

Nutrient Implications of Biomass Crops

Keith Reid
Soil Fertility Specialist
Ontario Ministry of Agriculture, Food
and Rural Affairs

How To Assess Nutrient Implications

- Nutrients for Biomass Crops have received relatively little attention
 - Google “Biomass energy” = 890,000 hits
 - + “soil quality” = 18,900 hits
 - + “nutrient removal” = 650 hits
- Assessment needs to be at three scales:
 - Direct (nutrient requirements for crop growth)
 - Short Term (impact on succeeding crop)
 - Long Term (impact on soil fertility levels)

Nitrogen use efficiency is determined at three levels. First, by maximizing the efficiency of energy transduction into biomass ... per unit of nitrogen invested... Secondly, by maximizing the amount of N, and other nutrients, translocated out of the canopy components on their senescence, either into other leaves or storage organs; i.e. efficient internal recycling. Thirdly, by maximizing capture of nutrients from the soil. This property will help to minimize both the quantities of N that need to be applied as fertilizer and the amount lost to drainage water.

Heaton *et al*, 2007; **Biomass Crops as a Source of Renewable Energy: European Experience with Miscanthus and Projections for Illinois.**

<http://www.ace.uiuc.edu/pERE/conference/papers/long.pdf>

Biomass Cropping Systems

■ Crop Types:

- Grain Crops for ethanol or biodiesel
- Crop Residue Removal
- Annual Biomass Crops
- Perennial Biomass Crops

■ System Types:

- "closed system" – digestate returned to soil
- "semi-closed system" – manure from livestock fed process residuals returned to soil
- "open system" – no return to soil

Nutrient Implications of Grain Crops for Energy

- Direct impact – no change, exactly the same (for now) as growing for food or feed
- Short-term – ditto
- Long-term – ditto

Nutrient Implications of Residue Harvest for Biomass Energy

- Direct impact – no change, exactly the same (for now) as growing for food or feed
- Short term – may decrease the N requirements of succeeding crops
- Long term – Increased nutrient removal will lead to depletion of soil fertility if not replaced by manure or commercial fertilizer

Potential Nutrient Removal in Crop Residues

Residue Type	P ₂ O ₅ (lb/ac)	K ₂ O (lb/ac)
Grain Corn (150 bu/ac)	20-40	100-200*
Winter Wheat (75 bu/ac)	10-15	70-120*
Soybeans (50 bu/ac)	5-10	50-150*

*Much of the potash will leach out of the crop residue before harvest

Nutrient Implications of Annual Biomass Crops

- Direct impact – Competing pressures on N rates (more N for more yield, vs. less N for higher C content)
- Short term – no impact
- Long term – “Open” systems will be exporting significant P&K off farm.
- “closed” systems will recycle much of the P&K, but will have issues with application systems for nutrient availability/retention

Nutrient Implications of Perennial Biomass Crops

- Direct impact
 - P&K requirements have not been well documented for crops like switchgrass
 - Nutrient requirements for establishment are likely to be different from maintenance requirements
 - Nitrogen fertilizer will likely be required for optimum productivity
 - Muir *et al* (2001) found optimum switchgrass growth with 168 kg N/ha (Texas).

Comparison of N uptake and yield of three switchgrass cultivars

Cultivar	Yields (T/ha)		N-use (kg/ha)	
	2 cut	1 cut	2 cut	1 cut
Alamo	24.2	20.2	160	52
Kanlow	22.4	20.1	152	51
Cave-in-Rock	22.9	16.3	157	28

McLaughlin *et al*, 1999. **Developing Switchgrass as a bioenergy crop.**

<http://www.hort.purdue.edu/newcrop/proceedings1999/v4-282.html#field>

Nutrient Implications of Perennial Biomass Crops

- Short term – same as forage grasses
- Long term – depends on type of system
 - “closed” system (e.g. anaerobic digestion, with digestate spread back on fields) – losses of P&K should be minor; N losses may be significant if digestate surface applied
 - “open” system – Significant removal of P from the system. K removal will be very large from fall harvested crops, very small from crops that are left over winter.

Conclusions

- TANSTAAFL!
- Bioenergy “promoters” have either ignored, or underestimated, the nutrient implications of biomass crops
- Significant work remains to be done to determine optimum nutrient application rates for biomass production, particularly for new crops.
- Ultimately, the energy balance will depend on the fertilizer required to grow the crop.

Thank You for your attention

Are there any questions?