# *Competition for Land in the Development of Biofuels*

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# Context

- **Preliminary indications for the emerging Biofuel industry indicates large economies of scale which means:**
  - Large capital investments depending on…..
  - Large quantities of sustainable feedstock supplies
- **From where will these quantities of biofuel feedstock come?**
- **Under what conditions will feedstock be supplied?**
- **Focus of this presentation is potential of dedicated energy crops for cellulosic ethanol in Canada**
  - Tree Plantations (e.g. poplar)
  - Annual Crops (e.g. switchgrass)
- **Neither of these is generally allowed on public lands, so we investigate private lands**
- **Therefore, crops will have to compete with current uses (i.e. agriculture)**

# Approach: Competition for Land (Land Use Change)

- **Will dedicated energy crops provide land owners with higher returns than current agricultural uses?**
- **First step: financial analysis (NPVs) without stochastic outcomes**
- **Challenges… Uncertainty!:**
  - Industry does not yet exist
  - Technologies evolving
    - Costs
    - Products
- **Second step: Real Options**
  - Choose potential land uses over 65 years
  - Find maximum values from "optimal behaviour"
    - What crop to plant
    - Whether and when to switch crops
    - When to harvest (trees)

# Some Values in the Models

| | Baseline Conditions | Alternative Scenario Values |
|---|---|---|
| Poplar Yields[a]<br>(OER = approx. 24 years) | 16.1 $M^3$/ Ha/ Year<br>1632 L/Ha/Year | 21.2 $M^3$/ Ha/ Year<br>2147 L/Ha/Year |
| Switchgrass Yield[b] | 10.3 ODT/ Ha/Year<br>2977 L/Ha/Year | 12.3 ODT/ Ha/Year<br>3555 L/Ha/Year |
| Agricultural Land Values | $2624.59[c] | $1590.34[d] |
| Ethanol Value Increases | $0.11/L | $0.21/L, $0.31/L |
| Assumed Distance from Market | 10 km | |
| Interest Rate[e] | 5.3% | |
| Ethanol Processing Costs[f] | $0.54/L | |

[a] Average (16.1 $M^3$/ Ha/ Year) and maximum (21.2 $M^3$/ Ha/ Year) poplar yields are derived from Joss et al.'s (2007) yield curve, scaled to account for soil quality and climactic conditions

[b] Switchgrass yields of 10-11.3 ODT/ ha have been reported in Ontario (OMAFRA, 2011), while the Canadian range is estimated to be 8-13 ODT/ ha (Kludze et al, 2011)

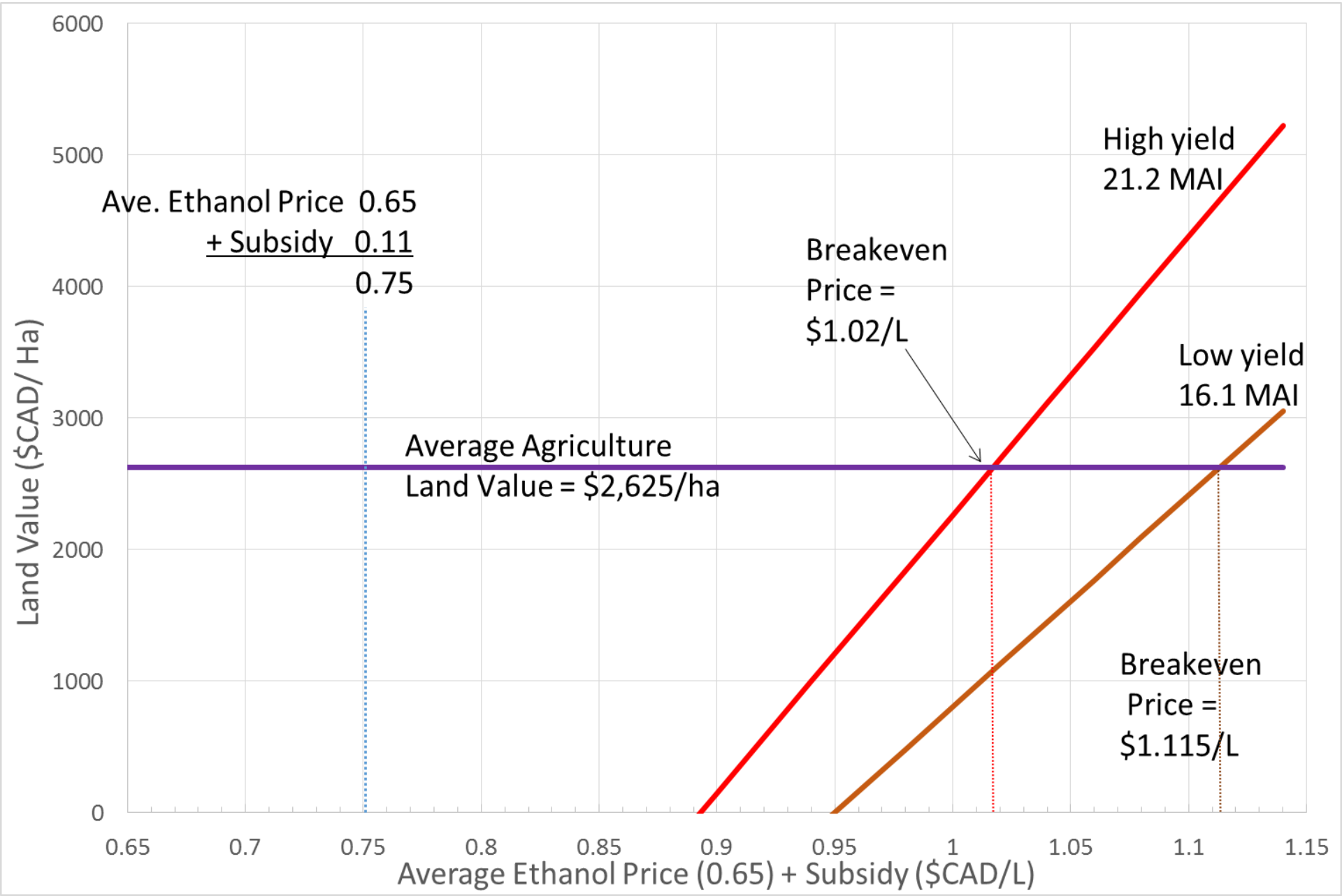
[c] Average of Agriculture Land Values in Alberta

[d] One standard deviation below the mean

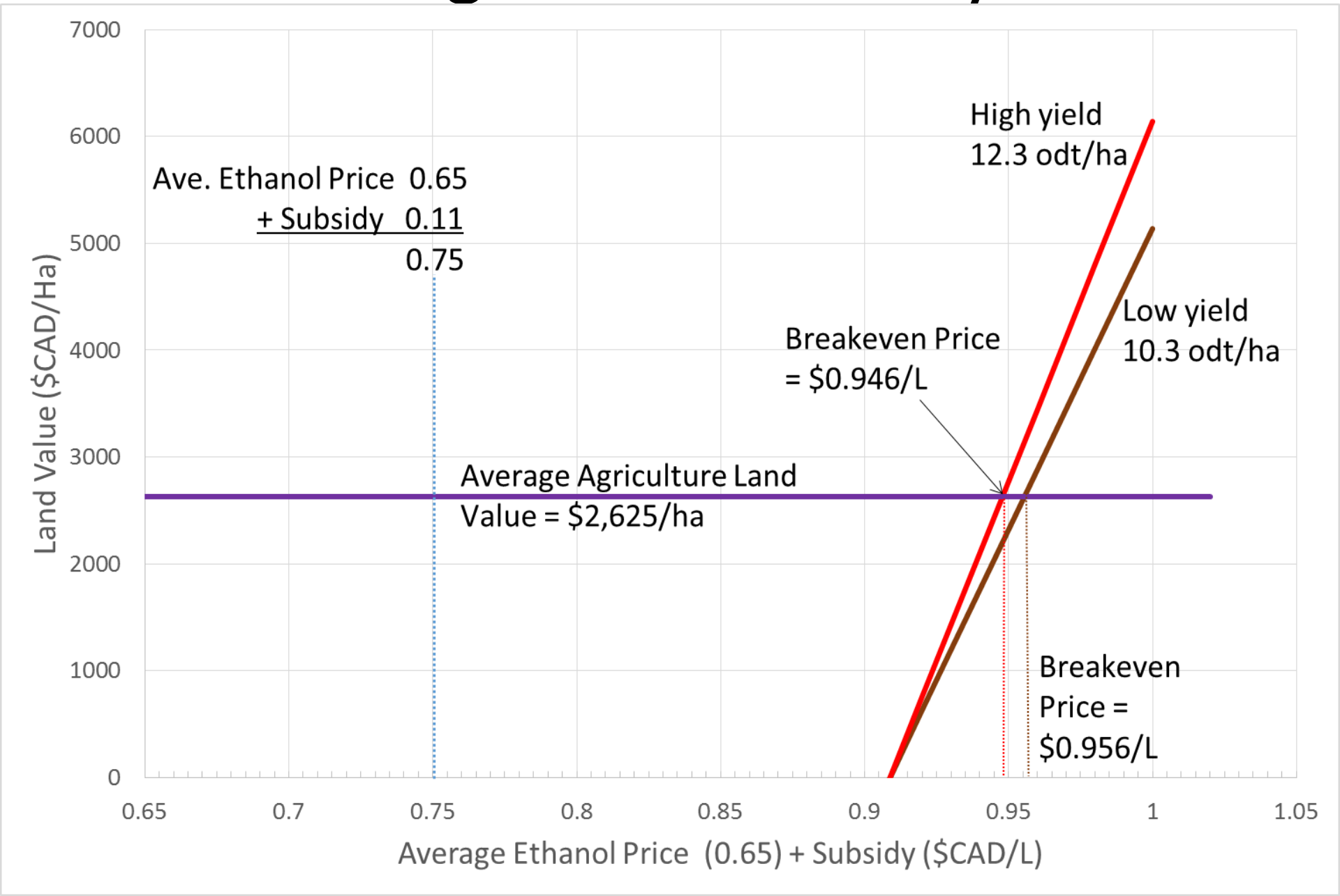
[e] Derived from the average annual growth rate of simulated land prices (2.3%) and the dividend rate for agriculture (i.e. rental value/land value = 3%).

[f] Kazi et al., (2010) based on a dilute-acid pretreatment process without feedstock costs.

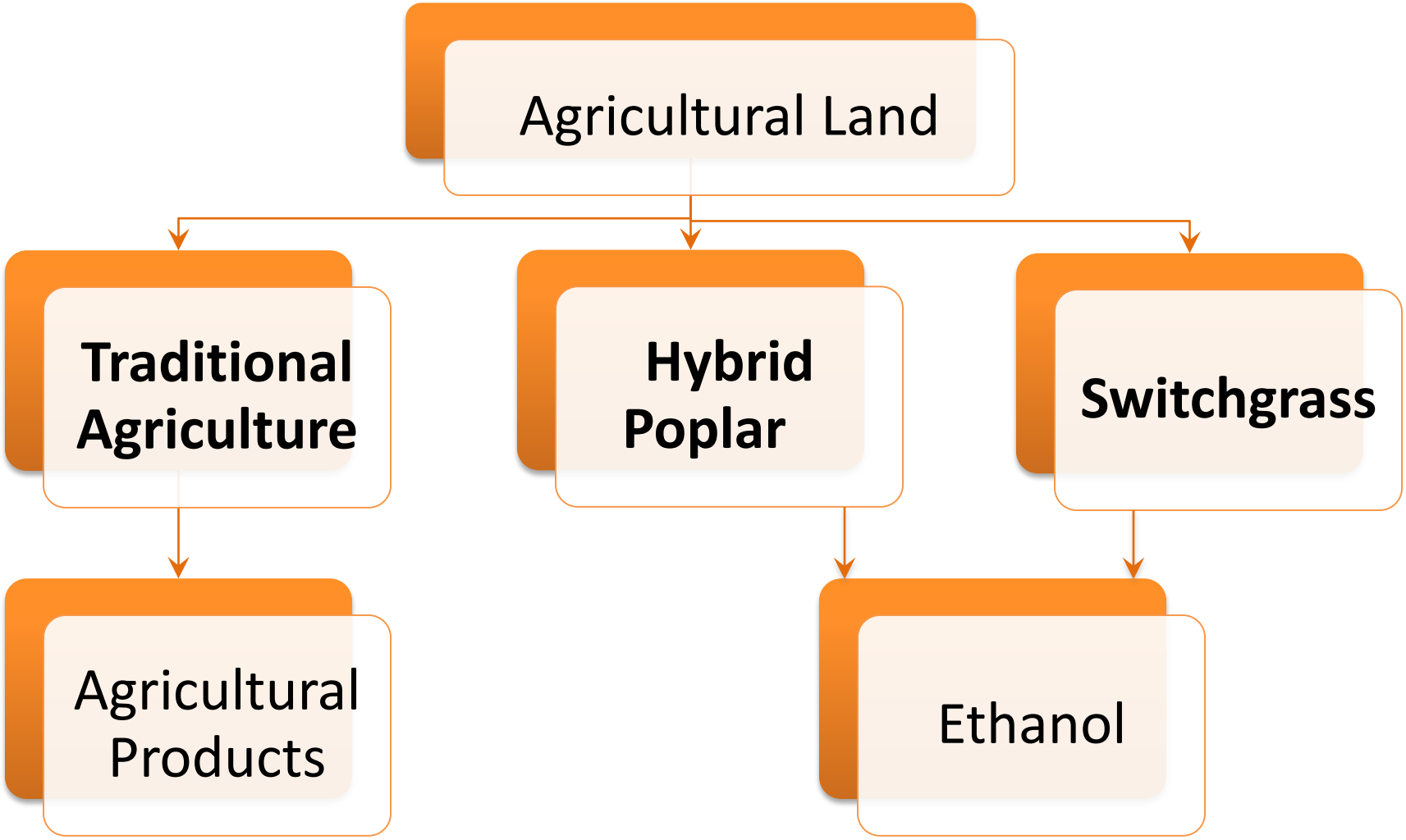
# Poplar NPV Analysis



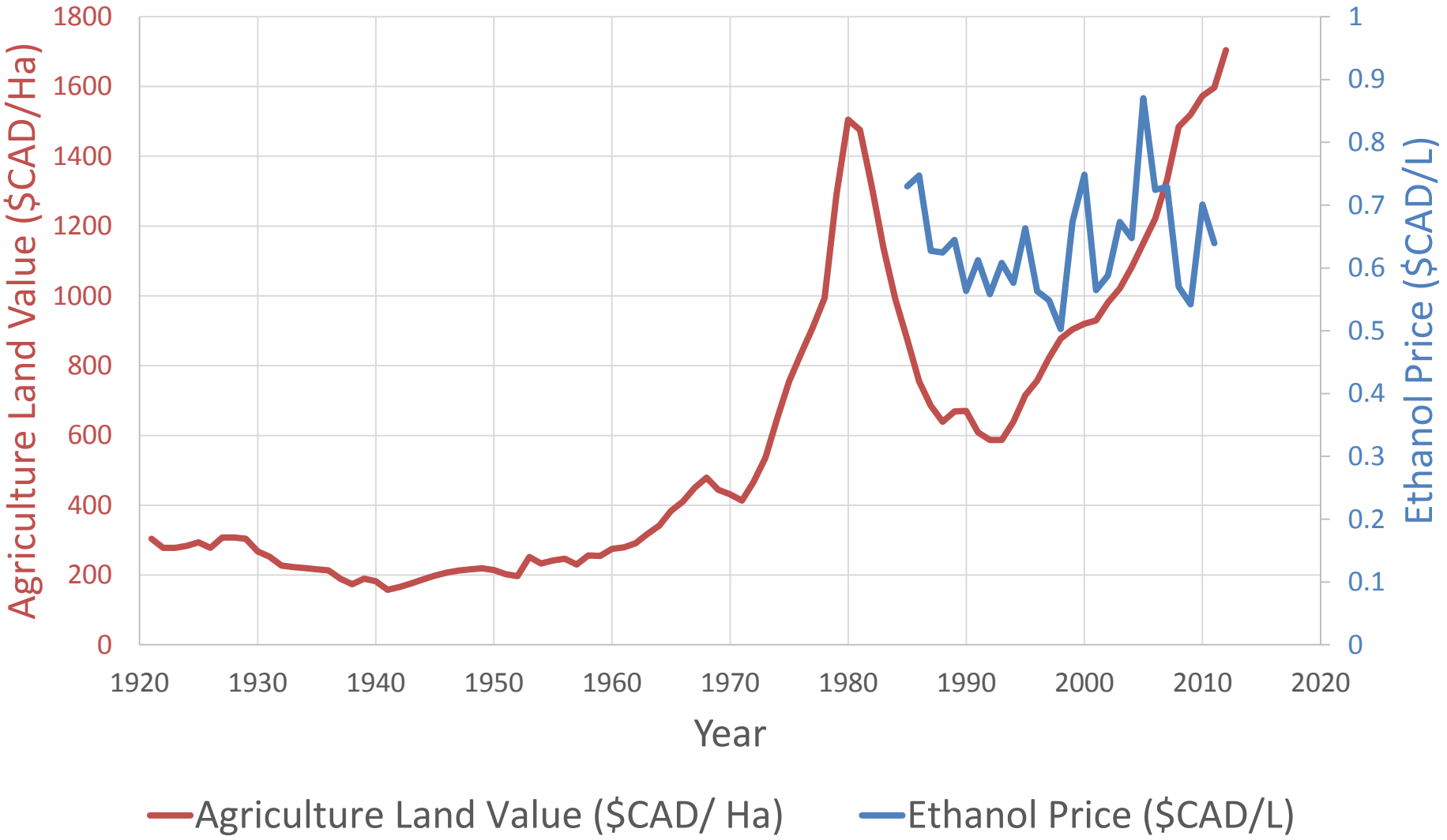
# Switchgrass NPV Analysis



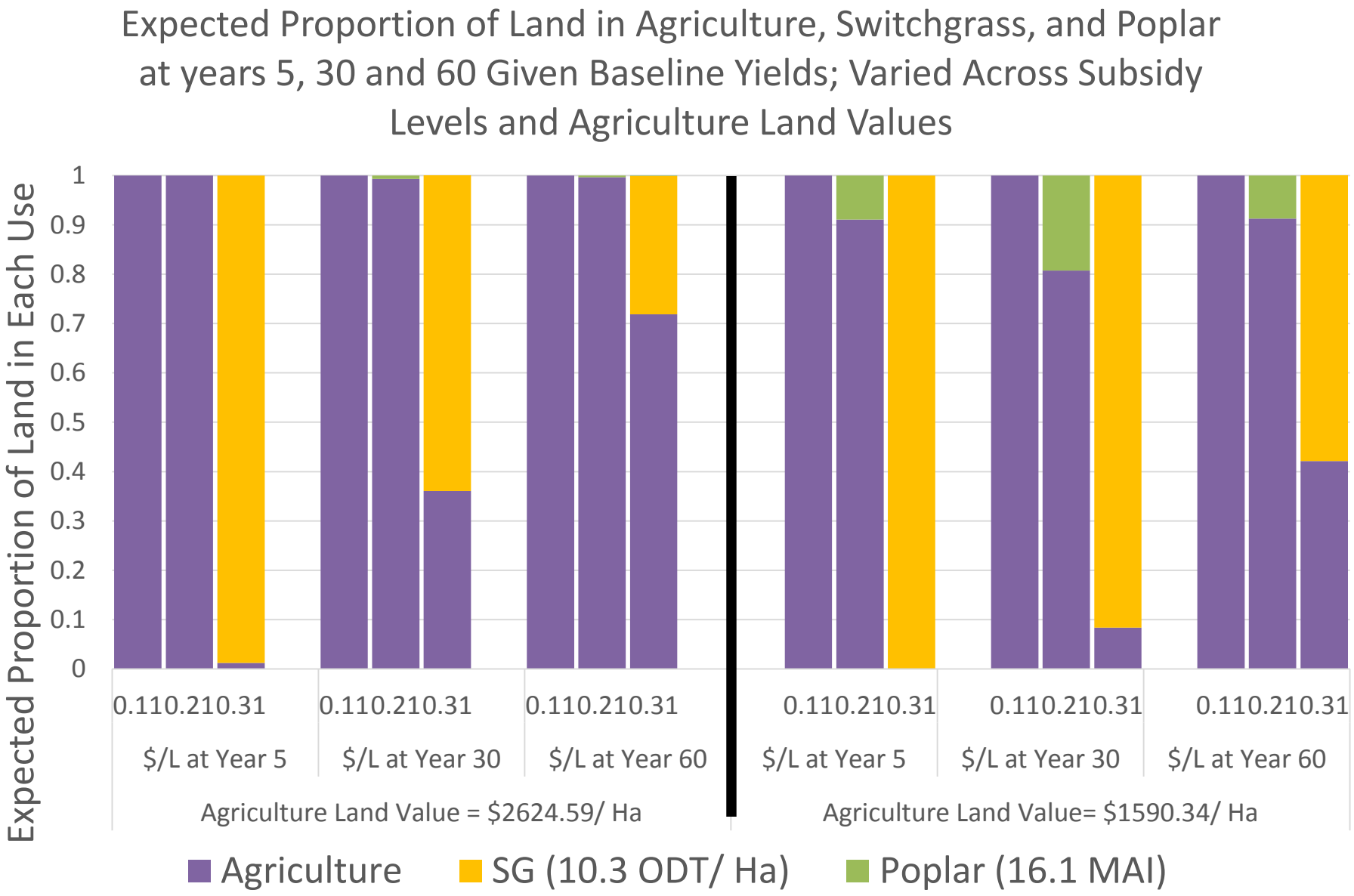
# Real Options Model



# Historic Agriculture Land Values and Ethanol Prices

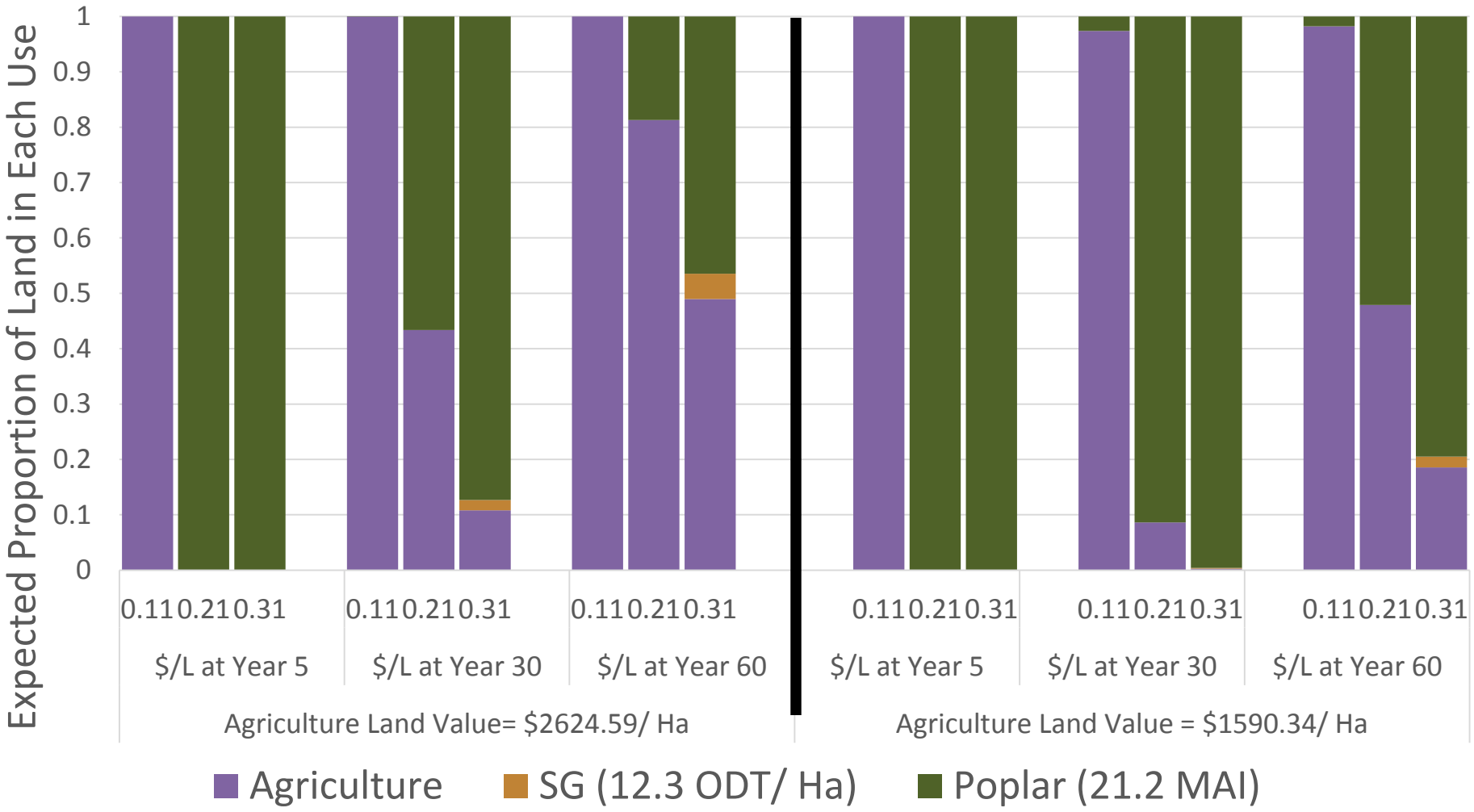


# Baseline Results



# High Yield Results

Proportion of Land in Agriculture, Switchgrass, and Poplar at Years 5, 30, and 60 Given High Yields; Varied Across Subsidy Levels and ALVs



# Conclusions

- Economic dimensions for providing feedstock for an emerging industry are fraught with uncertainty
- Landowners face uncertainty, which they may be addressed by considering multiple options that influence their supply decisions
- Multiple Options (e.g. crops possibilities) can increase prospects to change land uses from agriculture to dedicated energy crops

# Conclusions Contd.

- There is a significant gap between current economic conditions and those needed to supply dedicated energy crop feedstocks
  - For average value croplands, switchgrass starts to become viable with ethanol values increased by $0.30/L
  - For low value croplands, poplar starts to become viable with prices increased by $0.21/L, but these take approximately 24 years before harvesting
- Differing crops on different qualities of land, and long rotations for Poplar, suggest a portfolio of feedstocks will likely be needed for supplying a mill

# Further Work

- Add pulp as an option for poplar
- Add pellets as an option for switchgrass and poplar
- Add agricultural residues on private land as a potential feedstock source
- Add forest residues on public lands as a potential feedstock source

# ACKNOWLEDGEMENTS

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