

Pipelining Biomass to a Biorefinery



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Outline

- Need for large scale biomass transport through pipeline.
- Techno-economic assessment of biomass pipeline transport.
- Implications of pipeline transport on ethanol fermentation.
- Experimental work on pipeline transport of biomass.
- Future research.

Transportation Cost of Biomass

- A major component of total biomass processing cost (e.g. power production cost, ethanol production cost).
- Truck transportation cost of biomass for power plants at optimum scale (% of total power cost):
 - Whole forest – 14%.
 - Agricultural residue – 25%.
 - Forest harvest residue – 38%.

Large Scale Biorefinery Issues

- Truck congestion limit < 2 MT/yr.
 - 1 truck every 5 - 10 minutes.
- Plant size less than 5% of typical refinery.
- Pipelines allow aggregation of biomass.
- Fossil fuel power plants don't depend on highway truck delivery.

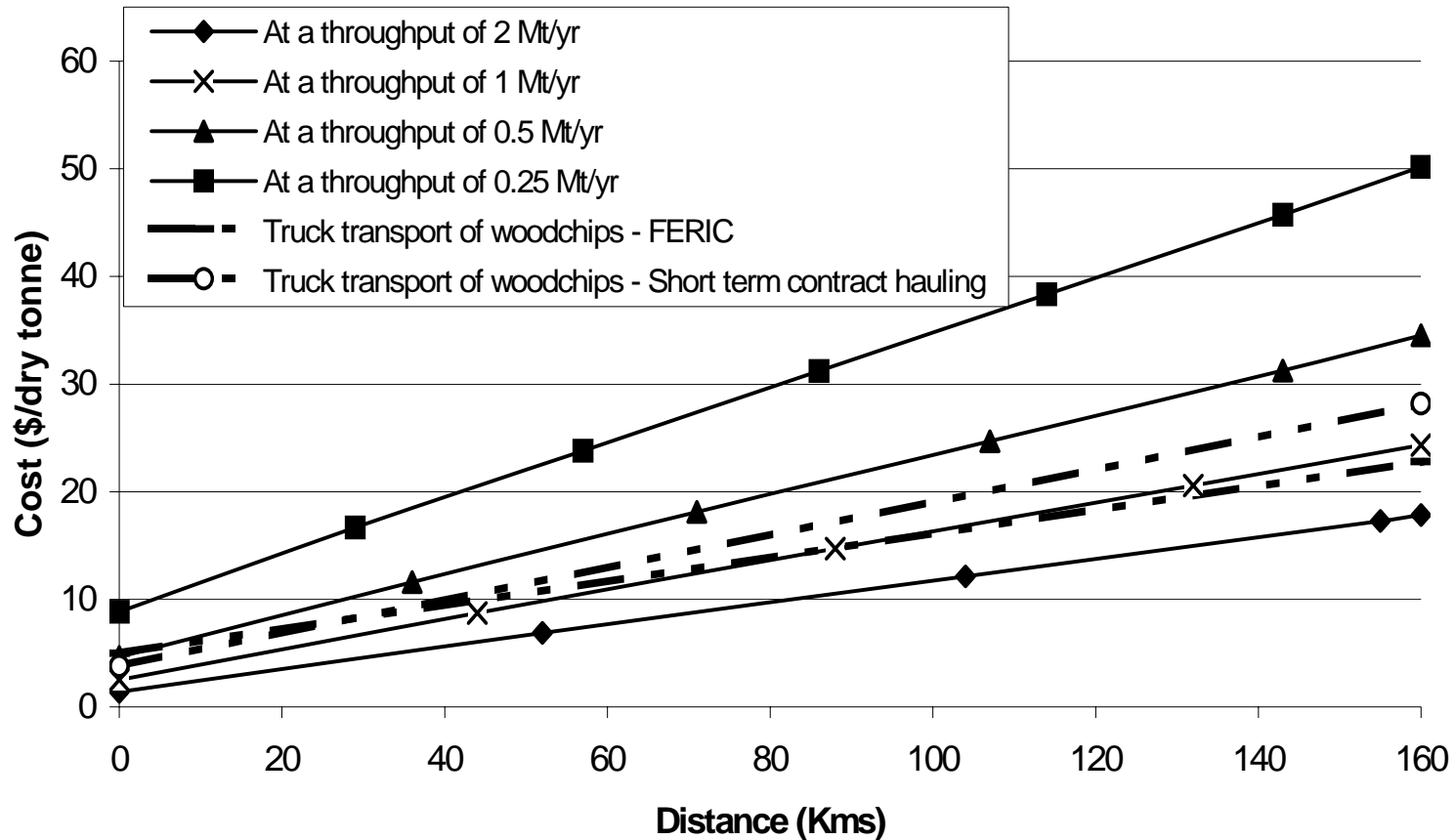
Approaches to Pipeline Transport

- Two-way pipeline transport
 - Pipeline for biomass slurry.
 - Pipeline for carrier fluid return.
- One-way pipeline transport
 - Pipeline for the biomass slurry.
 - No pipeline for carrier fluid return.
 - Carrier fluid used in the process.
- Implications of pipeline transport on biomass.

Components of Transport Cost

- Truck Transport Cost
 - Fixed cost: loading and unloading.
 - Distance variable cost: driving time, fuel.
- Pipeline Transport Cost
 - Fixed cost: inlet and outlet equipment.
 - Distance variable cost: pipeline, booster stations, pumping power.

Pipeline Transport Cost of Wood Chips With Carrier Fluid Return Pipeline



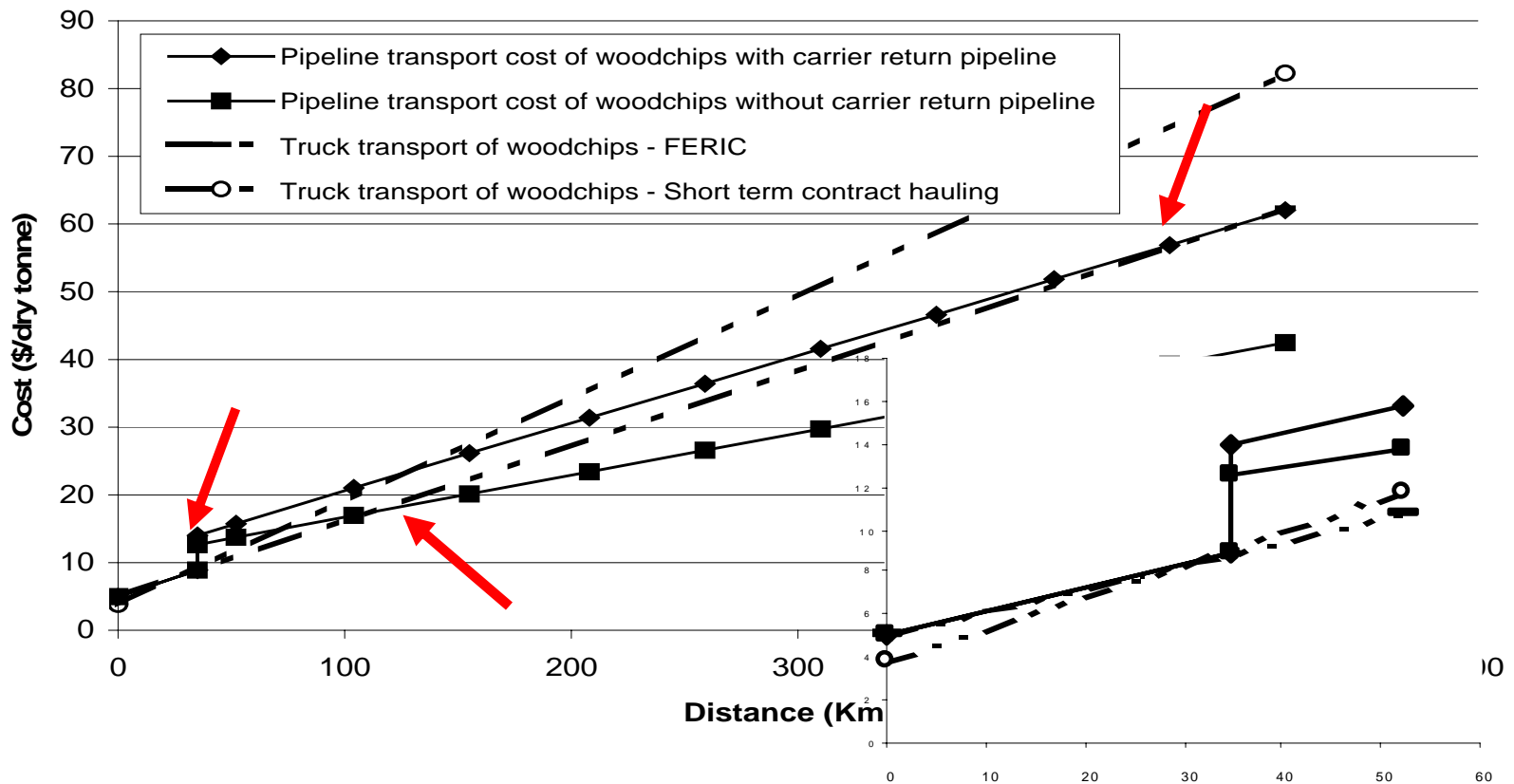
Kumar et al., *Applied Biochemistry and Biotechnology*, 2004, 113(1).

Truck Transport Cost



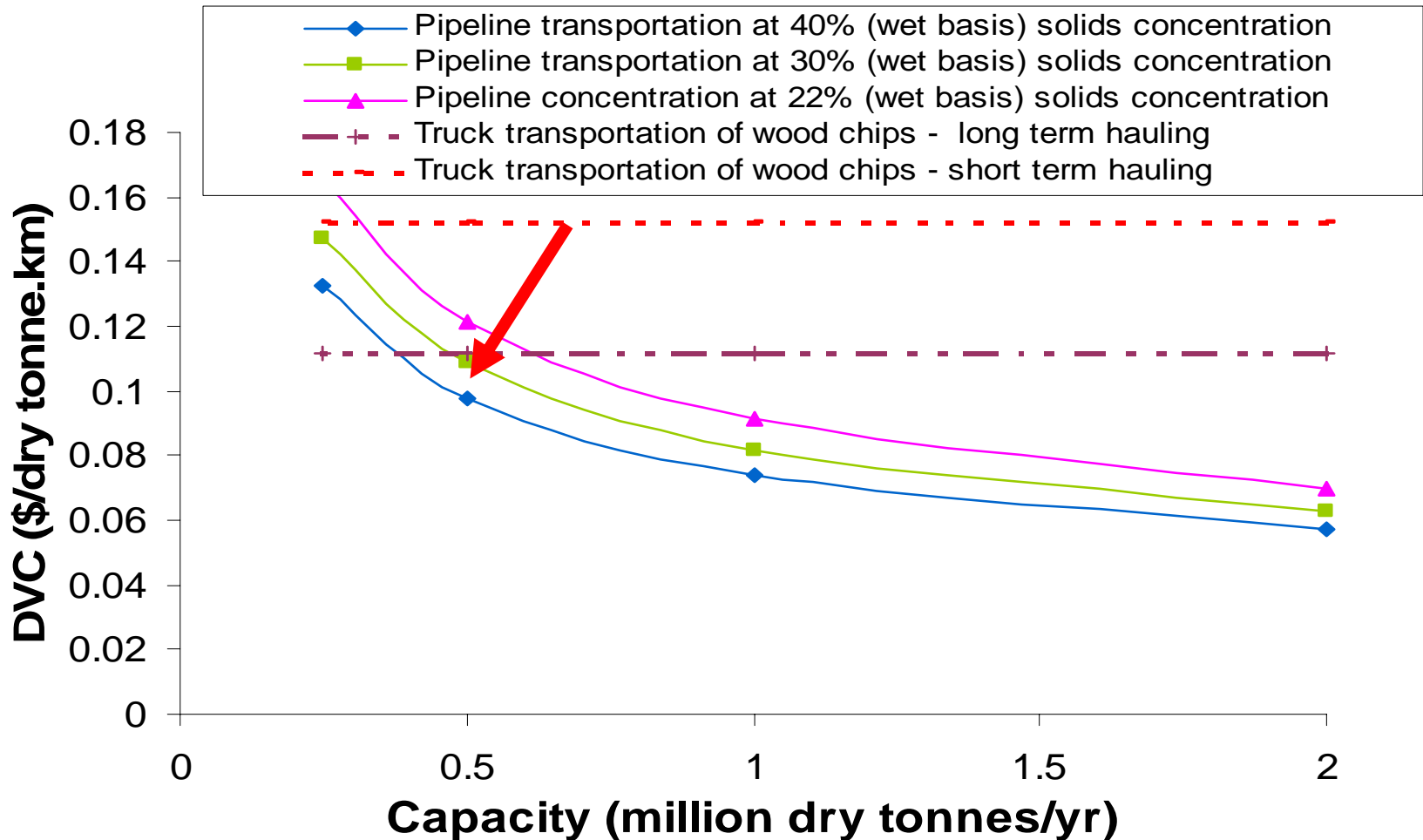
Integrated Pipeline and Truck Transport of Biomass

2 MT/year wood chip transport with two way pipeline



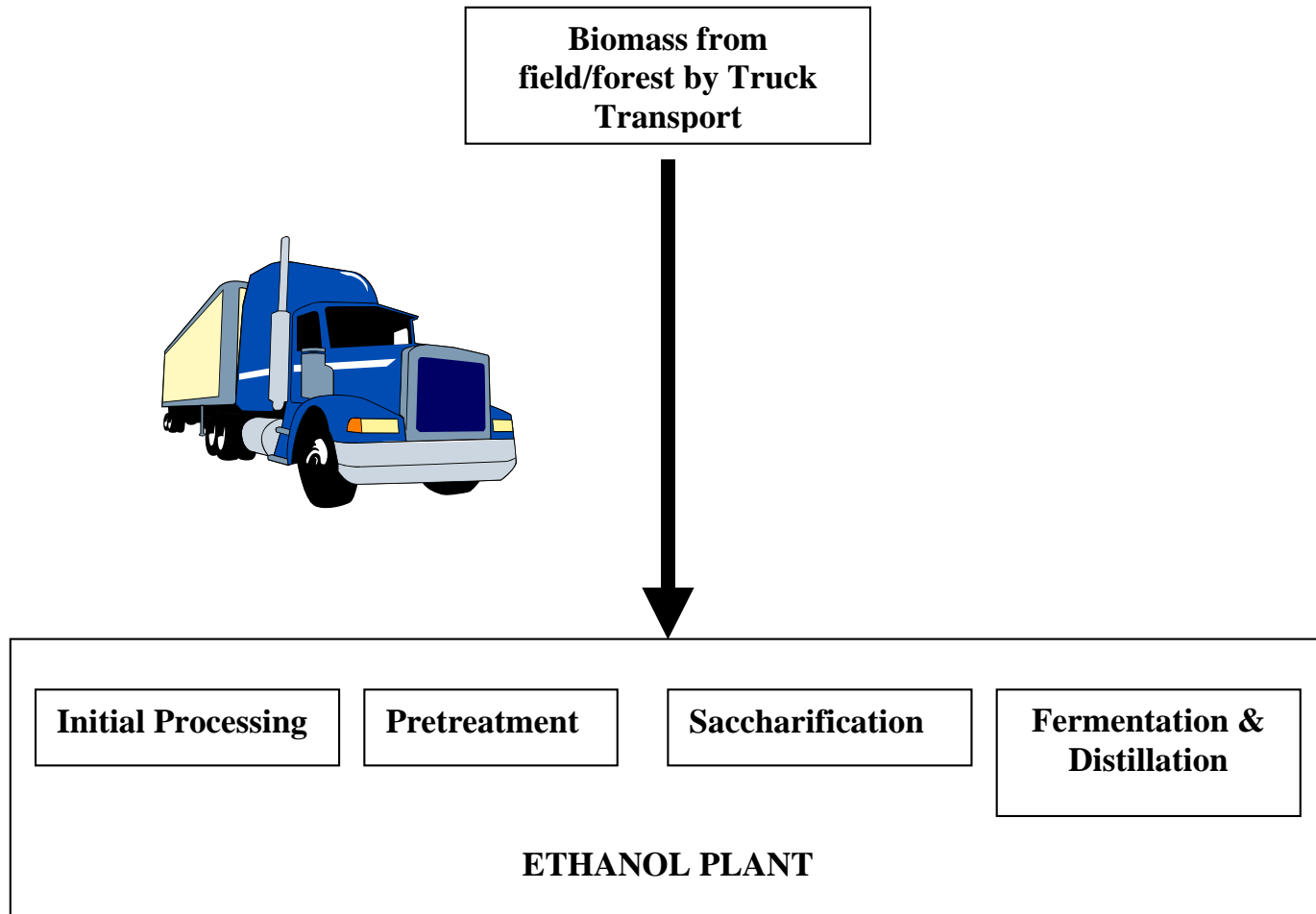
Kumar et al., *Applied Biochemistry and Biotechnology*, 2004, 113(1).

Distance Variable Cost (DVC) of Transporting Wood Chips by Pipeline

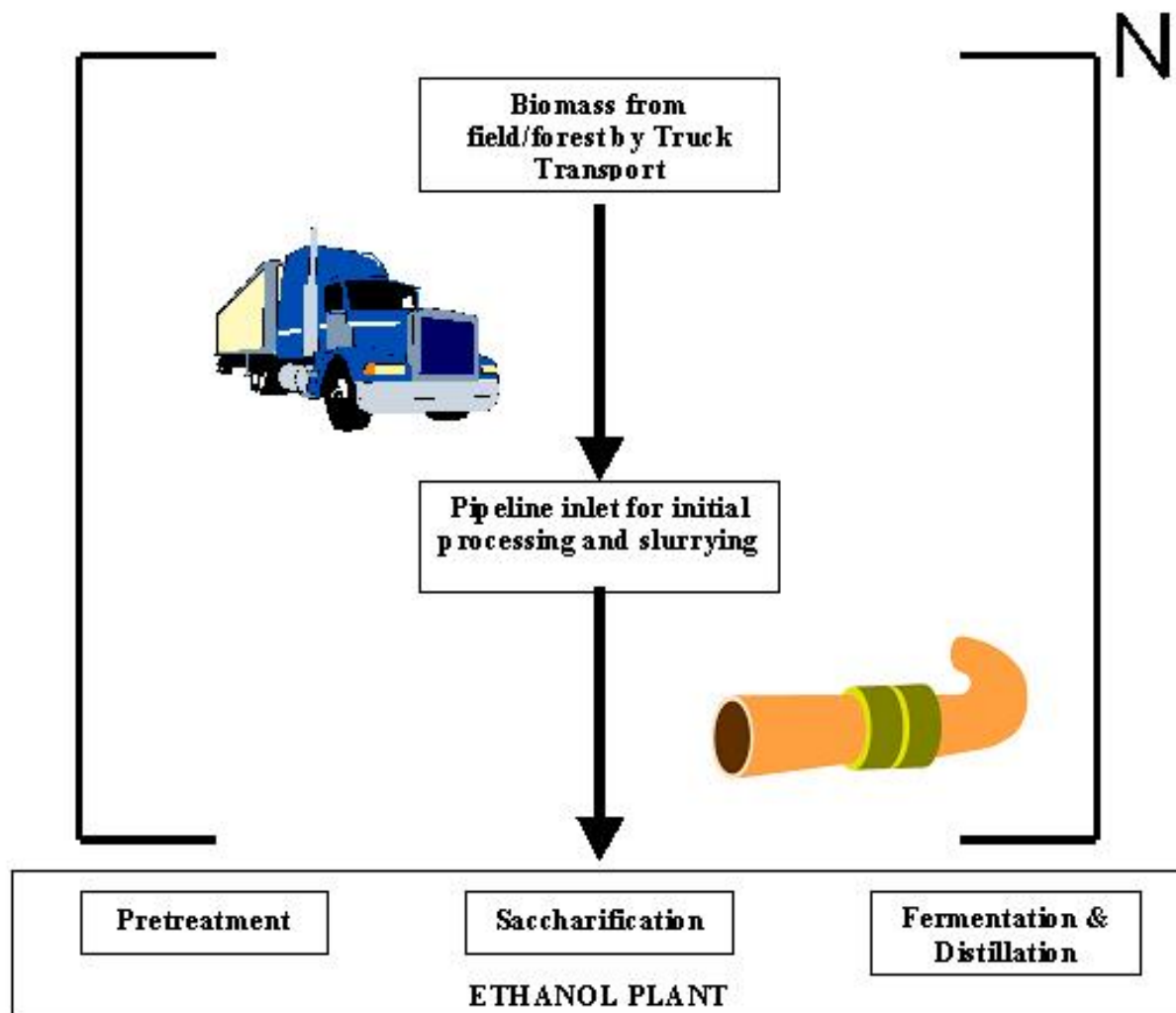


Kumar et al., *Applied Biochemistry and Biotechnology*, 2005, 121-124.

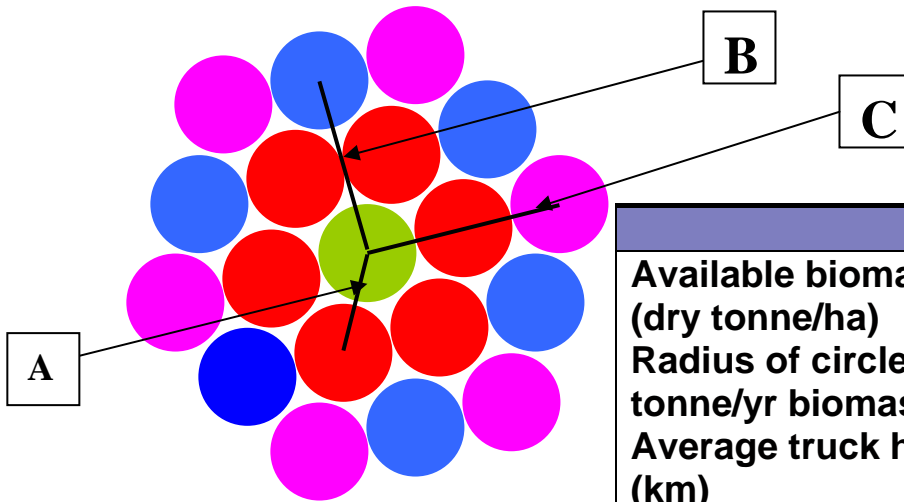
Model for Ethanol Plant Supplied by Truck Transport



Model for Ethanol Plant Supplied by Pipeline Transport



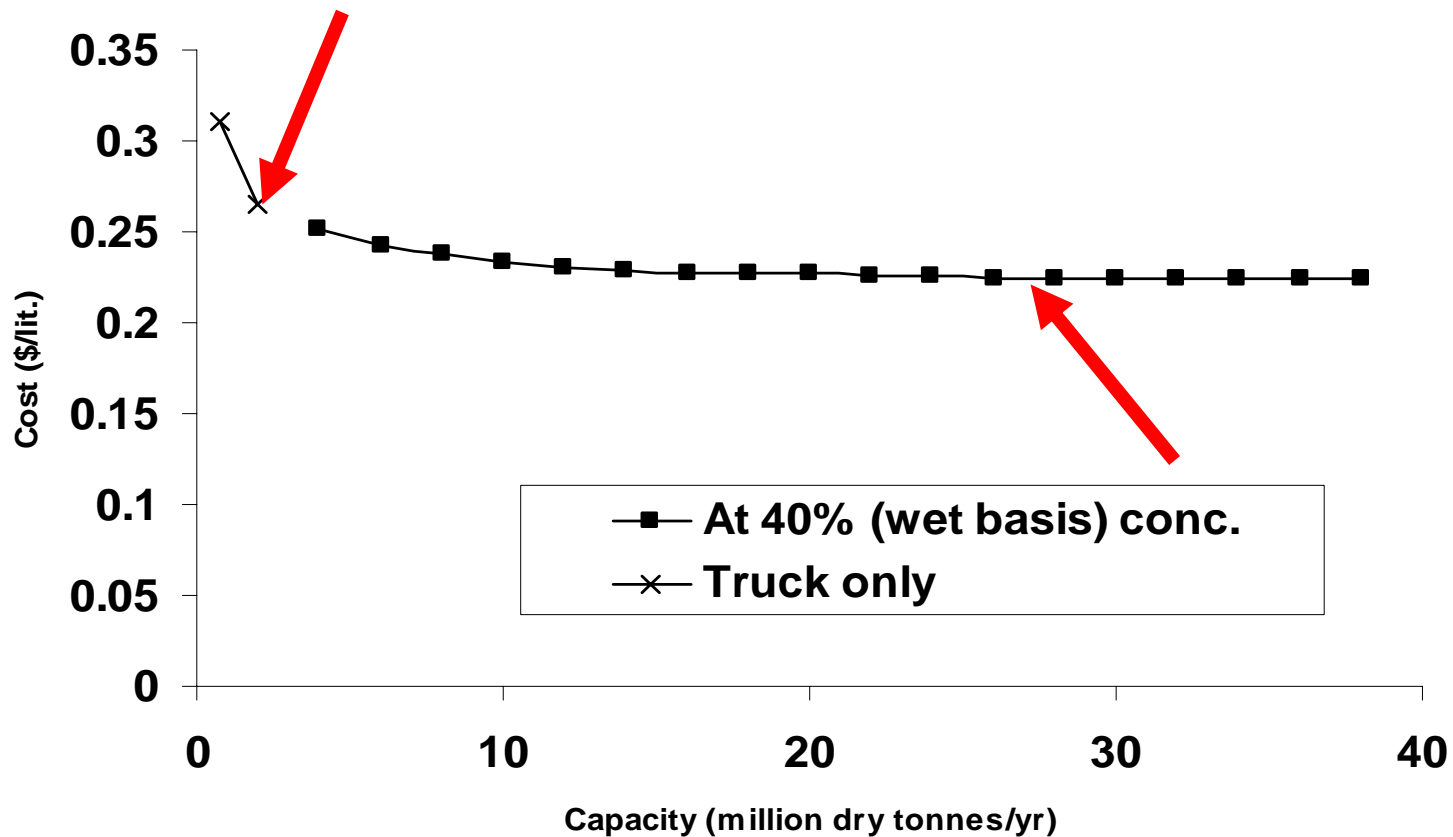
Sample Configuration for 19 Truck Based Ethanol Plants Vs. One Large Facility Supplied by Truck Plus 18 Pipelines



	<i>Corn Stover</i>	<i>Wood Chips</i>
Available biomass gross yield (dry tonne/ha)	2.47	84
Radius of circle containing 2 M dry tonne/yr biomass (km)	103	28
Average truck haul length per circle (km)	146	39
• A – pipeline length (km)	292	78
• Residence time in pipeline A (hr)	54	15
• B – pipeline length (km)	506	135
• Residence time in pipeline B (hr)	94	25
• C – pipeline length (km)	584	156
• Residence time in pipeline C (hr)	108	29

Kumar et al., *Applied Biochemistry and Biotechnology*, 2005, 121-124.

Comparison of Relative Cost of Ethanol from a Wood Chips Fermentation Plant Supplied by Truck Only Vs. Pipeline Plus Truck



Kumar et al., *Applied Biochemistry and Biotechnology*, 2005, 121-124.

Experimental Set-up for Studying Rheological Properties of a Slurry of Water and Biomass



Viewing Section of for Slurry of Water and Straw



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- University of Alberta.

Questions?