Photo by Elisabeth Spratt

REGENERATIVE GRAZING TRANSITION ANALYSIS

Upper Fox and Kishwaukee Watersheds

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delta institute

Pasture Project AT THE WALLACE CENTER

Introduction

The Delta Institute and the Pasture Project, part of the Resilient Agriculture & Ecosystems initiative of the Wallace Center at Winrock International, have partnered on a second year of shared work to expand grass-fed value chains in the State of Illinois. Support for this project was provided through Food:Land:Opportunity, an initiative of Kinship Foundation and The Chicago Community Trust, funded through the Searle Funds at The Chicago Community Trust. Following a statewide grass-fed value chain analysis and watershed selection process, the second year of shared work aims to work more deeply in the Upper Fox and Kishwaukee watersheds near Chicago to support grass-based production, expand processing and distribution, and connect producers and aggregators to buyers in Chicago, particularly institutions.

To advance the development of grass-based production in the selected watersheds, the team set up to define the parameters of the transition by:

- Setting perennial pasture transition goals for these watersheds based on statewide analysis,
- Defining a methodology for assessing grazing suitability for fields and soils across the watershed,
- Describing several possible transition pathways to reach established transition acreage goals, and
- Estimating environmental and economic impact for each transition scenario.

This memo describes the analysis and outlines recommendations below. The analysis focuses on transition of cropland to permanent perennial pasture, since perennialization of the landscape is shown to have the highest water quality, carbon, and infiltration impacts. However, transition for individual producers can take many forms and numerous other regenerative practices also have positive environmental and economic impacts. For example, many producers begin reintegrating livestock on the landscape through grazing cover crops as a stepping stone to trying perennial forages. Grazing cover crops can improve soil health, reduce nutrient, and soil loss, and offset feed costs or provide new rental income to a row crop producer. While this and other regenerative practices are important, particularly in terms of incremental reintegration of livestock, only perennial pasture is explored in detail here.

Setting Acreage Transition Goals

During the Phase 1 grass-fed value chain analysis,[1] the project team defined statewide transition scenarios. To understand the potential scale of grass-fed beef sector growth, we estimated the increase in production needed to 1) increase grass cover to meet the state's water quality goals; and 2) meet growing demand for grass-fed beef in Illinois.

Scenario 1: Increase Illinois Grass Cover to Meet Water Quality Goals

The Illinois Nutrient Loss Reduction Strategy (NLRS) sets a goal of decreasing nitrogen (N) by 15 percent and phosphorus (P) by 25 percent by 2025 and both nutrients by 45 percent eventually. The NLRS proposes and models several combinations of best management practices and land cover changes which would result in reaching proposed nutrient reduction targets. Only one proposed combination, shown below, includes perennial crops such as forage crops (highlighted). Under this scenario, 2,500,000 additional perennial grassland acres statewide would need to be added.

Figure 1. Each recommendation in the table must be true to result in a 45 percent reduction in N and P. (Source: Illinois Nutrient Loss Reduction Strategy, 2015)

Illinois Nutrient Loss Reduction Goal: 45% reduction in N and P

Scenario NP 3	Recommendation	Est. Acres (Million)	Nutrient Reduced	Potential Data Sources for Tracking Metric
MRTN	Applies to all corn acres, but reductions only realized on 10%	11	N	NASS
Spring-only N application	Tile drained corn acres	5.7*	N	NASS
Bioreactors (acres treated)	30% of crop acres	6.6	N	Illinois EPA-from voluntary reported data
No P fertilizer above STP maintenance	Assumes 12.5M acres are above maintenance	1.8	P	IL Dept of Ag tonnage report, other
Reduced till of conventional eroding >T	30% or greater crop residue cover	1.8	P	Soil Transect Survey
Cover crops on corn/soybeans	87.5% of acres	19.25	N&P	NASS, FSA, IEPA, NRCS, satellite imagery
» Buffers on all applicable lands	Estimated 100 feet from stream	0.2*	P	Illinois EPA, FSA, NRCS, GIS analysis
» Perennial crops on land eroding >T	Biofuels, hay, or CRP	1.6	N&P	FSA (CRP), IDNR (CREP), other
» Additional perennial crops	Biofuels, hay, or CRP	0.9	N&P	FSA (CRP), IDNR (CREP), other

[1] *Pasture Project; Delta Institute. "The State of Grass-Fed Value Chains in Illinois".* https://winrockgis.maps.arcgis.com/apps/Cascade/index.html?appid=38107c4379fa4ac2b254b8d1c60fe482

Scenario 2: Meet Increased Demand for Grass-Fed Beef by Increasing Illinois Production

SPINS data revealed that grass-fed demand grew 6 percent from 2017-2018 and 10 percent from 2018-2019.

Scenario 2.1: Standard Growth Rate

Assuming grass-fed beef demand is growing in Illinois at a constant rate of 8 percent each year for five years, the necessary production to meet this demand would be about **40,000 additional acres in grass statewide** in five years.[2]

Scenario 2.2: Accelerated Growth Rate

Though only two years of grass-fed demand data are available, these two years show that demand for grass-fed beef may be accelerating. It may also be possible to stimulate demand for grass-fed beef through consumer education, institutional procurement engagement, or other strategies.

Assuming that grass-fed beef demand is accelerating by 4 percent each year (6 percent in year one, 10 percent in year two, 14 percent in year three, etc.), then the necessary production to meet this demand would be about **78,000 additional acres in grass** in five years.[1]

To determine the acreage transition goals in the Upper Fox and Kishwaukee watersheds, the goal acreage for scenarios 1, 2.1, and 2.2 were divided across all Illinois watersheds, adjusted by 1) the watershed size and 2) the regenerative grazing suitability score based on spatial analysis in the Watershed Selection Memo.

Figure 2. The goals for each watershed, adjusted for watershed size and regenerative grazing suitability.

Watershed	Acres to be converted under Scenario 1	Acres to be converted under Scenario 2.1	Acres to be converted under Scenario 2.2	Total cropland acres
Upper Fox	35,802	573	1,117	82,000
Kishwaukee	39,636	634	1,237	559,000
Combined	75,438	1,207	2,354	641,000

Upper Fox and Kishwaukee watersheds had about 641,000 acres of cropland in Illinois combined in 2019. The ambitious Scenario 1 aims to transition 11.8% of cropped acres, and Scenarios 2.1 and 2.1 aim to transition 0.2% and 0.4% respectively.

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[2] *Assumes growth in grass-finished animals each year from a baseline of an estimated 4,475 grass-finished animals, at around 19 acres of lifetime forage needs per grass-finished animal (Pelletier et al., 2010).*

Assessing Acres to Transition

This section of the analysis examines which cropland acres should be considered for transition. Corn and soybeans are the predominant crops in Upper Fox and Kishwaukee, and we consider all the acres that were planted in corn and soybeans in 2019 as potential candidates. Four criteria were used to prioritize which acres should be transitioned: estimated net revenue from a corn-soybean rotation, distance from streams, slope, and erodibility class.

Estimated Net Revenue from A Corn-Soybean Rotation

Rationale:

Acres which are marginally productive for corn and soybeans are likelier to be transitioned to new management practices or having enterprises stacked (like grazing cover crops) if those alternatives are more profitable.

Methodology:

1. Use IL productivity index, as adjusted by NRCS for slope and flood frequency to determine yield (bu/ac) for each soil map unit
2. Apply estimated yields to each area on the landscape where corn or soybeans grew in 2019
3. Apply 2019 crop enterprise budgets from University of Illinois to yields as follows:

   *yield (bu/ac) * price ($4.50/bu for corn and $9/bu for soybeans) + estimated 2019 government payments ($57/ac) – rental rate (from USDA county data for 2019, not adjusted for land quality*

4. Average the corn and soybean net revenue for each pixel on landscape where corn or soybeans grew in 2019

Distance from Streams

Rationale:

Corn and soybean acres which are closer to streams may contribute more to nutrient loading and may benefit more from conversion to perennial forages.

Methodology:

For every soil unit, calculate the distance to the nearest stream from the USGS National Hydrography Dataset 1:24,000.

Slope

Rationale:

Corn and soybean acres which have steeper slopes may be contributing more to nutrient loading and may benefit more from conversion to perennial forages.

Methodology:

Use representative slope from SSURGO Soil Survey.

Erosion Class

Rationale:

Corn and soybean acres with higher erosion classes may be contributing more nutrients and may benefit more from conversion to perennial forages. Higher classes are higher erosion.

Methodology:

Use erosion class from SSURGO Soil Survey.

Transition Pathways

To define transition pathways, and to allow others to define transition pathways according to their priorities, the project team developed a beta transition modeler.[3] This modeler allows users to select combinations of the transition criteria to see the estimated number of acres which meet those criteria. The transition pathway modeler was used in determining the pathways below. These pathways are just a sampling of the potential combinations that reach acreage goals. While these criteria are well-established as enabling factors that may make transition to perennial grasses more worthwhile, they are not well-studied in combination and depend on individual and organizational priorities. Thus, the project team encourages individual exploration of the beta transition modeler as well as future analyses on cost-effectiveness to further evaluate which combinations might be most realistic for a given goal.

Pathways to Scenario 1 to Transition 75,438 acres:

Pathway A:

Corn/soybean revenue less than $0/acre/year and within 55 feet of a stream – potential transition acres: 76,754

Rationale:

Corn and soybean acres which are not earning revenue in the average year make up over half of the total acreage in the watershed. Some of these, such as those close to streams, may be contributing significantly to nutrient loss while operating at a loss in many years, making the cost effectiveness of transition highest (less opportunity cost and higher nutrient reduction potential).

[3] https://winrockgis.maps.arcgis.com/apps/webappviewer/index.html?id=3a6138df0512477b9c8eed9080f583bf

Pathway B:

Corn/soybean revenue is less than $90/acre/year – potential transition acres 80,867

Rationale:

Corn and soybean acres that may be far below breaking even, such as an average loss of $90/acre/year, may not be profitable even for debt-free producers that own their land outright. The opportunity cost may be lowest here.

Pathways to Scenario 2.1 to Transition 1,207 acres:

Pathway C:

Erosion is in the highest class, Class 3 – potential transition acres: 1,570

Rationale:

Acres that are in the highest erosion class may be the most critical areas to protect with perennial vegetation.

Pathways to Scenario 2.2 to Transition 2,354 acres:

Pathway D:

Slope is greater than 8% - potential transition acres: 5,741

Rationale:

Acres with a relatively steep slope (8-12% is the maximum slope in the watershed) may be a straightforward way to prioritize acreage for transition since slope is highly correlated with nutrient loss.

Pathway E:

Distance from streams is less than 10 feet and slope is greater than 4% - potential transition acres 3,272

Rationale:

These fields that adjoin streams directly and are steeply sloped may deliver significantly more nutrients and erosion directly to water bodies than surrounding acres.

Impact Analysis

The transition cost, water quality, and Greenhouse Gas implications of transition pathways are estimated in the beta transition modeler and documented below for the transition pathways set above.

Transition Cost

Methodology:

1. Estimate perimeter fencing costs based on 40-acre square field with 5,280 ft of two to three strand high tensile at $1.52/ft
    a. Cost is based on 2020 Illinois EQIP rate of $1.21/ft, which is set to cover 75% of cost including posts, wire, energizers, braces/corner posts, and installation labor. This rate was adjusted to 100% of cost.

2. Estimate temporary fencing costs at 2,000 feet at $0.35/ft
    a. Cost is based on 2020 Wisconsin EQIP rate of $0.28/ft, which is set to cover 75% of cost including polywire and step-in posts. This rate was adjusted to 100% of cost. Illinois EQIP does not publish a rate for polywire temporary fencing.

3. Estimate water system cost including 2,000 ft of buried pipeline at $2.14/ft
    a. Cost is based on 2020 Illinois EQIP rate of $1.71/ft, which is set to cover 75% of cost including pipeline, valves, troughs, and installation labor. This rate was adjusted to 100% of cost.

4. Estimate forage planting and establishment cost at $213.99/ac
    a. Cost is based on 2020 Illinois EQIP rate of $171.19/ac, which is set to cover 75% of cost including seed and seeding. This rate was adjusted to 100% of cost.

5. Estimate miscellaneous costs at $1,000 per 40-acre field. Different fields and producers may have miscellaneous improvement costs such lanes, gates, accessory equipment like reels, and even wells for water access.

Figure 3. Total estimated transition costs per acre.

Expense Type	Cost Estimate
Perimeter fence	$8,025
Interior temporary fence	$700
Water system	$4,280
Planting/Establishment	$8,560
Miscellaneous (e.g., lanes, gates, equipment)	$1,000
Total for 40-acre field	$22,565
Total per acre	$564

Water Quality

Methodology:

Water quality impact is estimated based on practice efficiencies published in the Illinois Nutrient Loss Reduction strategy (NLRS). Baseline cropland nutrient losses are based on those estimated in the NLRS for Major Land Resource Area 1 – Northern Illinois Drift Plain. Baseline nitrate-N yield for cropped acres is estimated at 20.4 lb/acre/yr and baseline P yield per cropped acres is estimated at 0.71 lb/acre/yr. The NLRS sets the efficiency of conversion of row crops to perennial crops (including perennial pastures) at 90% reduction of both nitrate-N and P.

Estimated Water Quality Impacts Per Acre:

This method results in reductions of 18.36 lb/ac of nitrate-N and 0.64 lb/ac of P in the Northern Illinois Drift Plain. These estimates are applied to all acres targeted for transition in each pathway.

Greenhouse Gas emissions

Methodology:

Greenhouse Gas impact is estimated based on the COMET Planner [4] model developed by NRCS for each county. The NRCS practice "Forage and Biomass Planting (CPS 512) - Conversion of Annual Cropland to Non-Irrigated Grass/Legume Forage/Biomass Crops" was used for each county to estimate per acre impact. For De Kalb and Lee Counties, no data was available and neighboring counties which share the longest border with them were used instead. De Kalb used Kane County values and Lee used Ogle County values. Importantly, COMET Planner does not allow users to combine practices on the same acres, so while Forage and Biomass Planting captures reduced emissions from improved soil health, it does not capture increased emissions from additional livestock. However, if livestock are being moved from confinement management to grazing management within the same county, there may only be small net changes in emissions from livestock since methane emissions are higher in grazed systems, but fertilizer and soil emissions from feed production are higher in confinement operations (Stanley et al. 2018).

[4] http://bfuels.nrel.colostate.edu/beta

Figure 4. Estimated Greenhouse Gas impacts per acre.

County	Carbon Dioxide (tonnes/ac)	Nitrous Oxide (tonnes/ac)	Total CO_2- Equivalent (tonnes/ac)
Boone	1.02	0.14	1.16
Cook	0.66	0.24	0.9
Kane	1.02	0.14	1.16
Lake	0.66	0.24	0.90
McHenry	1.02	0.14	1.16
Ogle	0.64	0.24	0.88
Winnebago	1.02	0.14	1.16
De Kalb	1.02	0.14	1.16
Lee	0.64	0.24	0.90

Cumulative Impact

Figure 5. the cumulative impact of transition to perennial grass.

Pathway (Acres)	Transition Cost	Water Quality Impact - Nutrient Loading Reduction		Greenhouse Gas Emission Reduction		
		N (lbs)	P (lbs)	CO_2 (tonnes)	N_2O (tonnes CO_2 e)	Total GHG (tonnes CO_2 e)
A (76,754 acres)	$43,298,121	1,409,199	49,122	73,657	11,965	85,622
B (80,867 acres)	$45,609,085	1,484,721	51,755	78,537	12,361	90,898
C (1,570 acres)	$885,357	28,821	1,005	1,552	233	1,786
D (5,741 acres)	$3,237,897	105,403	3,674	5,615	869	6,484
E (3,272 acres)	$1,845,648	60,081	2,094	3,012	544	3,556

Conclusions, Limitations, and Next Steps

These results indicate that significant positive environmental impact could result from even marginal increases in perennial grass cover in the greater Chicago foodshed. Pathways A and B would move the watershed towards meeting state and Gulf Hypoxia Task Force nutrient reduction goals and would offset the emissions of over 19,000 cars for a year.[5] Pathways C, D, and E may be more reasonable 5-year goals, and would prevent upwards of 20 dump truck loads of nutrients from flowing downstream each year.[6] To reach these goals will require influx of capital, particularly to producers in the form of cost share, to make start-up grazing infrastructure investments—and potentially decades of benefits—possible.

Limitations

- The environmental impacts are estimated from state- and county-level sources and modeling and are not specific to soil types and field attributes. More refined modeling of these impacts would improve accuracy of this analysis and would facilitate analysis of where changes might be most cost-effective on the landscape.
- The estimated transition costs do not include costs beyond the farm gate, such as needed improvements and investments in expanded technical assistance networks, sale barns, processing, aggregation, and distribution. These costs are also important to consider as farm transitions will depend on these supporting services and markets.
- Estimated transition costs are considered, but additional transition revenue is not. Many different conservation practices (e.g., cover crops or buffer strips) cost money to implement, without appreciable changes in revenue. Regenerative grazing, however, has the potential to increase farm revenue or make farm revenue more resilient. Regenerative grazing may also have potential for unlocking revenue from ecosystem services like carbon and nutrient loss reduction. Estimating potential revenue changes associated with transition to regenerative grazing would give a clearer picture of how cost-effective this strategy is compared to other conservation practices discussed in the NLRS.

Next Steps

The model developed analysis and the interactive transition modeler created can be used to engage and work with stakeholders, both in these watersheds and outside, to prioritize acreage for transition and visualize the costs and benefits. This team is working on scoping two additional analyses:

- More refined nutrient loss modeling and cost-effectiveness analysis
- Estimation of revenue changes due to perennial grass transition, with comparison to other nutrient best management practices from the NLRS

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[5] *Assuming 4.6 MT CO2 per car annually (https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle).*
[6] *Assuming a load of 2,500 lbs.*

References

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