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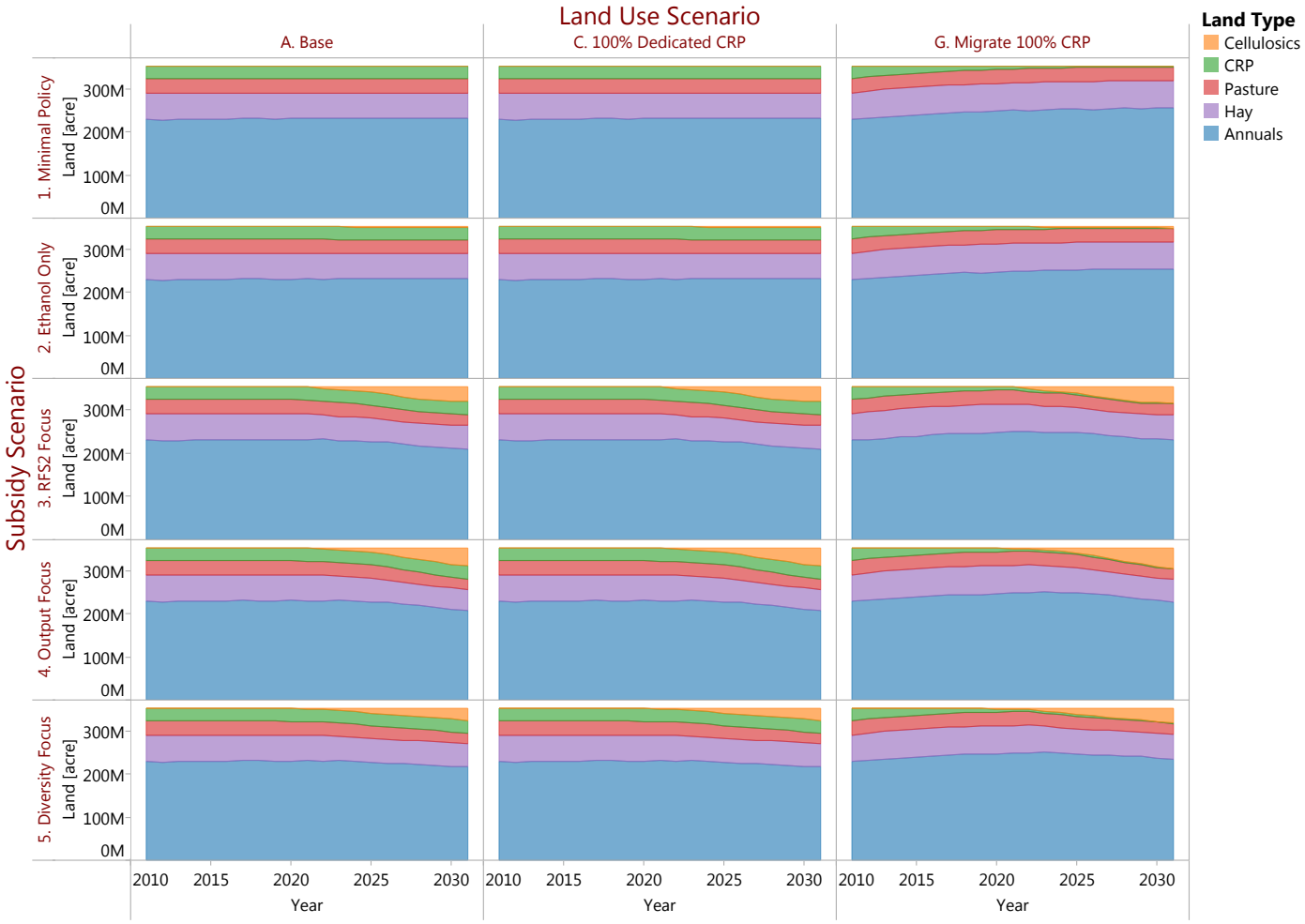
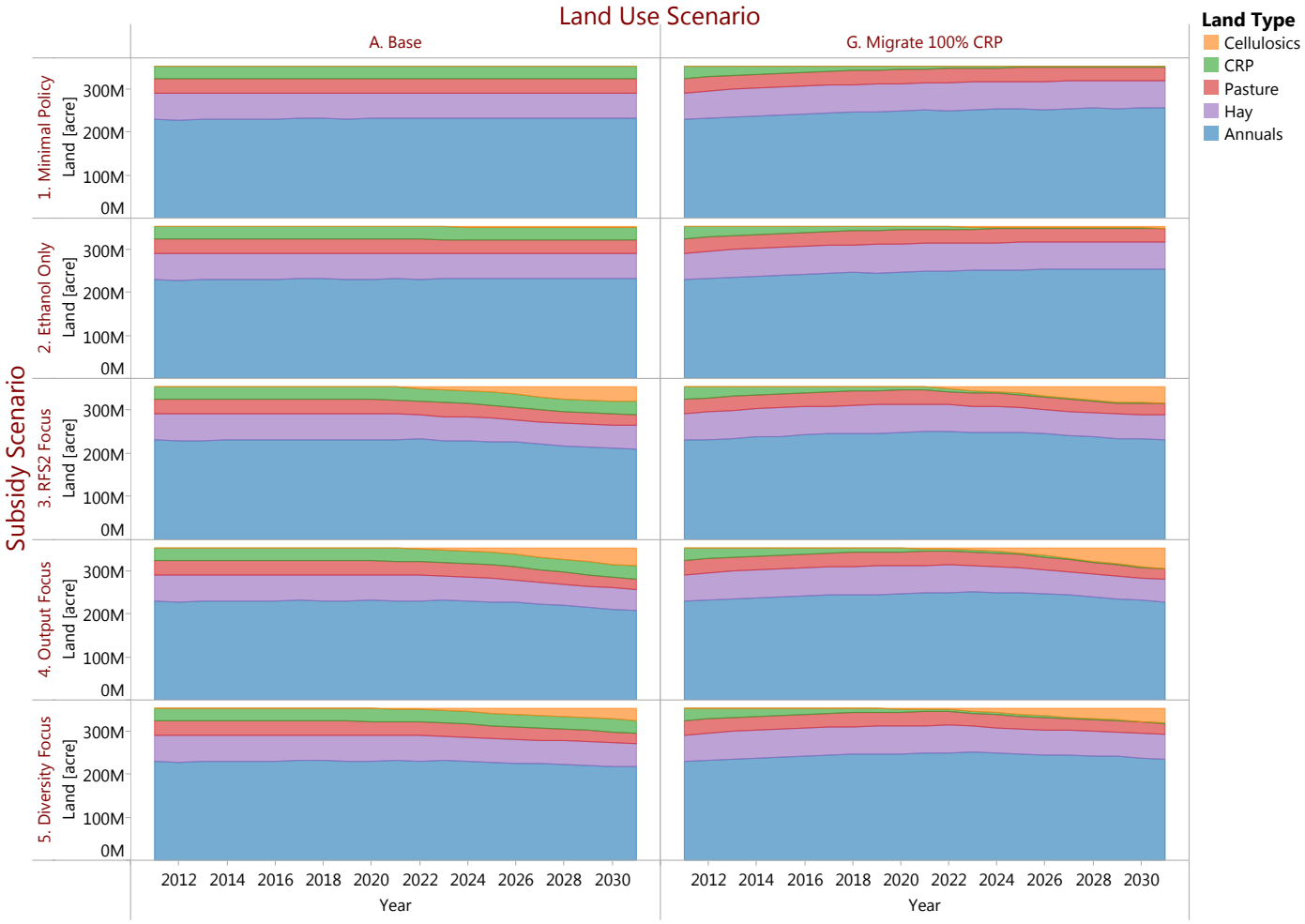
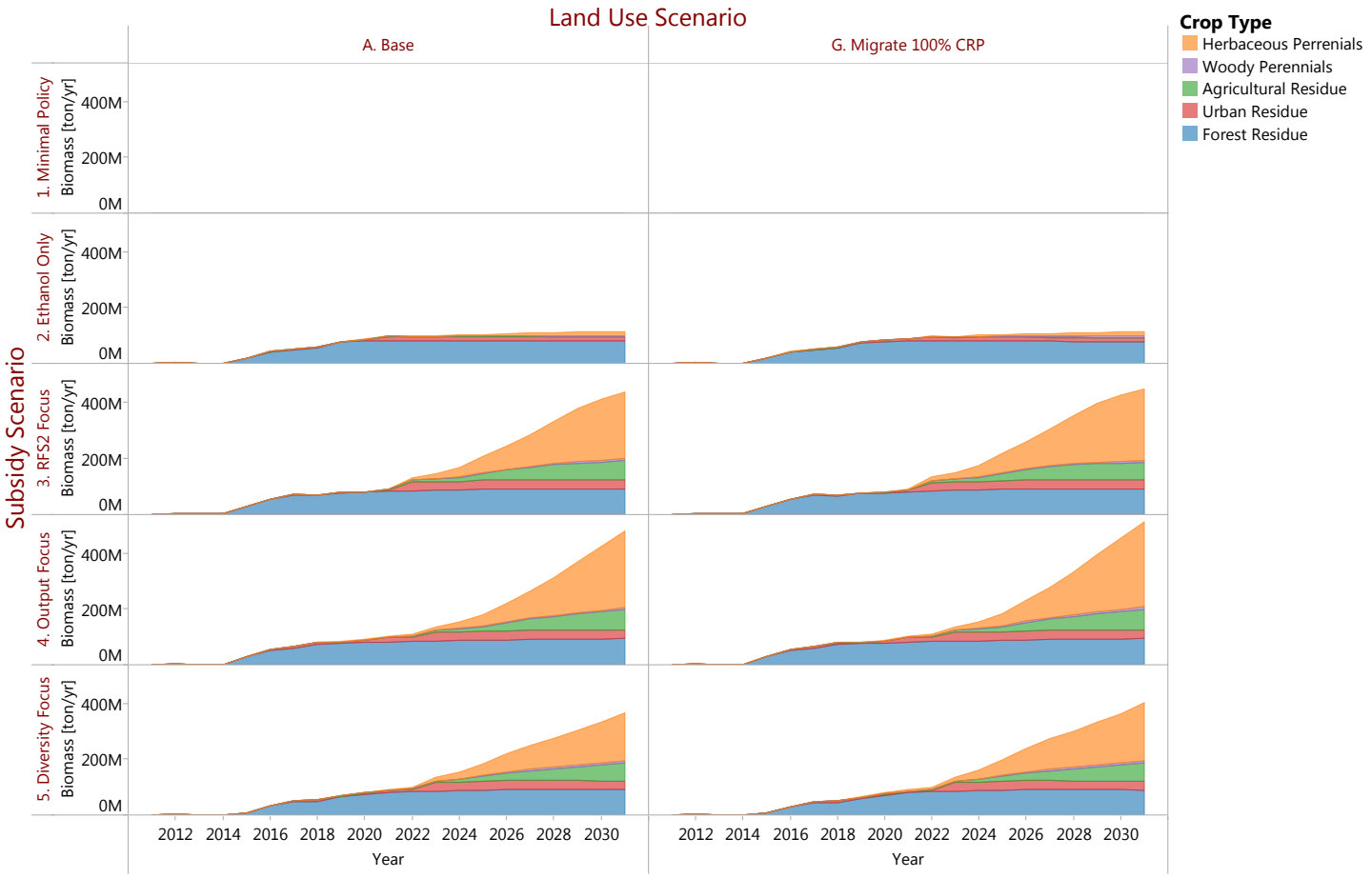
Growing a sustainable biofuels industry: economics, environmental considerations, and the role of the Conservation Reserve Program

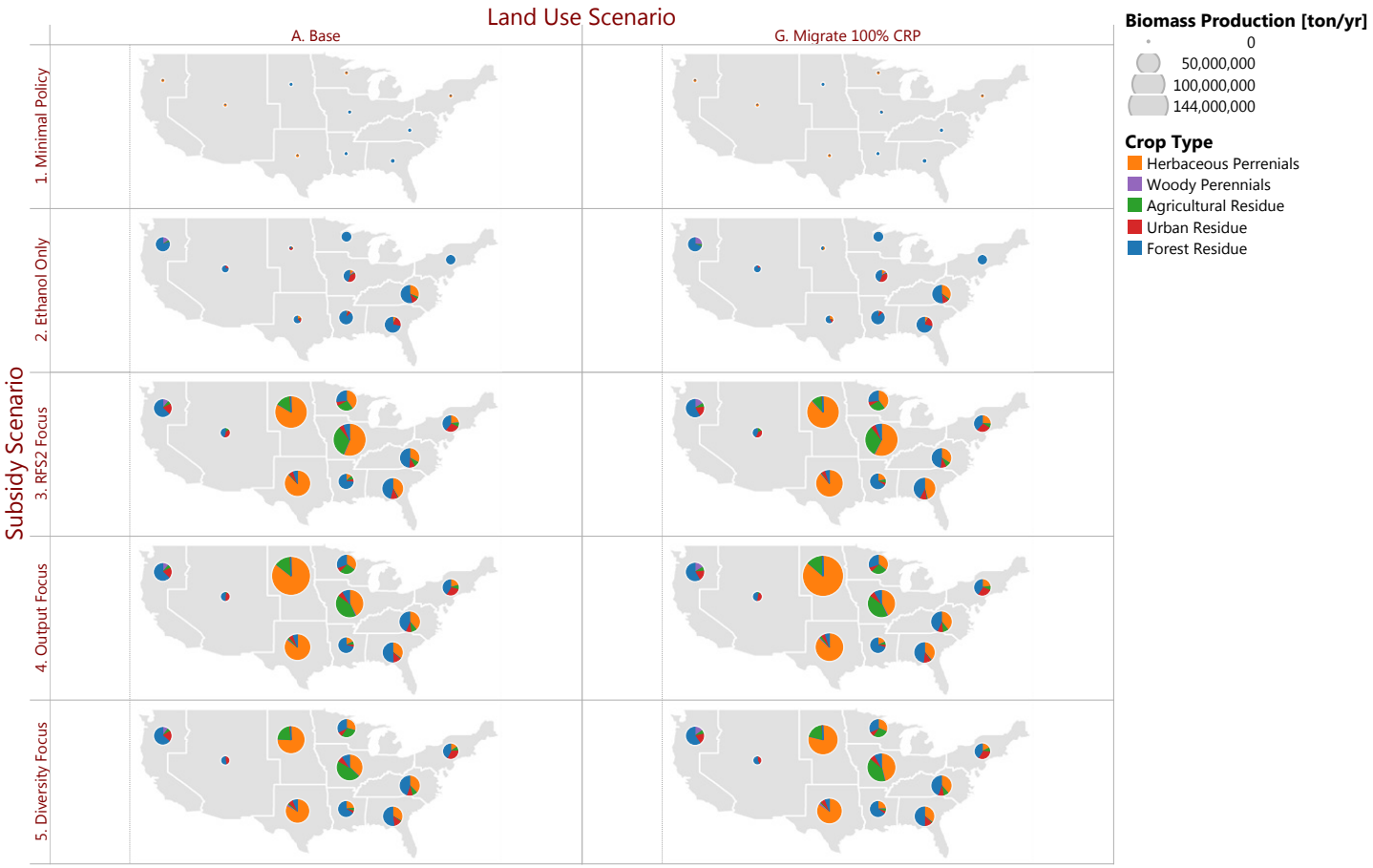
Abstract

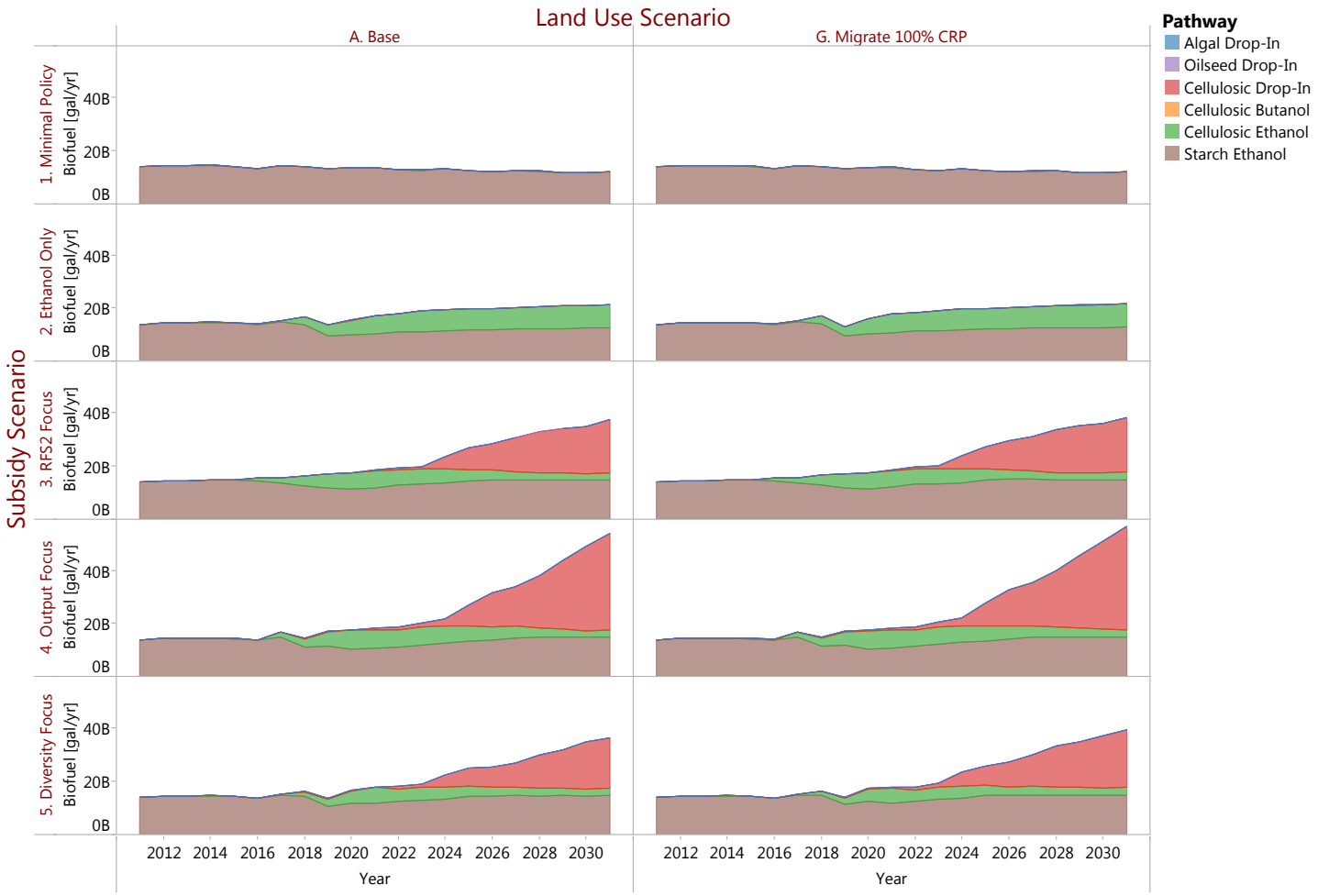
Biofuels are expected to be a major contributor to renewable energy in the coming decades under the Renewable Fuel Standard (RFS). These fuels have many attractive properties including the promotion of energy independence, rural development, and the reduction of national carbon emissions. However, several unresolved environmental and economic concerns remain. Environmentally, much of the biomass is expected to come from agricultural expansion and/or intensification, which may greatly affect the net environmental impact, and economically, the lack of a developed infrastructure and bottlenecks along the supply chain may affect the industry's economic vitality. The approximately 30 million acres (12 million hectares) under the Conservation Reserve Program (CRP) represent one land base for possible expansion. Here, we examine the potential role of the CRP in biofuels industry development, by (1) assessing the range of environmental effects on six end points of concern, and (2) simulating differences in potential industry growth nationally using a systems dynamics model. The model examines seven land-use scenarios (various percentages of CRP cultivation for biofuel) and five economic scenarios (subsidy schemes) to explore the benefits of using the CRP. The environmental assessment revealed wide variation in potential impacts. Lignocellulosic feedstocks had the greatest potential to improve the environmental condition relative to row crops, but the most plausible impacts were considered to be neutral or slightly negative. Model simulations revealed that industry growth was much more sensitive to economic scenarios than land-use scenarios-similar volumes of biofuels could be produced with no CRP as with 100% utilization. The range of responses to economic policy was substantial, including long-term market stagnation at current levels of first-generation biofuels under minimal policy intervention, or RFS-scale quantities of biofuels if policy or market conditions were more favorable. In total, the combination of the environmental assessment and the supply chain model suggests that large-scale conversion of the CRP to row crops would likely incur a significant environmental cost, without a concomitant benefit in terms of biofuel production.

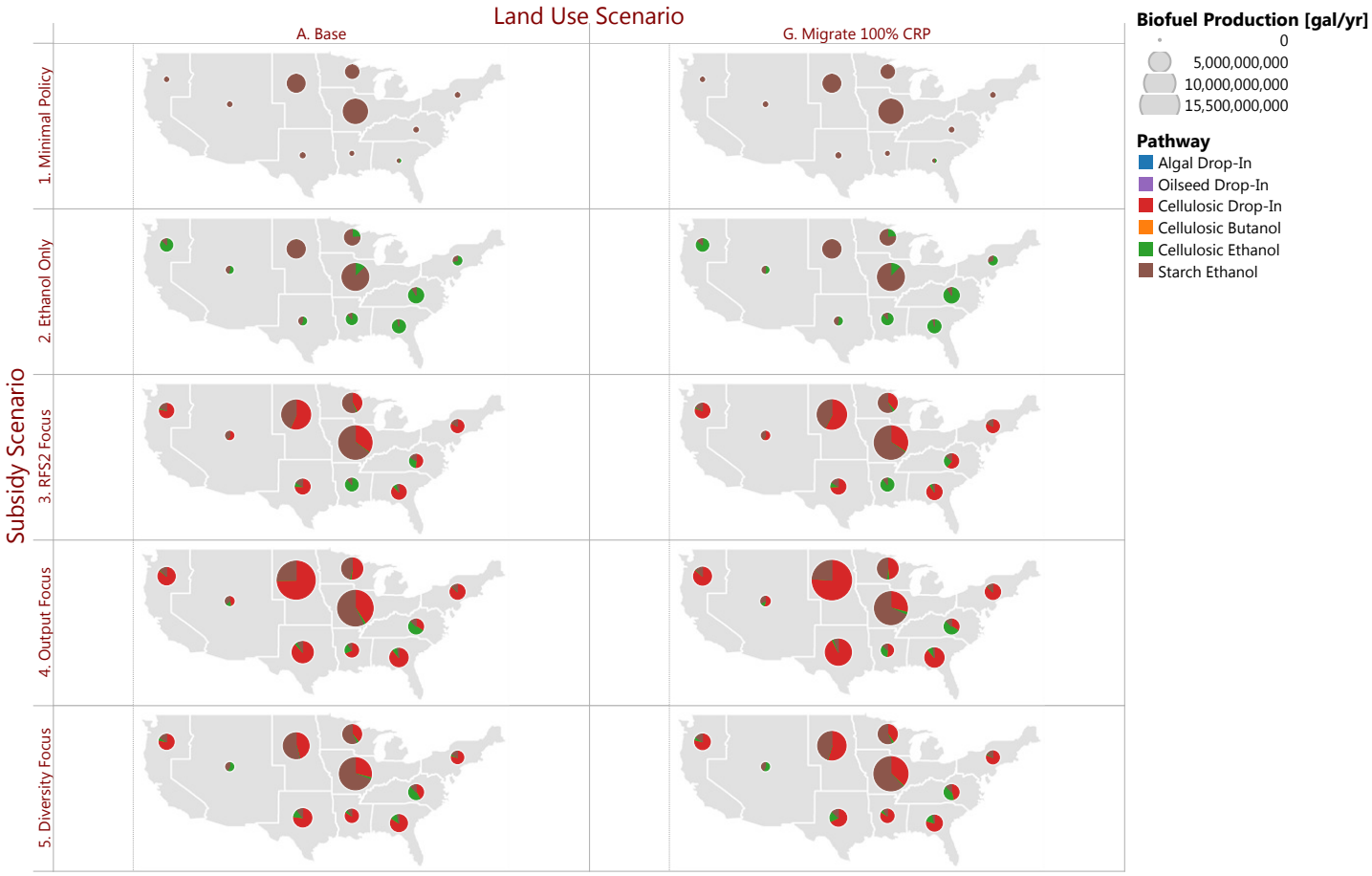

Land Use Scenario
A. Base
C. 100% Dedicated CRP
G. Migrate 100% CRP
Land Type
Cellulosics
CRP
Pasture
Hay
Annuals
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Land [acre]
300M
200M
100M
0M
2010
2015
2020
2025
2030
Year

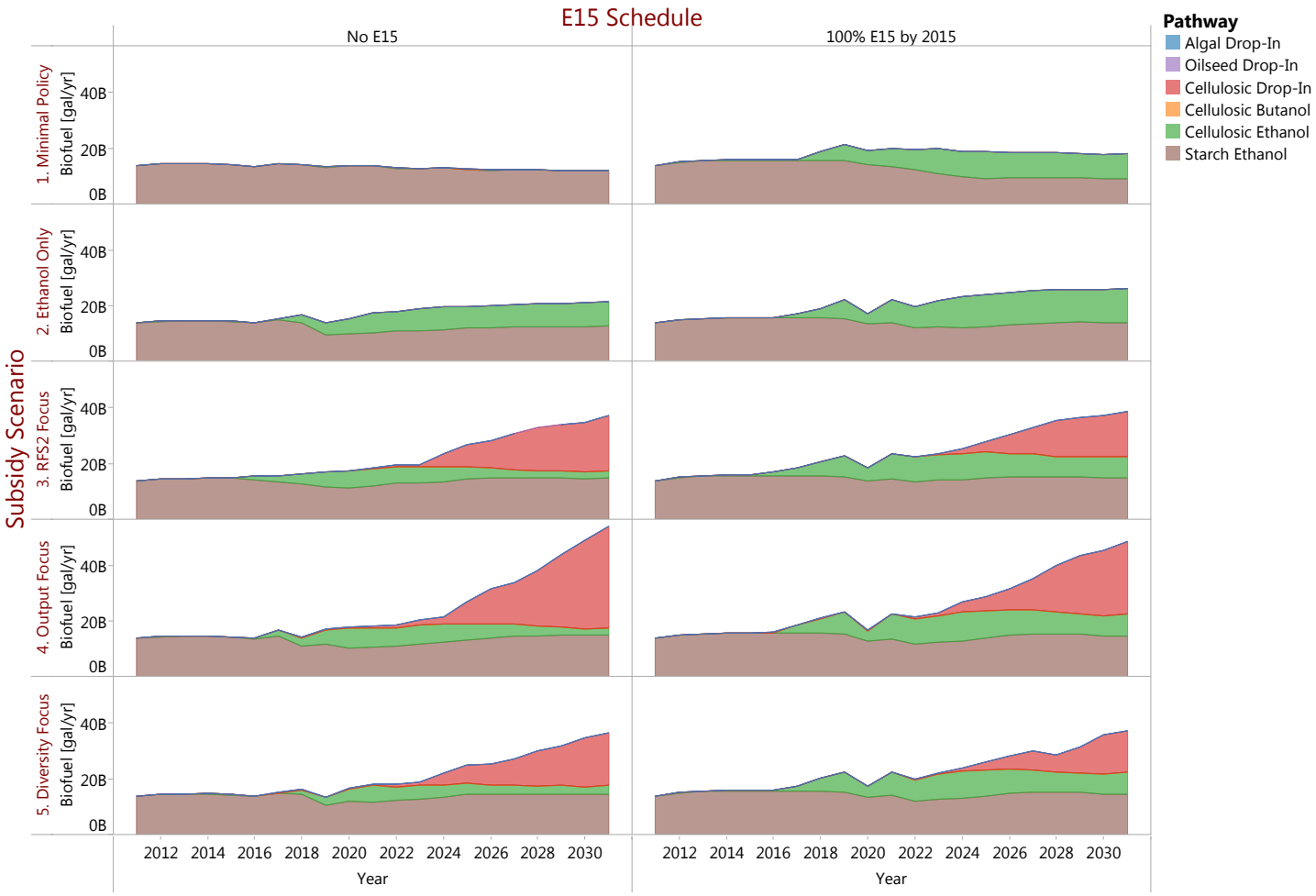

Land Use Scenario
A. Base
G. Migrate 100% CRP
Land Type
Cellulosics
CRP
Pasture
Hay
Annuals
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Land [acre]
300M
200M
100M
0M
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year

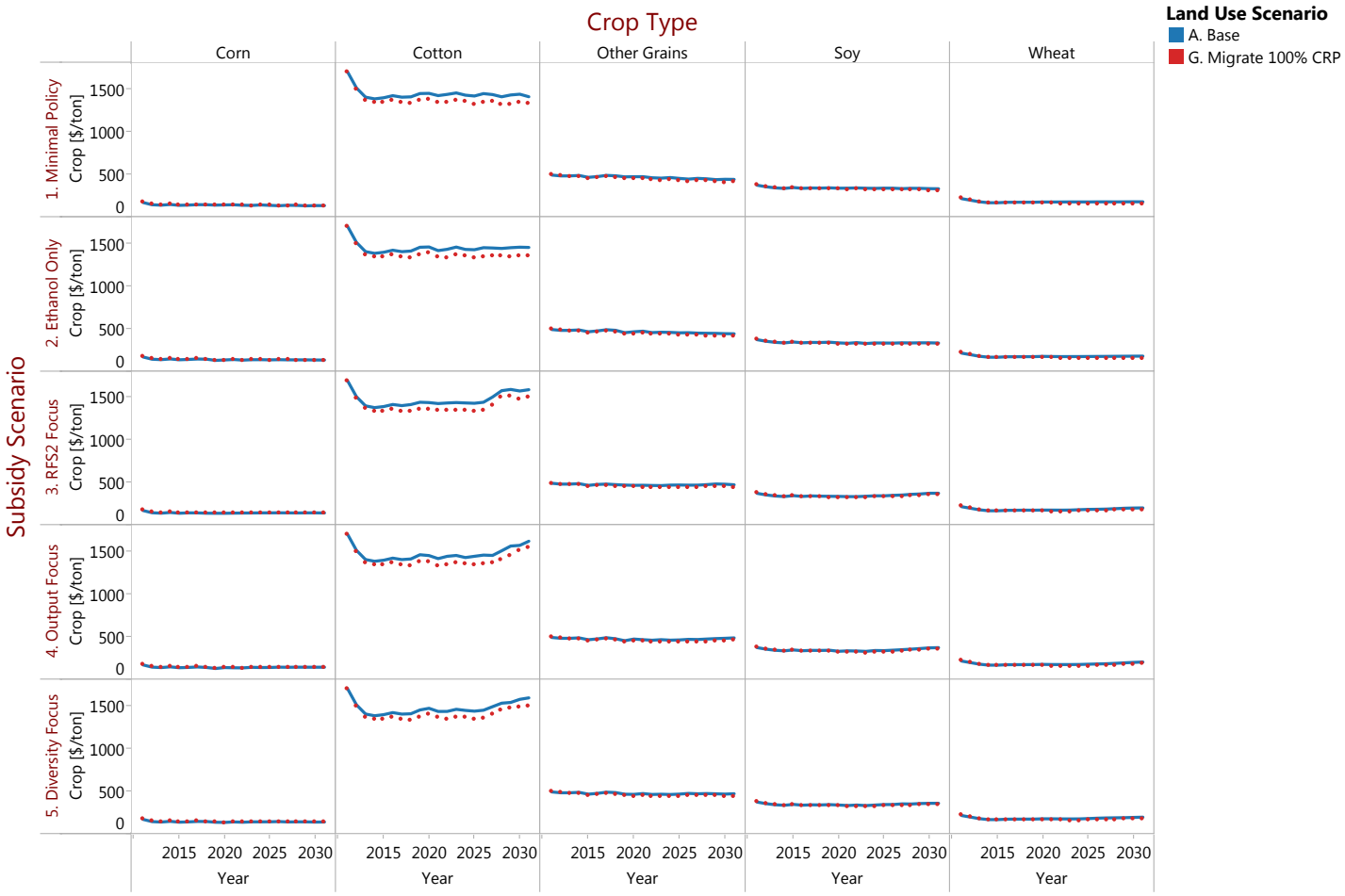

Land Use Scenario
A. Base
G. Migrate 100% CRP
Crop Type
Herbaceous Perrenials
Woody Perennials
Agricultural Residue
Urban Residue
Forest Residue
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Biomass [ton/yr]
400M
200M
0M
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year


Land Use Scenario
A. Base
G. Migrate 100% CRP
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Biomass Production [ton/yr]
0
50,000,000
100,000,000
144,000,000
Crop Type
Herbaceous Perrenials
Woody Perennials
Agricultural Residue
Urban Residue
Forest Residue


Land Use Scenario
A. Base
G. Migrate 100% CRP
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Biofuel [gal/yr]
40B
20B
0B
2012 2014 2016 2018 2020 2022 2024 2026 2028 2030
Year
Pathway
Algal Drop-In
Oilseed Drop-In
Cellulosic Drop-In
Cellulosic Butanol
Cellulosic Ethanol
Starch Ethanol


Land Use Scenario
A. Base
G. Migrate 100% CRP
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Biofuel Production [gal/yr]
0
5,000,000,000
10,000,000,000
15,500,000,000
Pathway
Algal Drop-In
Oilseed Drop-In
Cellulosic Drop-In
Cellulosic Butanol
Cellulosic Ethanol
Starch Ethanol


E15 Schedule
No E15
100% E15 by 2015
Subsidy Scenario
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Biofuel [gal/yr]
40B
20B
0B
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Year
Pathway
Algal Drop-In
Oilseed Drop-In
Cellulosic Drop-In
Cellulosic Butanol
Cellulosic Ethanol
Starch Ethanol


Crop Type
Land Use Scenario
A. Base
G. Migrate 100% CRP
Subsidy Scenario
Corn
Cotton
Other Grains
Soy
Wheat
1. Minimal Policy
2. Ethanol Only
3. RFS2 Focus
4. Output Focus
5. Diversity Focus
Crop [$/ton]
0
500
1000
1500
2015
2020
2025
2030
Year