Lessons from modeling the joint effects of climate and bioenergy policies

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UT Agricultural Policy Analysis Center

SunGrant Initiative

Overview

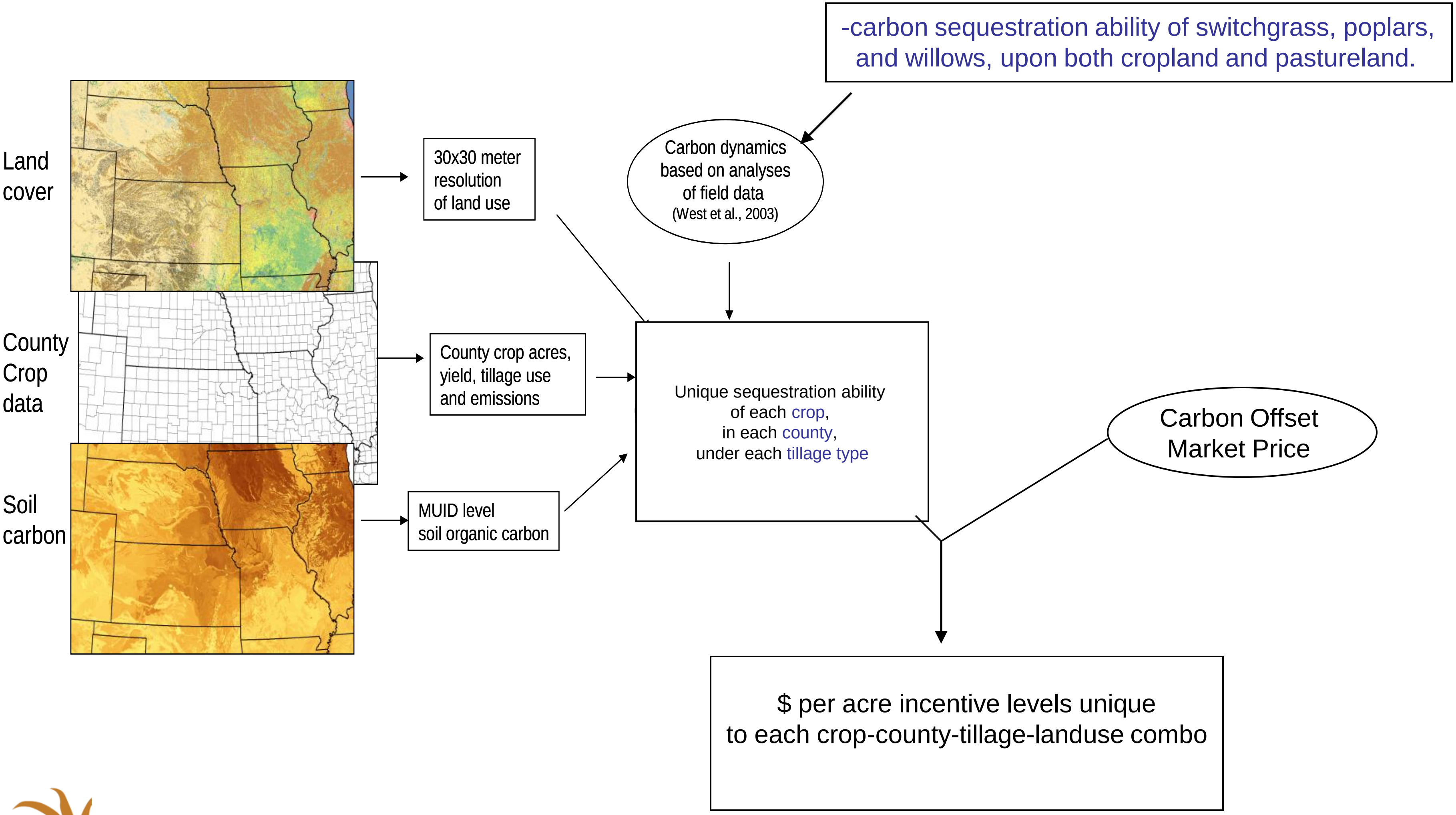
"*Send me legislation that places a market-based cap on carbon pollution and drives the production of more renewable energy in America.*"
– President Obama, Joint Session of Congress 2009

- Carbon legislation could change the landscape of biomass potential:
  - Biomass crops may receive incentives for building soil carbon.
  - Residue harvesters may receive incentives for NOT harvesting residues.
  - Higher input crops will see costs rise relative to lower-input crops.
- Questions:
  - Will ACES help or hinder fulfilling EISA?
  - Will ACES alter the geography of biomass supply potential?
  - Will EISA help or hinder reducing atmospheric carbon?
  - Are there conflicts/synergies between the policies?

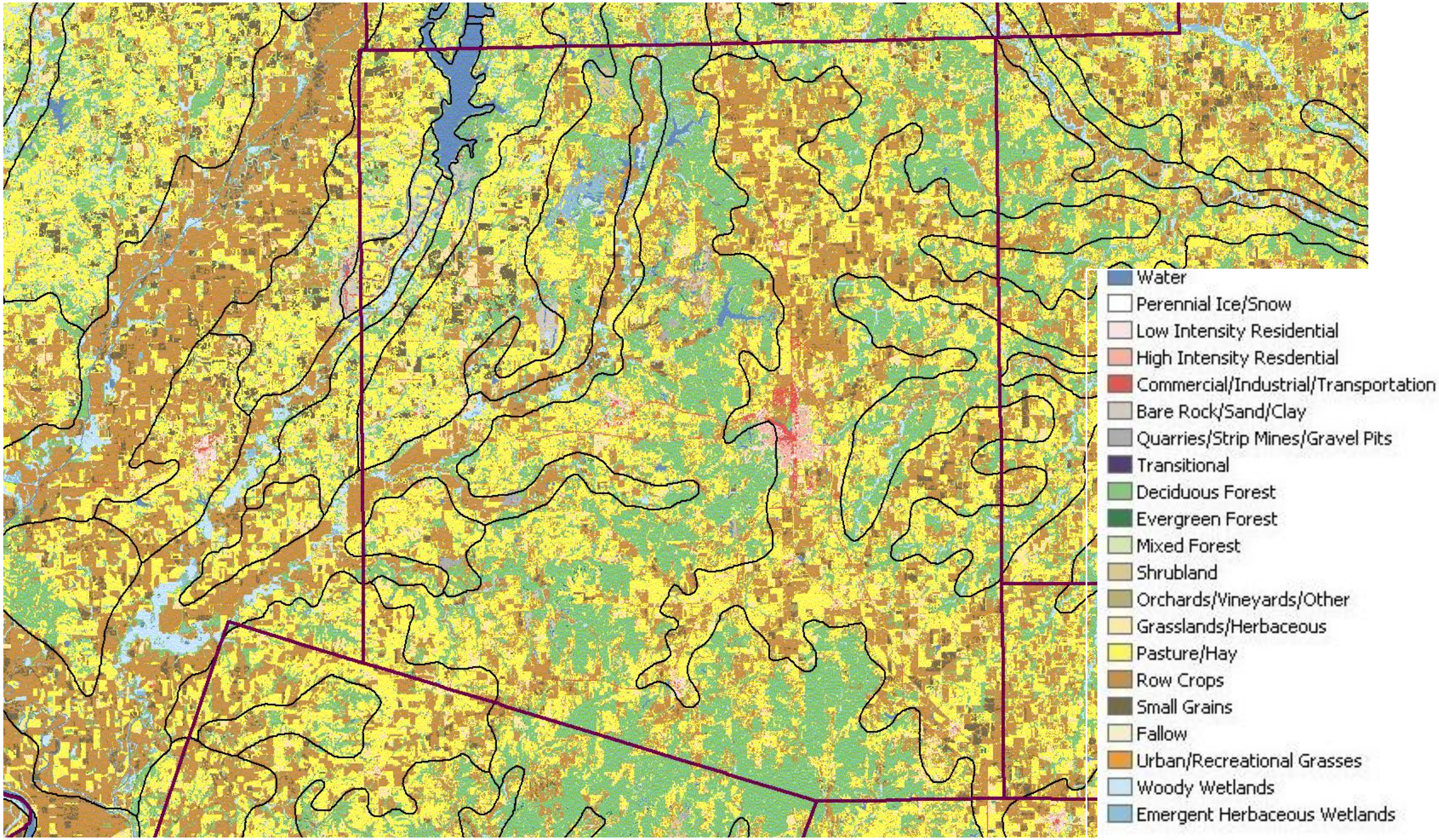
POLYSYS carbon-biomass Model

- Biomass Module
  - Switchgrass, poplars, willows, crop residues, wood residues.
  - County level yields and residue constraints.
  - Given a demand level, module will determine price and location to meet that demand.
  - Pasture can convert if forage made up through intensification.
- Carbon Module
  - Links market carbon price to:
    - local crop and land sequestration rates.
    - actual embodied carbon in crop production inputs.

Soil Carbon Incentives



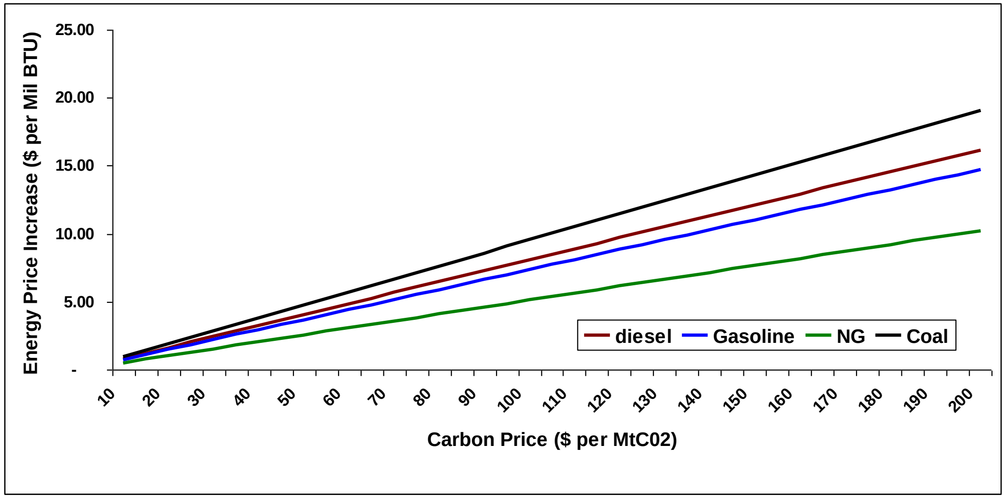
Example of actual high resolution overlay



Counties are outlined in purple, STATSGO soils regions are outlined in black, and NLCD data is displayed at the 30 meter resolution (Randloph County, MO).

Embodied Carbon Costs

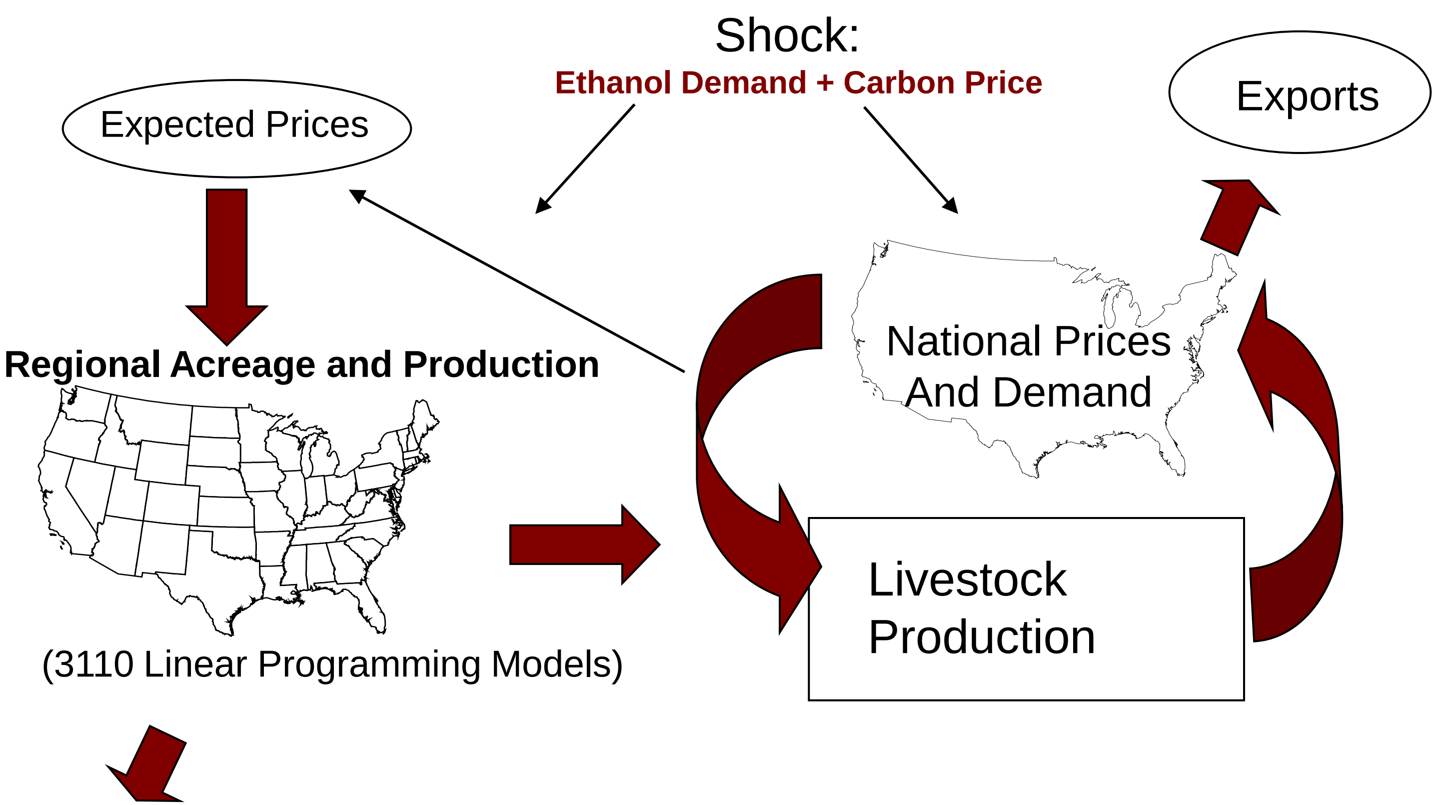
- Using CBO and EPA methodology of transferring carbon price to energy price via embodied carbon content.
- Energy prices are linked to the embodied carbon costs by the source energy type of each input.
- Includes operation budgets, embodied energy and carbon for herbaceous grasses and residue harvesting.



APAC Embodied Energy and Carbon Budgets: Example Barley in Nebraska

MachName	TractorName	Machinery/Implement Fuel Consumption (gallons per acre)	Direct Energy Use (Btu/ac)	C Emissions from Direct Energy Use, MT per acre	Embodied Energy Use - Fertilizers (Btu/ac)	C Emissions from Embodied Energy Use - Fertilizers (MT per acre)	Embodied Energy Use - Herbicides, Pesticides, Fungicides (Btu/ac)	C Emissions from Embodied Energy Use - Herbicides, Pesticides, Fungicides (MT per acre)	Embodied Energy Use - Seeds (Btu/ac)	C Emissions from Embodied Energy Use - Seeds (MT per acre)
Field Cultivator GE15ft	Tractor 2wd 100 hp (diesel)									
Moldboard Plow REG 4-6b	Tractor 2wd 135 hp (diesel)	0.28	38,531	0.00085						
Culti-mulch Roller LT18ft	Tractor 2wd 100 hp (diesel)	2.03	282,376	0.00622						
Dry Fert Spreader (trailer mtd)	Multiple Operation	0.51	70,640	0.00156						
Dry Fert Spreader (trailer mtd)	--	0.00	0	0.00000	120,944	0.00300				
Land plane-Leveler	Tractor 2wd 100 hp (diesel)				1,970,411	0.03107				
Plain-disc Grain Drill GT14ft	Tractor 2wd 135 hp (diesel)	1.44	200,238	0.00441						
Chem Applicator GE30ft (tractor mtd)	Tractor 2wd 100 hp (diesel)	0.78	108,161	0.00238					134,109	0.00279
Combine-2wd (self-prop)	Self Propelled	0.17	23,914	0.00053			46,584	0.00088		

POLYSYS Simulation
Structure and Flow (Annual)

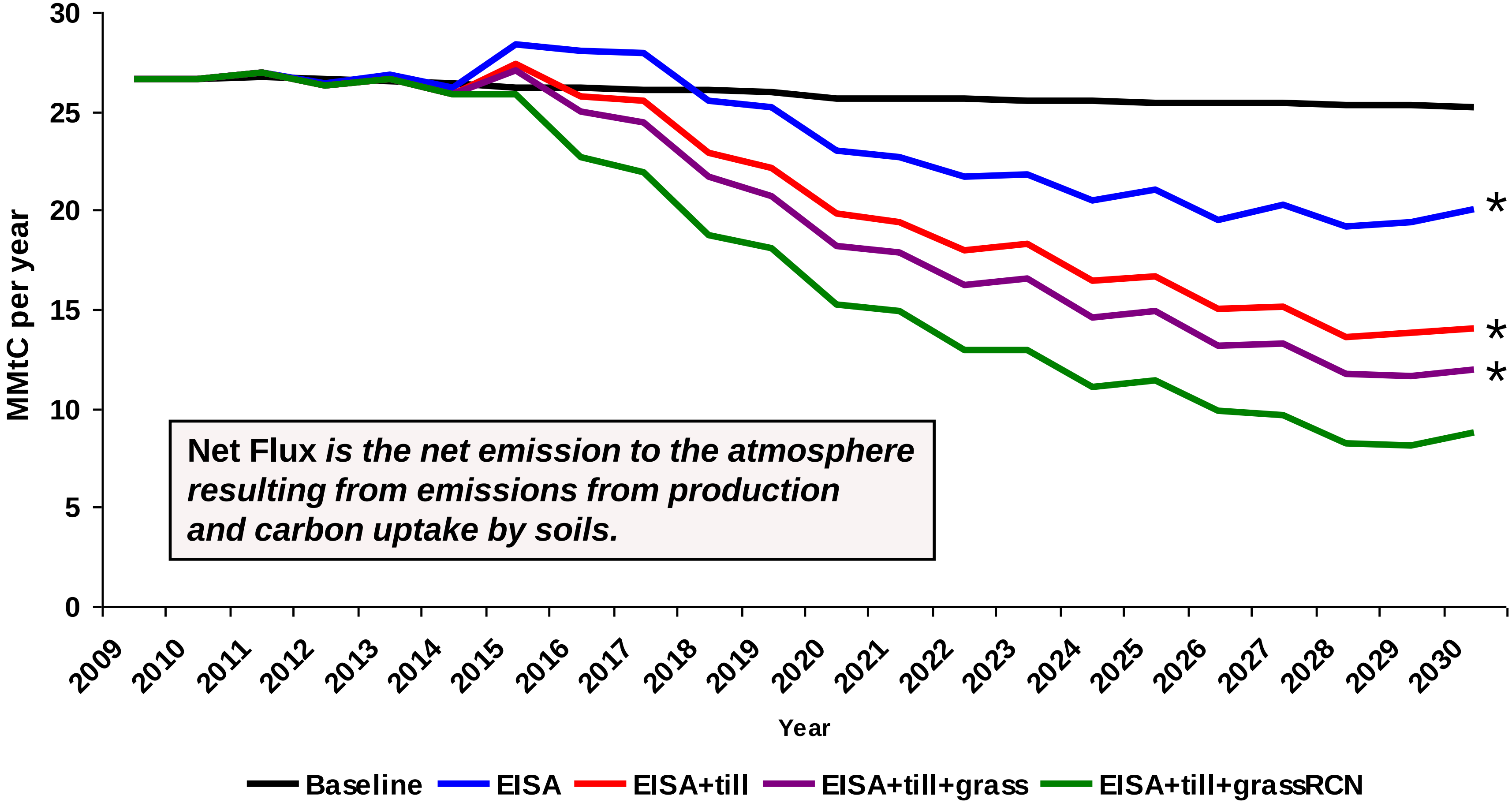


Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net carbon flux (NCF) MMtC t	26.60	26.56	26.90	26.29	26.62	25.64	25.68	22.27	21.32	18.03
Carbon Payments Mil$	-	-	94	191	289	398	557	718	879	1,081
Carbon Costs	-	-	122	243	365	484	620	661	714	763
Net Crop Returns(NCR)	54,204	55,804	55,056	60,703	58,616	65,476	60,696	69,560	65,195	73,559
Biomass Price ($/DT)	30.00	30.00	30.00	30.00	30.00	31.00	60.00	60.00	60.00	60.00

Scenarios Evaluated:
EISA and a Carbon Bill (ACES)

- **Baseline**
  - USDA baseline extended to 2030.
- **EISA**
  - Meet Energy Independence and Security Act mandate of 36 billion gallons.
- **EISA+till**
  - Meet EISA.
  - ACES: Carbon offsets to reduction in tillage intensity.
- **EISA+till+grass**
  - Meet EISA.
  - ACES: Carbon offsets to reduction in tillage intensity.
  - ACES: Carbon offsets to perennial herbaceous energy crops (switchgrass).
- **EISA+till+grass+RCN**
  - Meet EISA.
  - ACES: Carbon offsets to reduciton in tillage intensity.
  - ACES: Carbon offsets to perennial herbacious grasses.
  - Residue harvesting constrained to ‘carbon neutral’ level.

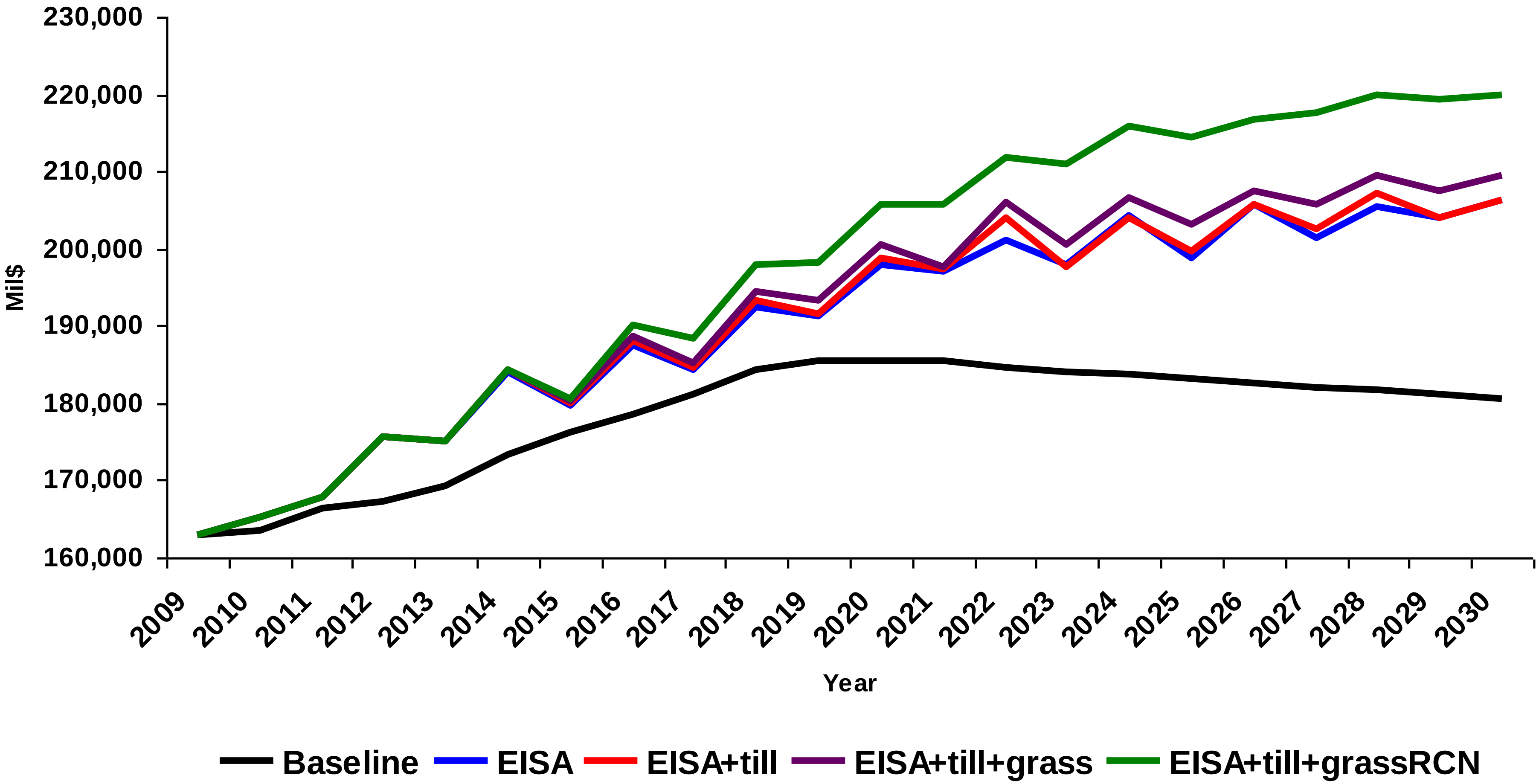
Net Carbon Flux



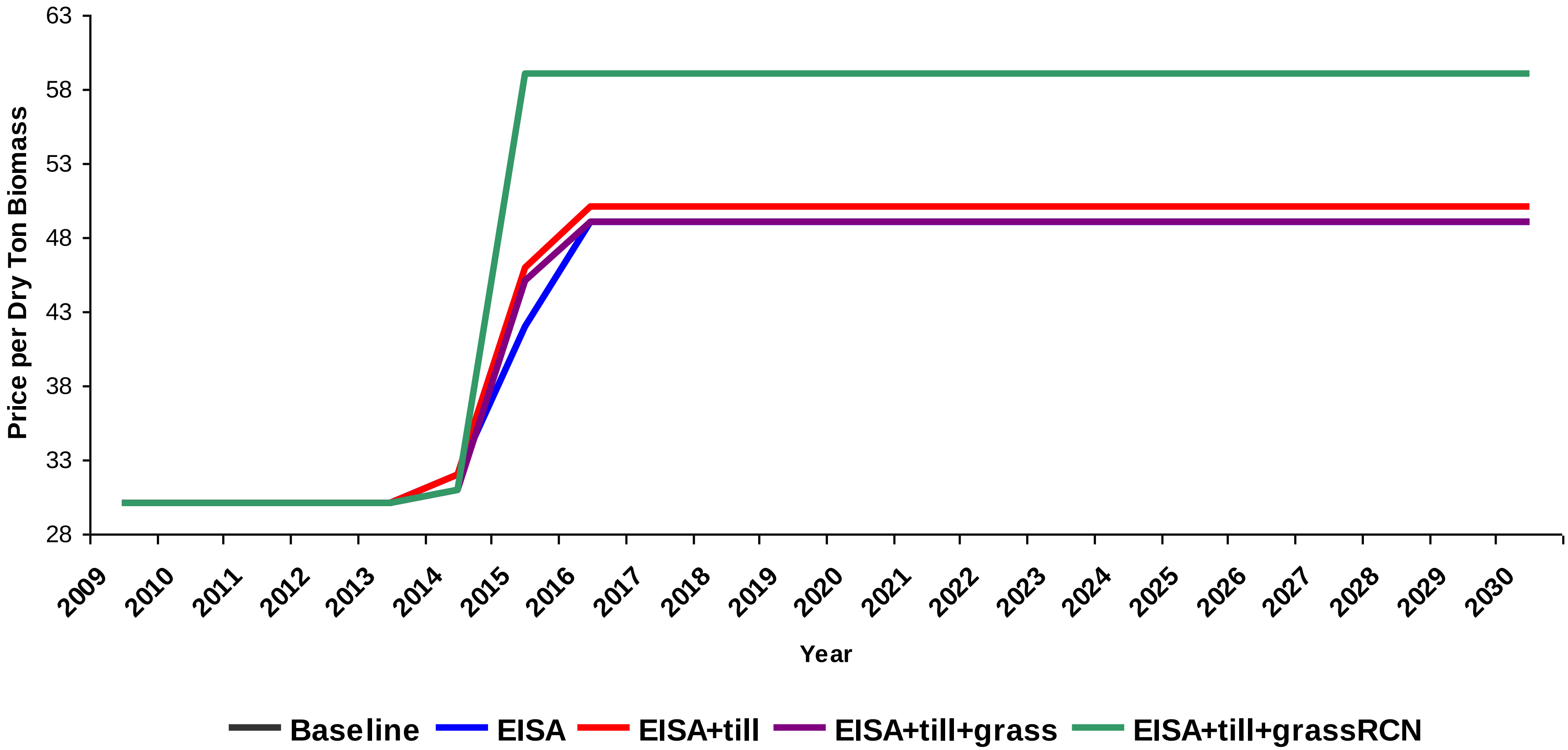
*losses of soil carbon from residue harvesting NOT accounted for!

Residue removal limited to minimum of tolerable erosion or collection efficiency (<40% of total available)

Total Net Returns: Crops



Biomass Prices



Ranking under Objectives
(Accumulated 2010 – 2030)

Objective

	Economic Indicator *Ag Net Returns* *Bil$*	**Climate Benefits** *Net Carbon Flux* *MMtCeq*	**Cheap Feedstock** *Max Biomass Price* *$/dt*
Baseline	3,759 **(5)**	543 **(5)**	0.00
EISA	4,023 **(4)**	497 **(4)***	49.00 **(1)**
EISA+till	4,033 **(3)**	436 **(3)***	50.00 **(3)**
EISA+till+grass	4,064 **(2)**	411 **(2*)**	49.00 **(1)**
EISA+till+grassRCN	4,181 **(1)**	362 **(1)**	59.00 **(4)**

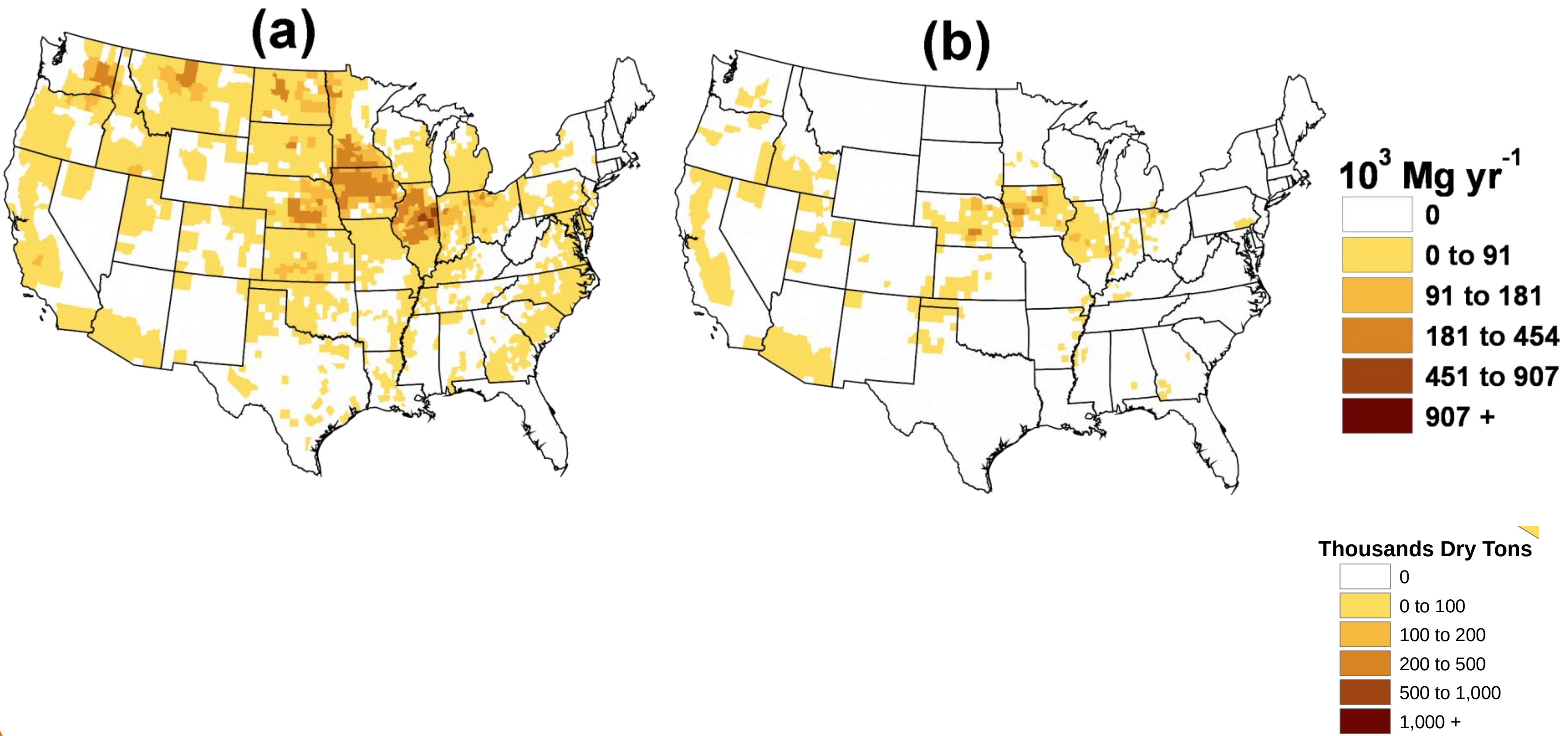
totals from 2010 through 2030

*not accounting for soil losses from residue remova

What will the adopted policy mean for biomass availability, source and location?

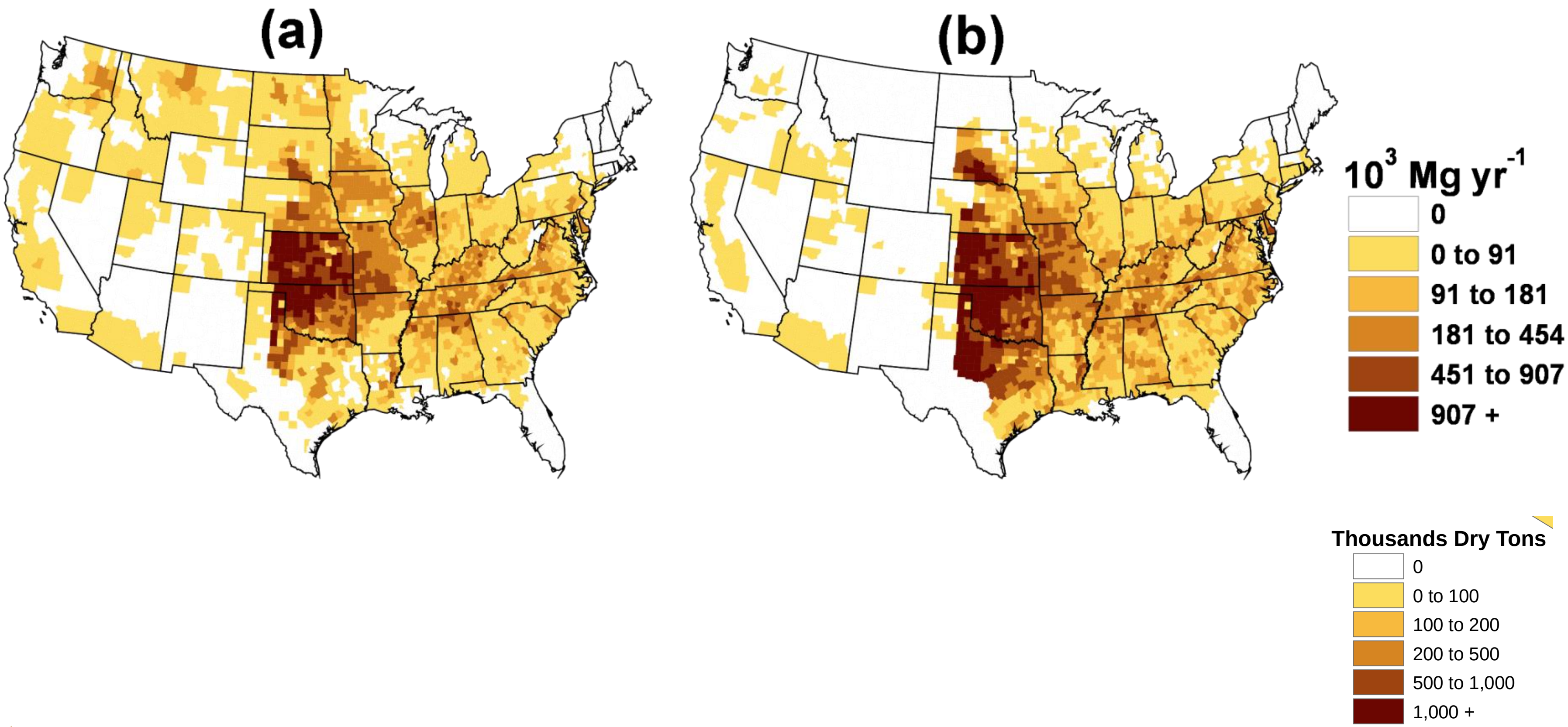
Change in Residue Production per county in 2025:

a) EISA alone b) EISA+till+grass+RCN



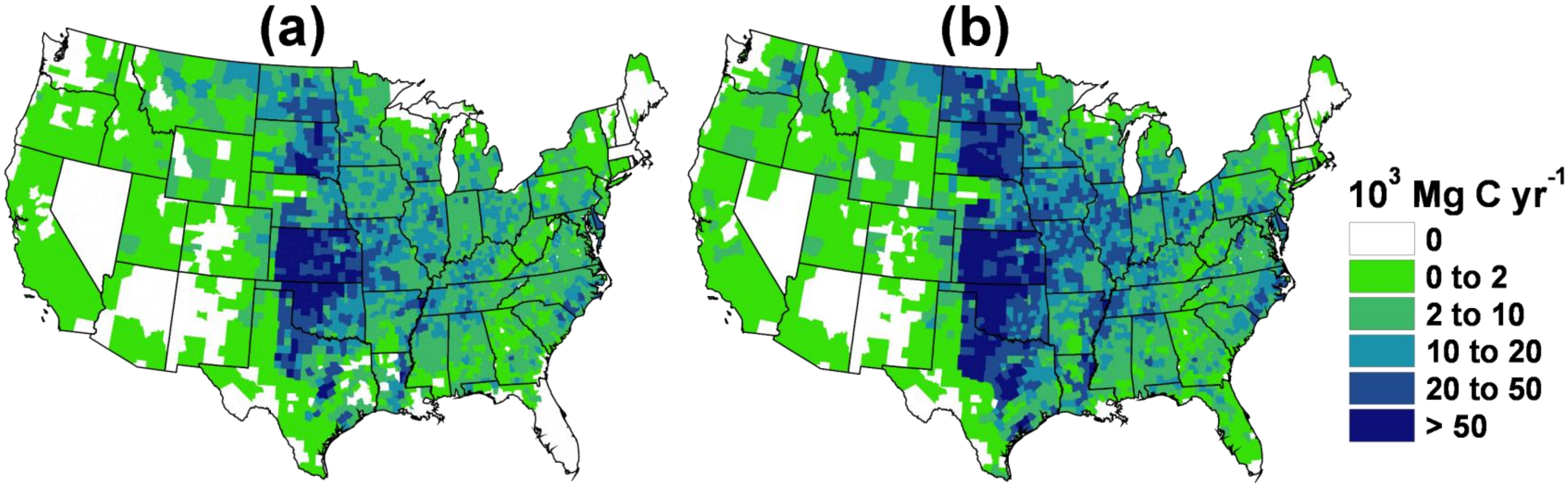
Change in All Biomass Production per county in 2025:

a) EISA alone   b) EISA+till+grass+RCN



Gain in Soil Carbon per county in 2025:

a) EISA alone   b) EISA+till+grass+RCN

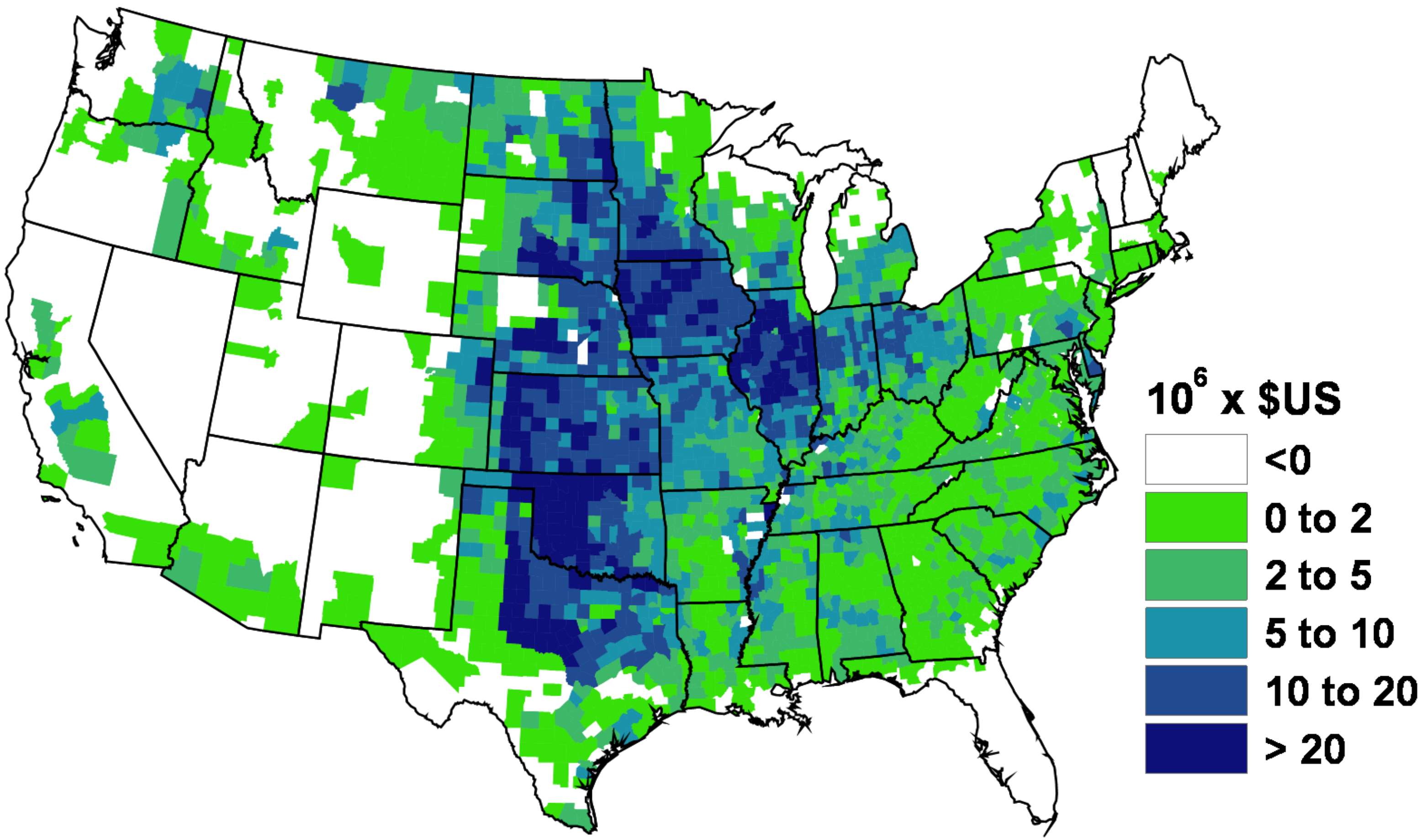


Carbon Payments (2025)

EISA+till+grass+RCN

Crop Net Returns (2025)

Change from EISA to EISA+till+grass+RCN



Lessons Learned

- **EISA alone could deliver great *carbon* and *net return* benefits.**

- **Soil carbon offsets to herbaceous biomass enhances both carbon and farmer benefits.**

- **Restricting residue harvesting to be *'carbon neutral'* has a positive impact upon carbon benefits and net returns.**

- **ACES could alter the geography of feedstock availability (towards herbaceous grasses, away from residues).**

Future Directions

- Pasture intensification
  - Right now assuming: For every acre of biomass-displaced pasture, 1 acre of additional pasture must be ‘intensified’ to replace lost forage. This assumes ‘intensification’ can DOUBLE existing forage yield.
  - In future: Add Management Intensive Grazing (MiG) as an ‘official’ land-use option.
    - Budgets, stocking rates, and sequestration rates will be regional
    - MiG could also qualify for carbon payments

- Residue restrictions to ‘carbon neutral’ level
  - Right now using: Wilhelm et al. 2007
  - In future: include residue ‘carbon curves’ indicating how much SOC decreases per unit of residue removed.

- Tie baseline acreage to new ‘Cropland Data Layer’ instead of NASS data.

Conclusion

Thank you.

Agricultural Policy
Analysis Center