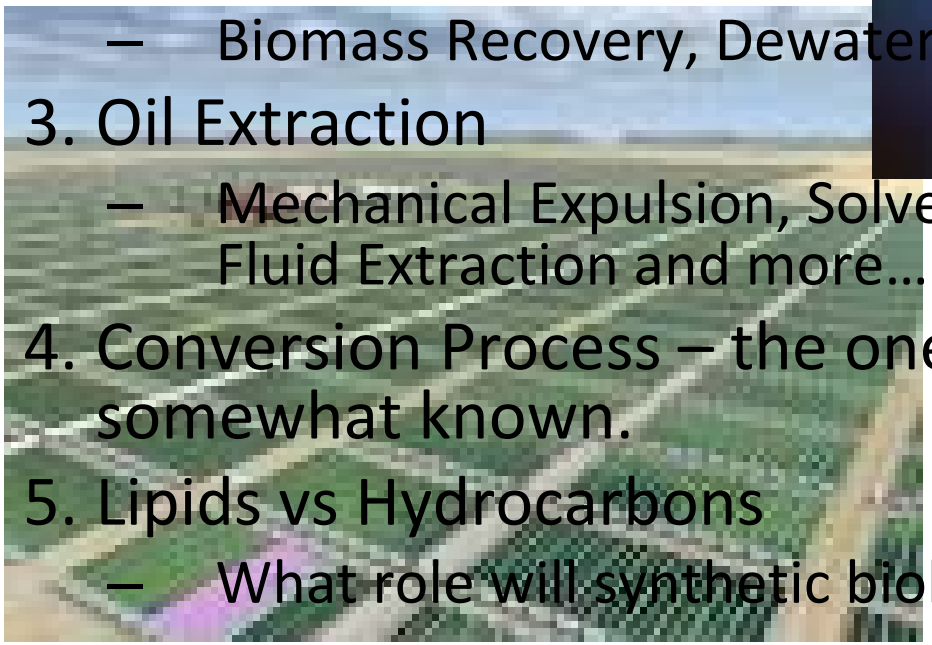
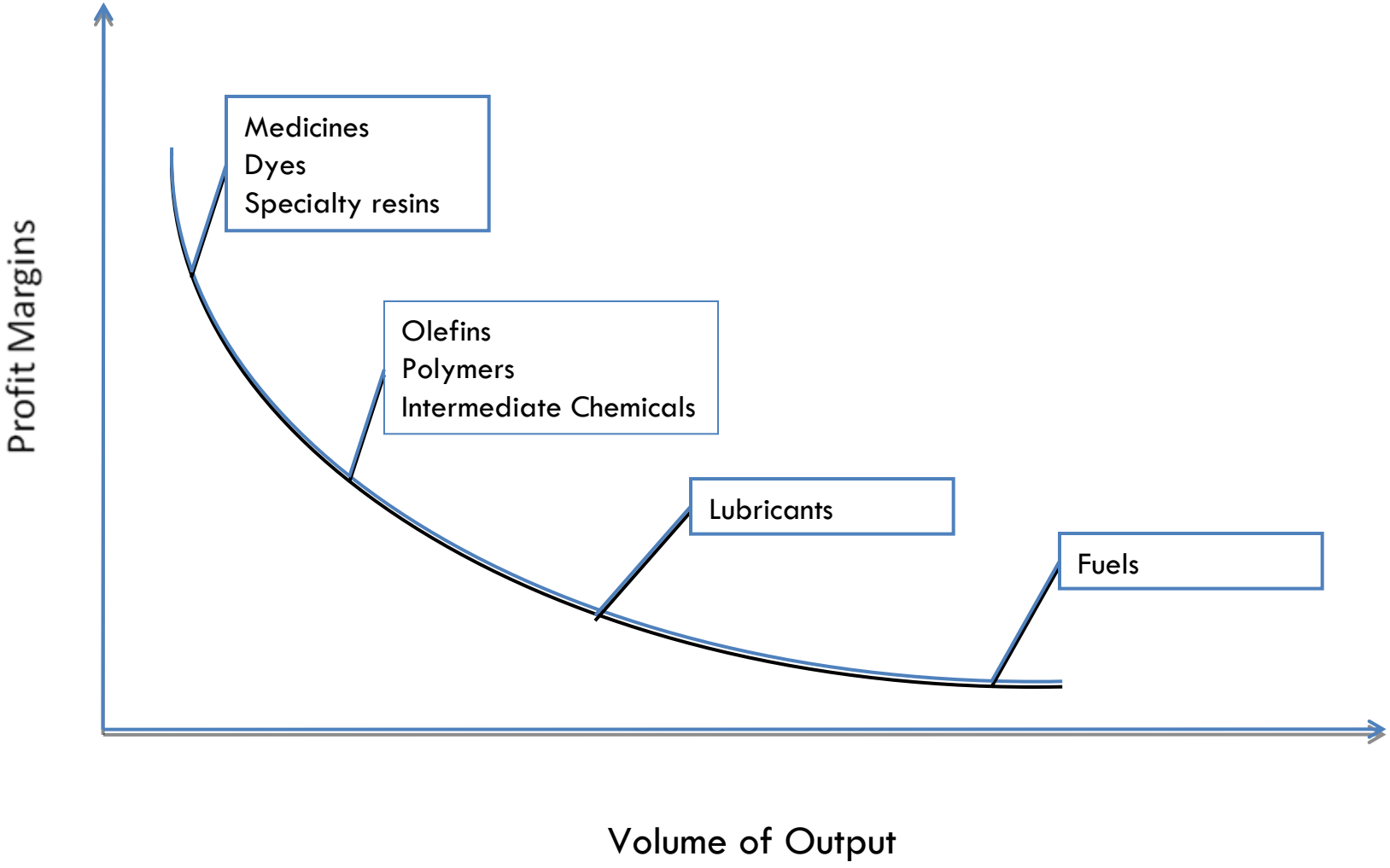
Alg

So Many Unknowns:

1. Cultivation
   - Open Ponds, Photobioreactors, Heterotrophic Fermentation, some sort of hybrid of all three?
2. Harvesting
   - Biomass Recovery, Dewatering, Drying
3. Oil Extraction
   - Mechanical Expulsion, Solvent Extraction, Supercritical Fluid Extraction and more…
4. Conversion Process – the one piece that is actually somewhat known.
5. Lipids vs Hydrocarbons
   - What role will synthetic biology play?



Petroleum Refining Margins



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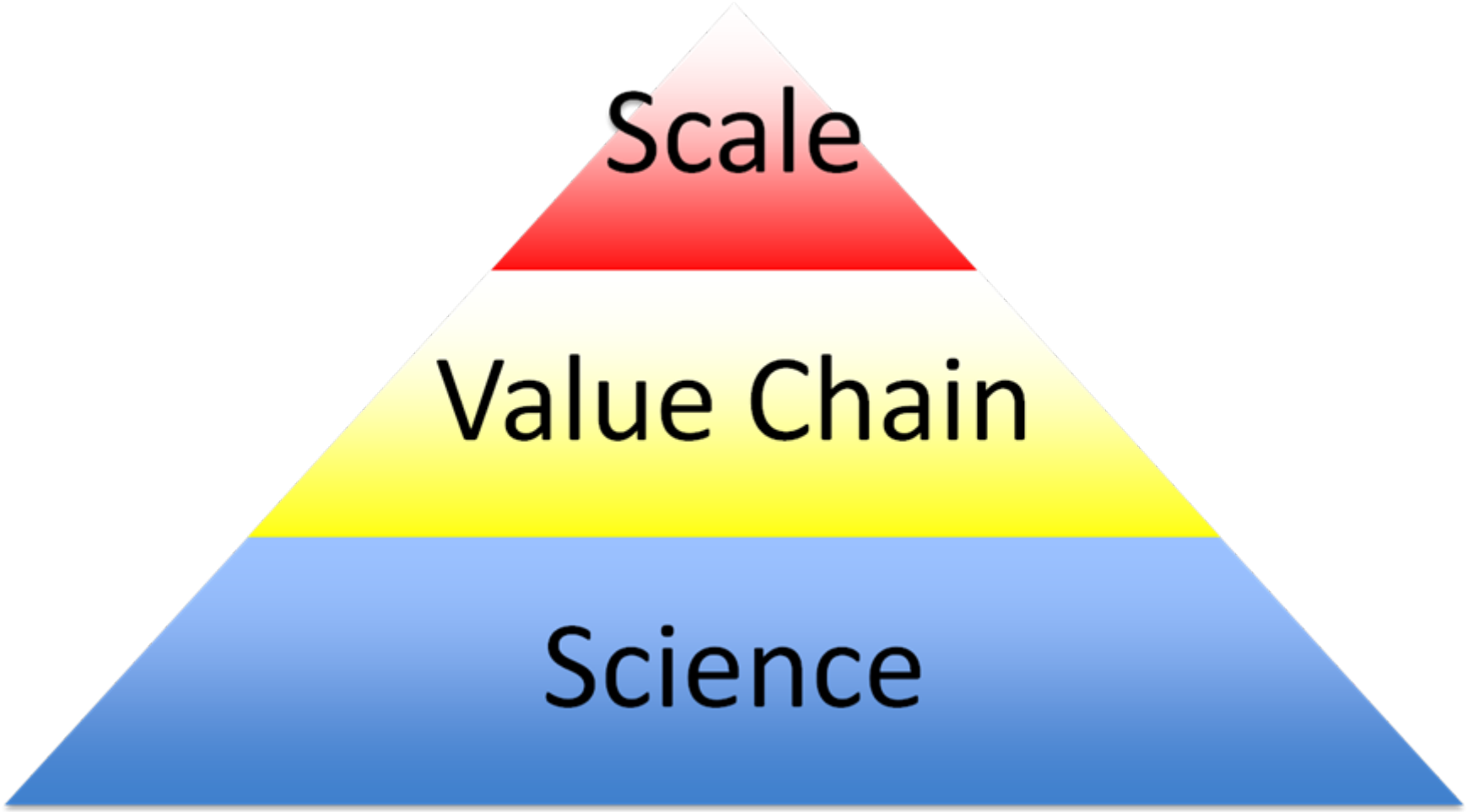
Steps to Algae Production…



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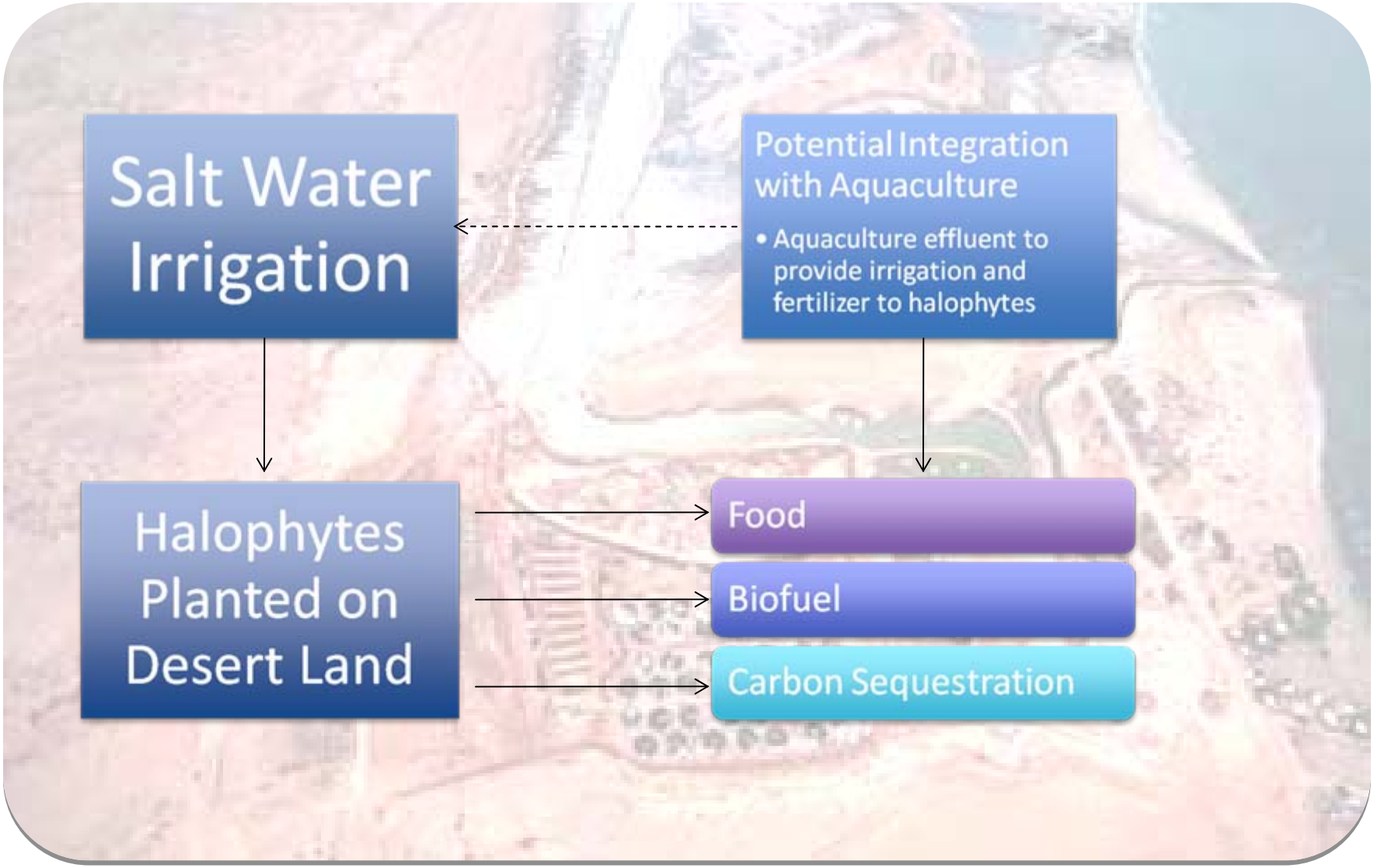
Halophyte Overview



Camelina Overview

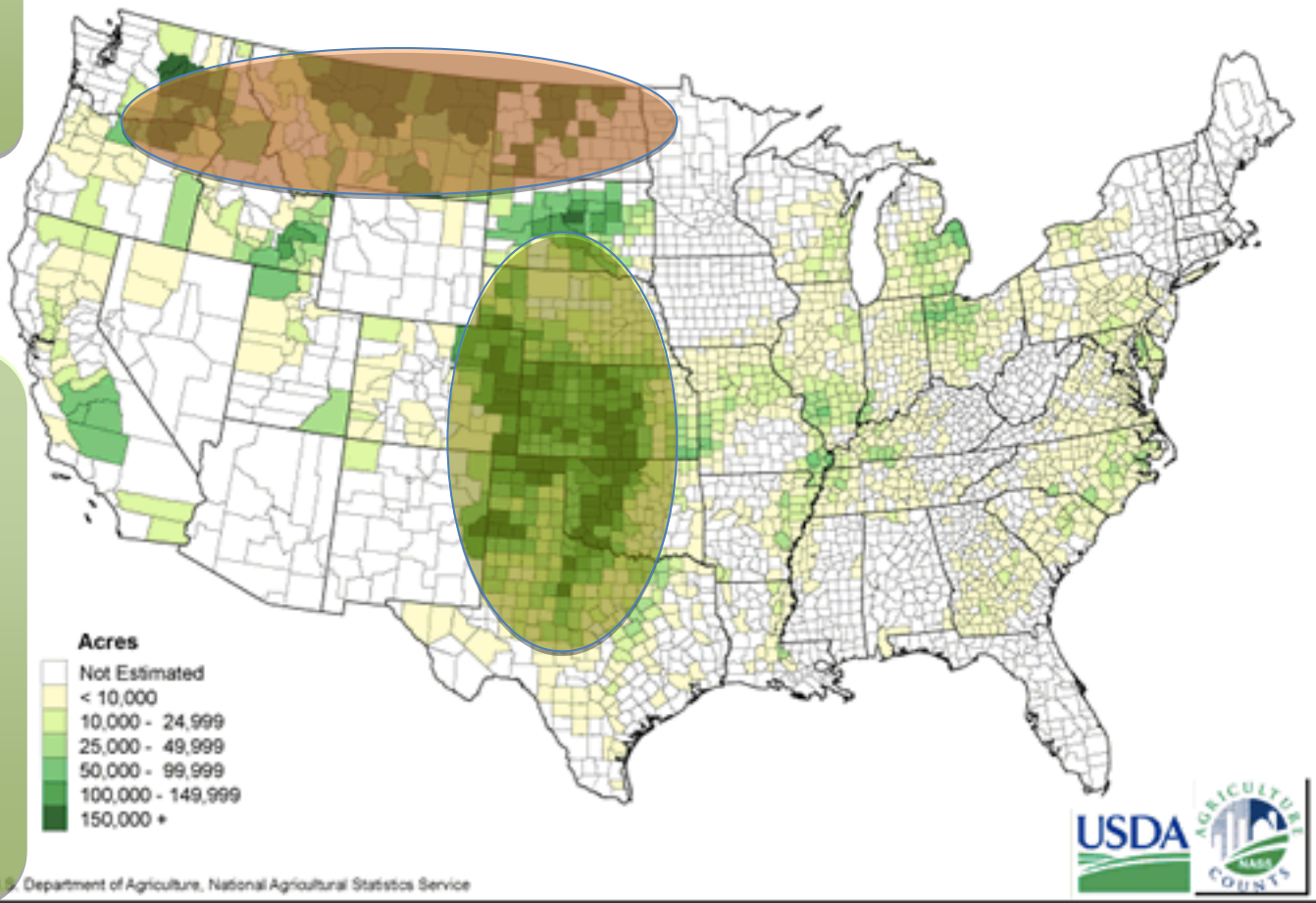
Grown during fallow period of wheat crop rotation

- Dry farming: no irrigation
- No land use conversion
- Potential: ~ 1 billion gallons/yr

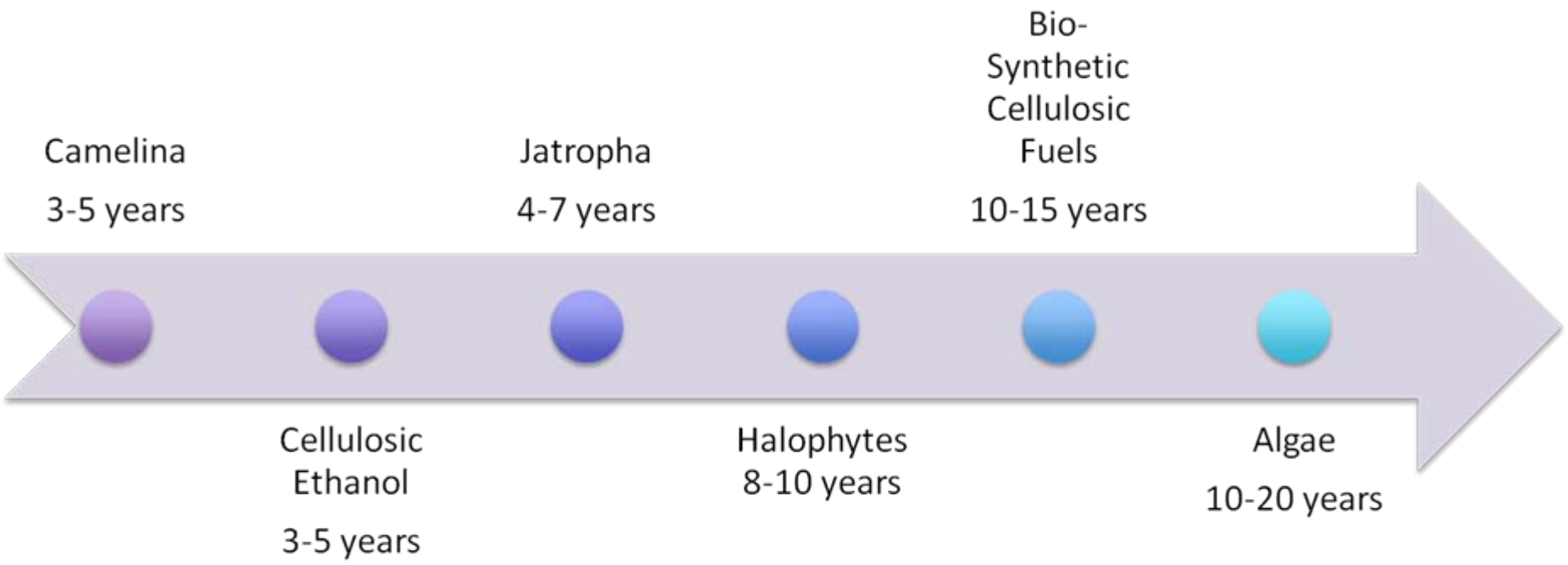
Fully mechanized production, harvesting, and processing

- Near term commercial opportunity
- Little improvements in agronomy/plantation management – only room for improvement in genetics

Camelina Production Potential in U.S.



Commercialization Timeline



Successful commercialization assumes oil is at or above $80 per barrel

Thank You

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