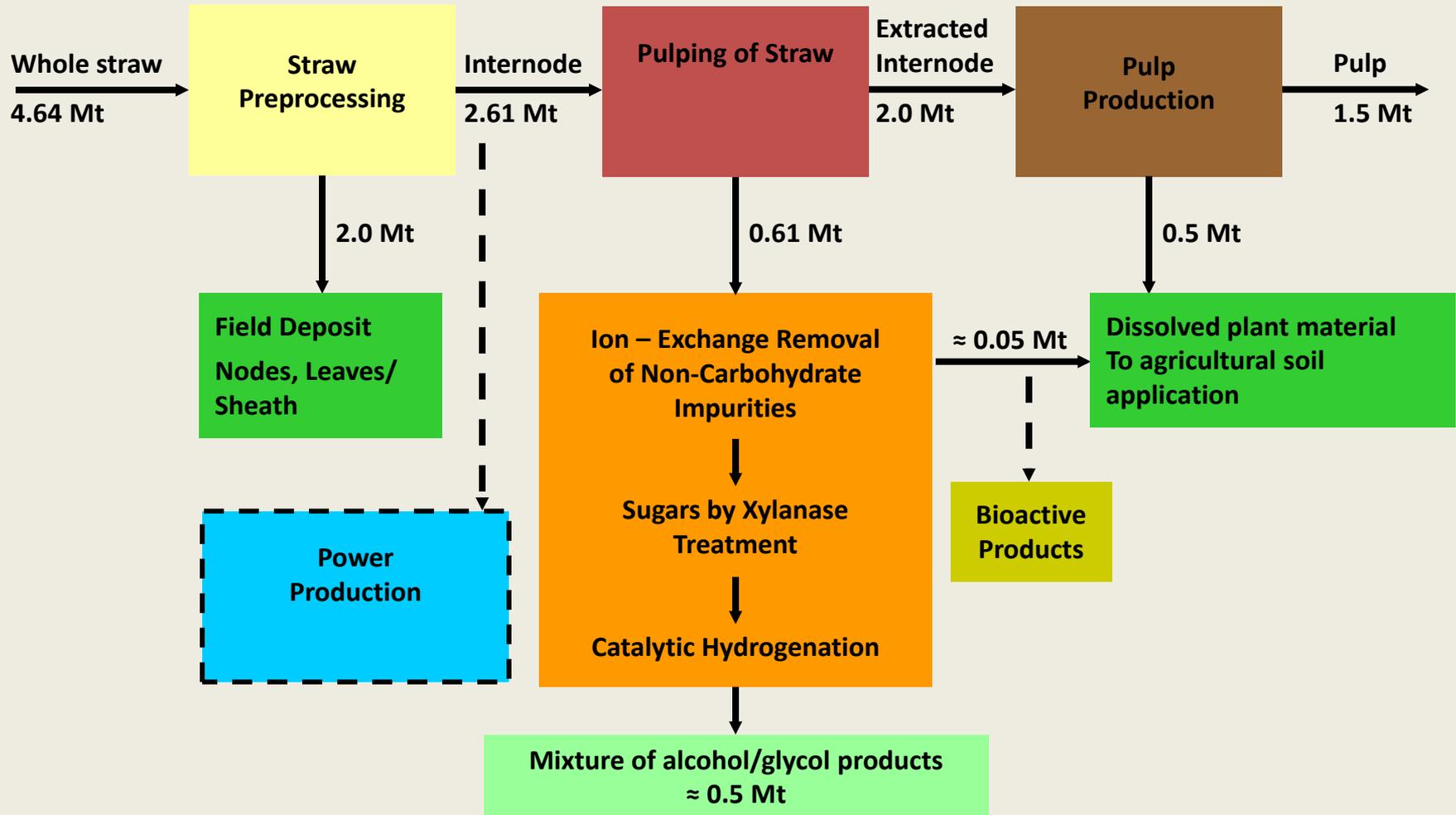


# Cereal Straw Biorefinery

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**June 9, 2009**

# Conceptual Process For Integrated Power, Fuel, Chemical, and Pulp Fiber Production



# Technical Issues

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- What's Known
- Transportation
- Quest for Brightness
- Liquor treatment
- Trial Run Opportunities
- Mill start up

# What's Known

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- Straw Pulping is not new
- Major fiber source in China
- Fiber length similar to hardwood
- Easily pulped
- Hard to convey
- Enough wheat and alfalfa straw in Washington for all paper produced, not just copy paper

# Will this work on Commercial Machines?

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- Commercial trials on Linerboard Papermachine, Molded Pulp machines, Paperboard Cylinder Machine
- Pilot Papermachine trials on various grades of bleached, semi-bleached and unbleached grades
- Commercialization on molded pulp machine
- Upcoming trials in new molded pulp mill

# Proposed Work 2009-11

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- Phase 1 Hydroseeding
- Phase 2 Liquor Utilization
- Phase 3 Bleaching of Market Pulp
- Phase 4 Feasibility Study for Eastern WA Facility



**29 Sept. 2008 Hydromulch application; Pullman, WA; Rep. 1**

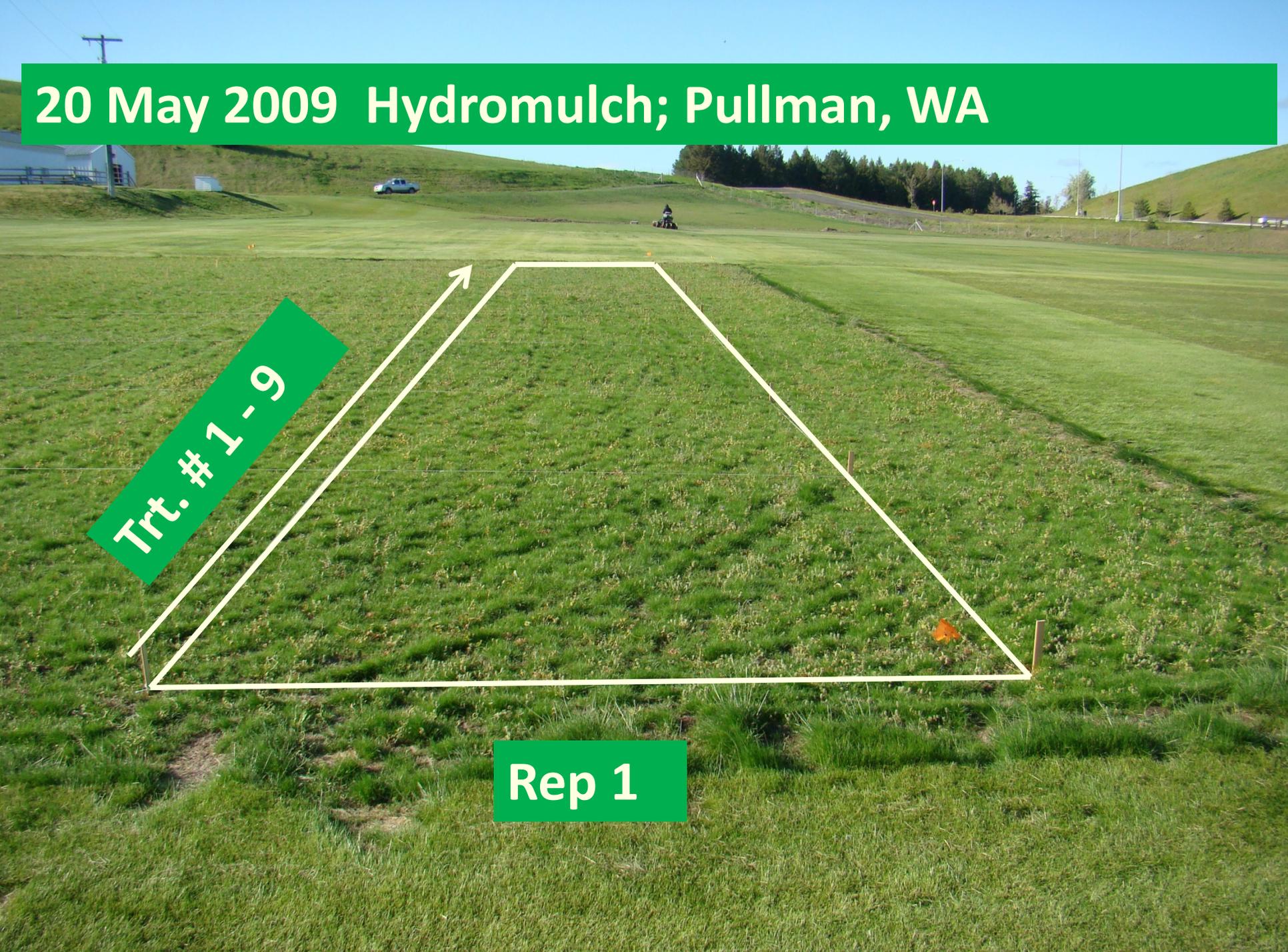


**22 Oct. 2008 Hydromulch Seedling Counts; Pullman, WA**

20 May 2009 Hydromulch; Pullman, WA

Trt. # 1-9

Rep 1



# Phase 1 Hydroseeding

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- Experimental design around selected pulping methods and application rates
- Impact of black liquor on soil
- Impact of black liquor as a fertilizer

# Phase 2 Liquor Utilization

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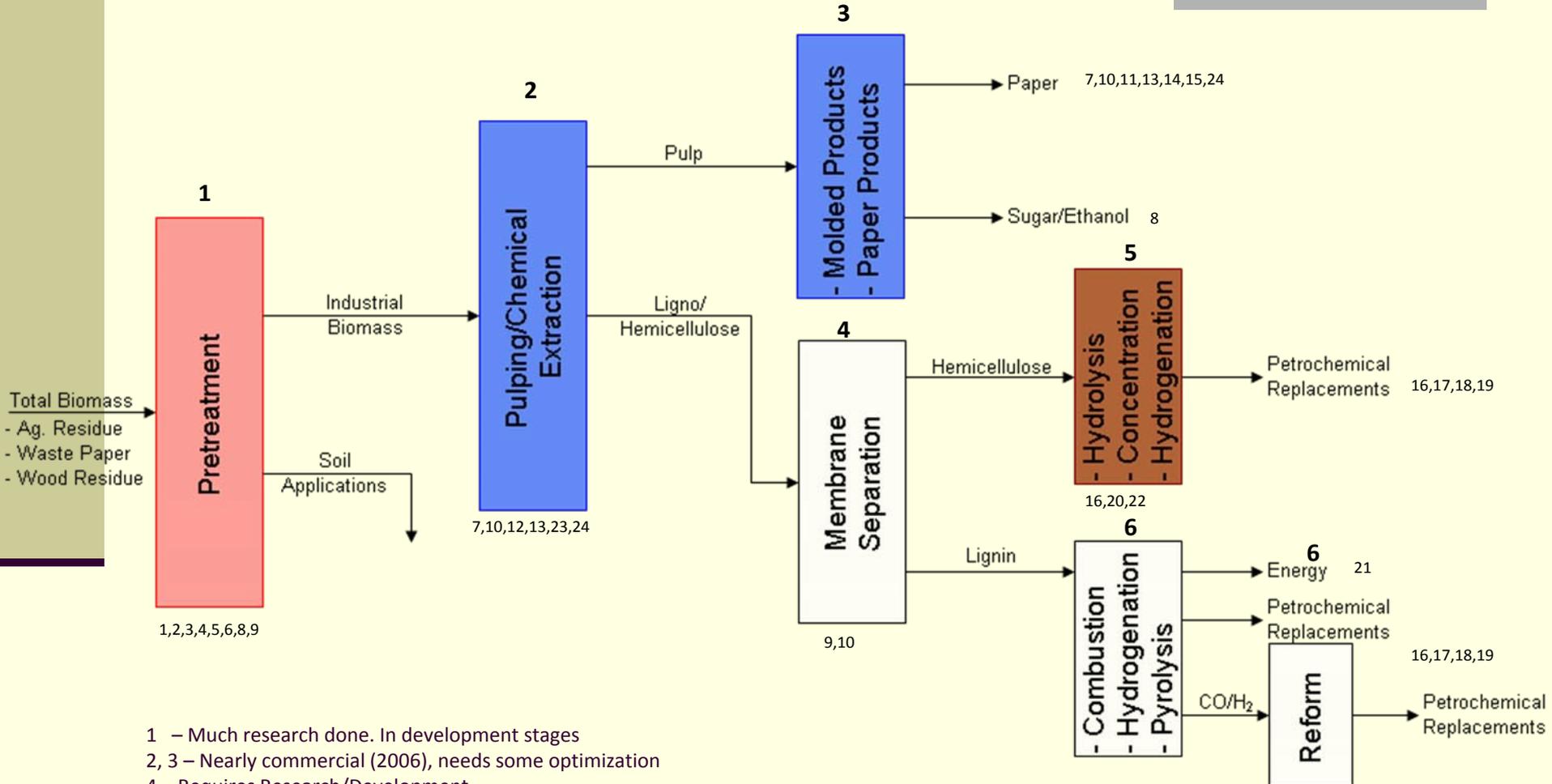
- Optimized Pulping and Spent Liquor Recovery
- Optimized Liquor Concentration
- Hydrogenation of Hemicellulose Sugars to produce glycols
- Optimized Membrane Purification of Liquor
- Utilization of Liquor for Dust Abatement

# Liquor/Chemical Applications

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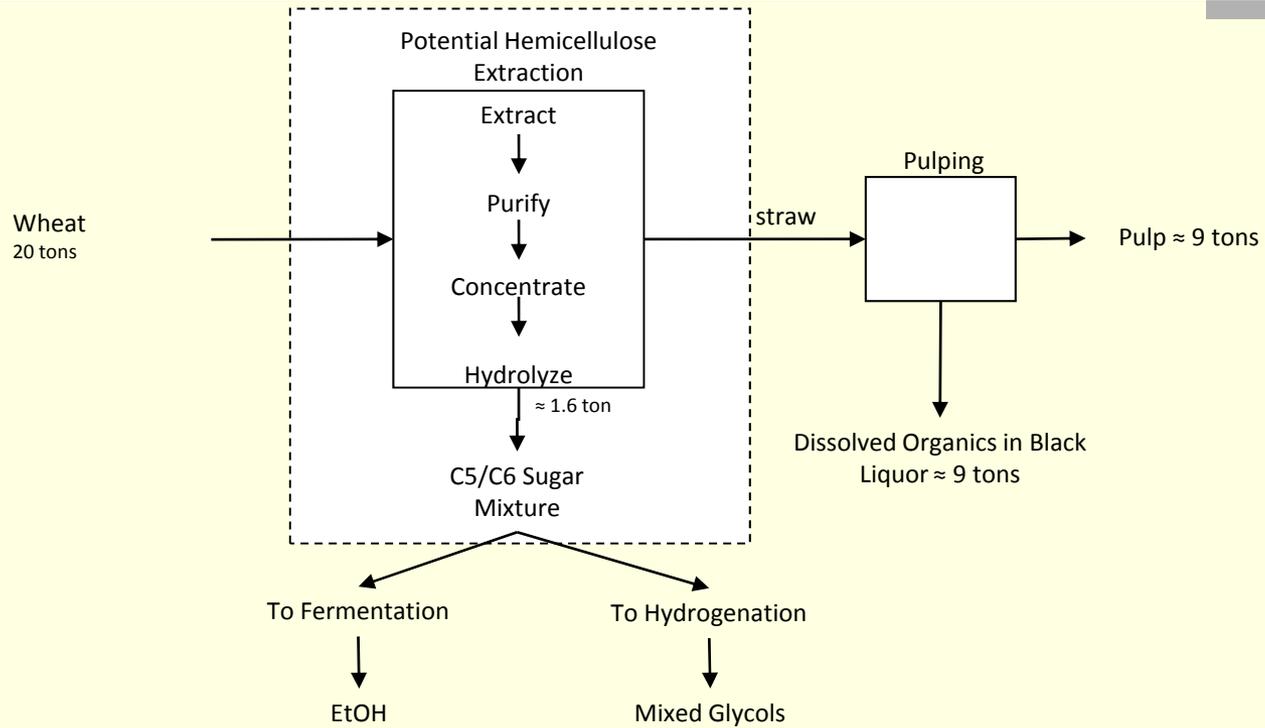
- Soil amendment and dust suppression
- Recovery of sugar structures
- Hydrolysis/fermentation to glycols
- Hydrogenation to produce commercially valuable glycols
- Purification of Sugar solution
- Concentration of hemicellulose solution

# Potential Washington Agro-Industry Manufacturing Configuration

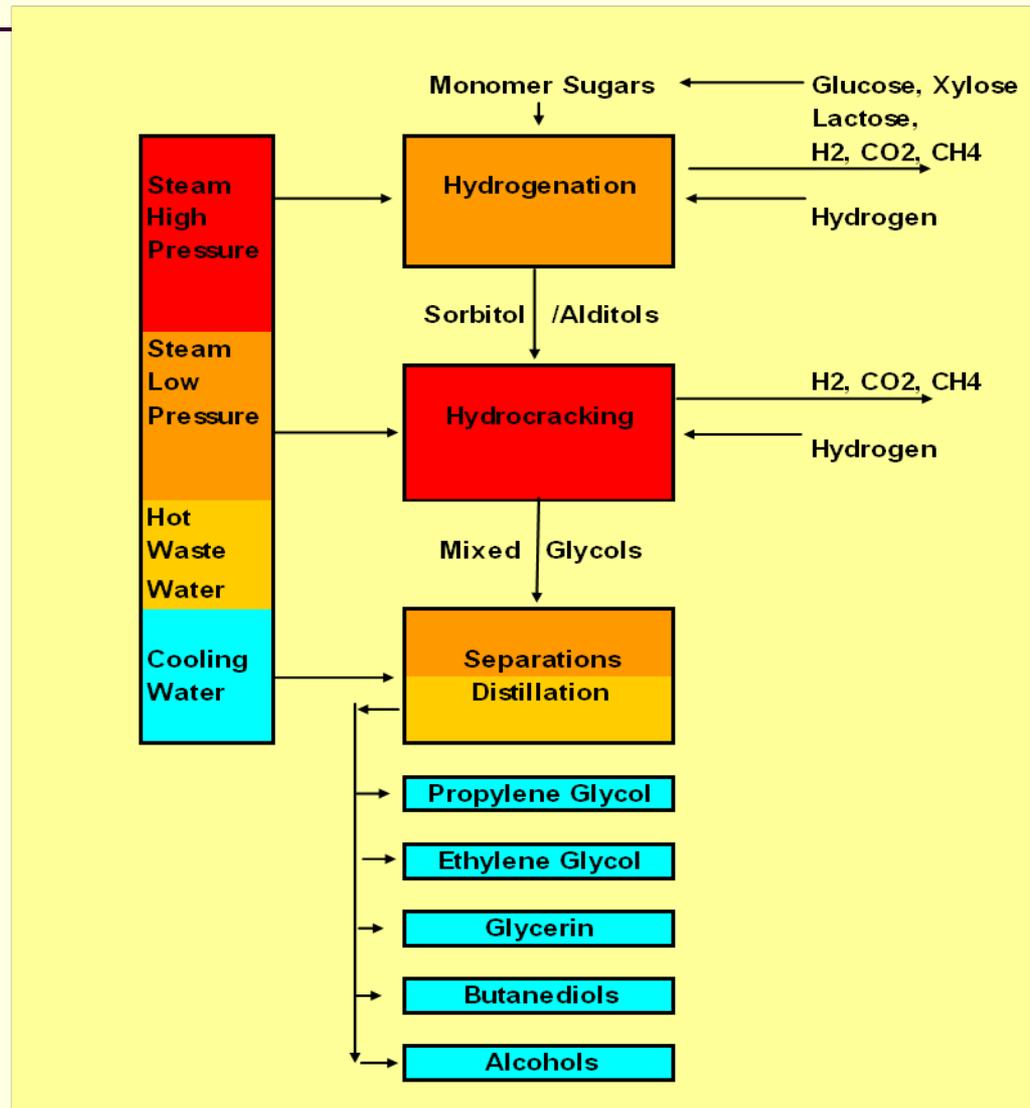


- 1 – Much research done. In development stages
- 2, 3 – Nearly commercial (2006), needs some optimization
- 4 – Requires Research/Development
- 5 – Process presently commercial/needs R/D for bio-sugar and glycerin feeds
- 6 – Requires Research/Development – Current Agenda 2020 USDOE Projects

## Potential Operations



# Five and Six Carbon Sugar to Glycol Block Flow Diagram



# 10,000 Mt Glycol Production Facility Changchun, China

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# Phase 3 Bleaching of Market Pulp

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- Alternative Pulping Chemistry for High Brightness Grades
- Evaluate Elementally Chlorine Free (ECF) Bleaching

# Quest for Brightness

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- Major Hurdle
- 73 brightness TCF wheat straw is currently achievable for use in newsprint or book grade
- 80 brightness is a minimum for commercial copy paper
- 80+ brightness achieved with seed alfalfa straw
- Research is ongoing
- Higher brightness grade a plus for biorefinery/market pulp mill

# Production of Bleached Market Pulp

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- Customers are asking for pulp samples for evaluation
- Inland Empire in Spokane and Blue Heron in Portland are interested in possible straw trials, but need pulp for internal evaluations

# Yakima Straw Pulp Mill

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- Start Up First Quarter 2009
- Starting up on alfalfa straw
- Will expand to wheat straw
- Mill has committed to production expansion
- Approximately 25 new jobs will be created











# **Feasibility of an Eastern Washington Biorefinery, Pulpmill, Biomass Power Generation Facility**

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- Products and Markets
- Process Configuration

# Budget

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- Phase 1 Hydroseeding
  - \$15,000
- Phase 2 Liquor Utilization
  - \$35,000
- Phase 3 Bleaching of Straw Market Pulp
  - \$35,000
- Phase 4 Feasibility Study
  - \$10,000
- Phase 5 Final Report
  - \$5,000