Ecological Effects of Residue Burning on Soil Fertility

Bobby R. Golden

LSU AgCenter
Research & Extension

Outline

- Introduction
- Nutrient Uptake
- Nutrient Removal
- Replacement Cost
- Conclusion

Introduction

- Producers have historically dealt with high amounts of residue by burning

Benefits of Residue Burning

- Faster soil warming
- Faster soil drying
  - Getting in and out of the field
  - Elimination of pathogen host for diseases and insects
  - Reduced equipment needs
- May increase availability of potash and phosphate from residue
- Greater N availability to the following crop

Negatives of Residue Burning

- Agronomic
  - Land degradation
  - Water infiltration
  - Immobilization of pesticides by ash
- Social
  - Polluters
  - Smoke problems
- Environmental
  - Air pollution
- Loss of carbon
  - Loss of potential OM
- Wind and water erosion of soil
- Nutrient losses
- Risk of fire escapes

Nutrient Uptake and Removal Trends

Crop	Yield/acre	Nutrient			
		N	P2O5	K2O	S
		- - -Total Uptake (lb nutr./ac)- - -			
Cotton	2,600 lb	120	41	103	20
Corn	150 bu	235	101	185	24
Sorghum	60 bu	115	47	110	- - -
Soybean	50 bu	277	56	148	35
Wheat	40 bu	70	25	50	8

Source: Osmond and Kang, 2008. www.soil.ncsu.edu/publications/Soilfacts/ag-439-16W.pdf and IPNI (Nutrients removed in Harvested portion of crops)

Nutrient Uptake and Removal Trends

Crop	Yield/acre	Nutrient			
		N	P2O5	K2O	S
		Harvested Portion (lb nutr./ac)			
Cotton	2,600 lb	63	25	31	5
Corn	150 bu	135	66	40	10
Sorghum	60 bu	50	27	15	5
Soybean	50 bu	188	40	74	23
Wheat	40 bu	50	20	15	3

Source: Osmond and Kang, 2008. www.soil.ncsu.edu/publications/Soilfacts/ag-439-16W.pdf and IPNI (Nutrients removed in Harvested portion of crops)

Nutrient Uptake and Removal Trends

Crop	Yield/acre	Nutrient			
		N	P2O5	K2O	S
		Aboveground Biomass (lb nutr./ac)			
Cotton	2,600 lb	57	16	72	15
Corn	150 bu	100	37	145	14
Sorghum	60 bu	65	20	95	- - -
Soybean	50 bu	89	16	74	12
Wheat	40 bu	20	5	35	5

Source: Osmond and Kang, 2008. www.soil.ncsu.edu/publications/Soilfacts/ag-439-16W.pdf and IPNI (Nutrients removed in Harvested portion of crops)

Nutrient loss by burning

- Determining the Economic impact of burning residue may be as difficult as when we bale straw.

- Variations due to:
  - Harvest technique
  - Foliar leaching
  - Extent of weathering
  - Fertility program

30 % Variation

Nutrients loss by burning

- Wheat and Oat
  - 90% loss of N and C
  - 75% Loss of Sulfur
  - 24% Loss of phosphate
  - 35% Loss of Potash

Heard et al., (2006) Better crops with plant food 90:3

- Corn Residue
  - 81% loss of N
  - 55% loss of S
  - 11% loss of phosphate
  - 18% loss of Potash

Kruse (2011) LA Newsletter

Standards for Calculations

- 150 bushel corn crop
- 8400 lb residue
- 15% moisture
- Elemental analysis
  - USDA 1990
  - SDSU 2006
  - NCST 2008
  - LA 2010
- All prices do not reflect application cost

Nitrogen

Source	N loss from Residue	Price of Nitrogen (cent/lb)		
		0.60	0.80	1.00
	(lb N/acre)	(replacement cost/acre) (dollars)		
USDA 1990	67	40.00	54.00	67.00
SDSU 2006	43	26.00	34.00	43.00
NCST 2008	100	60.00	80.00	100.00
LA 2010	59	35.40	47.00	59.00
Average	67	40.20	53.60	67.00

Remember, the Nitrogen contained within the corn residue would not be released and made plant available for the next season's crop. Also consider the organic material not added, that would have become Organic Matter.

Sulfur

Source	Sulfur loss from Residue	Price of Sulfur (cent/lb)		
		0.20	0.30	0.40
	(lb S/acre)	(replacement cost/acre) (dollars)		
USDA 1990	9	1.80	2.70	3.60
SDSU 2006	5	1.00	1.50	2.00
NCST 2008	11	2.20	3.30	4.40
LA 2010	4	0.80	1.20	1.60
Average	**7**	**1.40**	**2.10**	**2.80**

Assuming a 75 % loss of Sulfur

Nutrient cost only does not factor in application expense

Phosphate

Source	P205 loss from Residue	Price of Phosphate (cent/lb)		
		0.40	0.60	0.80
	(lb P2O5/acre)	(replacement cost/acre) (dollars)		
USDA 1990	4	1.60	2.40	3.20
SDSU 2006	8	3.20	4.80	6.40
NCST 2008	9	3.60	5.40	7.20
LA 2010	5	2.00	3.00	4.00
Average	**7**	**2.60**	**3.90**	**5.20**

Assuming a 24 % loss of Phosphate

Nutrient cost only does not factor in application expense

Potash

Source	K2O loss from Residue	Price of Potash (cent/lb)		
		0.30	0.50	0.70
	(lb K2O/acre)	(replacement cost/acre) (dollars)		
USDA 1990	44	13.20	22.00	30.80
SDSU 2006	36	10.80	18.00	25.20
NCST 2008	51	15.30	25.50	35.70
LA 2010	17	5.10	8.50	11.90
Average	**37**	**11.10**	**18.50**	**25.90**

Assuming a 35 % Loss of Potash

Nutrient cost only does not factor in application expense

More Specific

- On average nutrient replacement cost for the Big 3 and sulfur could range from
  - 55.30 to 100.90 dollars/acre
  - Can we add this to our production budget
- What if we do not count the Nitrogen
  - 15.10 to 33.90 dollars/acre

Conclusions

- Cant put a value on carbon
  - Our climate favors microbial degradation
- Rented vs. owned land
  - Weigh equipment cost for residue management vs. nutrient cost
- Be mindful of soil sampling fields, uneven burns, added variability

Conclusions

- At the end of the day what do you feel comfortable planting into.
  - Seed and associated technology fees are a big investment and we want to start the plant off on the right foot
  - Residue burning should be taken into account on a farm by farm or field by field basis

Photo: Erik Larson

Photo: Collin Jensen

Questions ?

LSU AgCenter
Research & Extension

N cost analysis

Most of the N can be lost:

180 bu = 10,080 lb X 0.845 = 8,518 lb X 1%N= 85 lb

85 lb N X $0.78/lb N = $ 66.30

Ohio State Univ. has simple table estimating N loss:

		-----32 % UAN/Ton------		
		$400	$500	$600
Yield (Bu/Ac)	**N Lost (Lb/Ac)**	$ .63	$ .78	$ .94
120	40	25.20	31.20	37.60
160	54	34.02	42.12	50.76
200	67	42.21	52.26	62.98
240	81	51.03	63.18	76.14

Remember, the Nitrogen contained within the corn residue would not be released and made plant available for the next season's crop. Also consider the organic material not added, that would have become Organic Matter.

Sulfur will be lost as well, about 30 lb, more-or-less;
P, K, Ca, Mg and Zn will remain in the ashes, unless blown away or redistributed by wind or the effects of erosion.

- It was getting a little hot, no doubt about it. I am up in north Louisiana for Labor Day and staying at my family's lake house. While I was swimming yesterday it started raining ash and corn husks, like God was making tamales. So, of course, I had to try to find the burning fields. Maybe they will burn another one today and I can get the full conflagration.

Illinois data suggest

- Residue left on the field in continuous corn has little to no effect on yield if tillage is done
- In no-till systems removing residue increases yield by 18 bu and reduced optimum N rate by 40 lbs

Corn Residue

- 200 bushel corn crop can leave behind 5 tons of residue
  - Heavy residue makes planting difficult, and decreases soil warming, influencing early season corn growth
  - Corn residue is a source of inoculum for corn disease
  - BUT, residue is organic material, breaking down to form stable soil organic matter.

- Corn residue has a high CN ratio, favoring immobilization of N in the soil
- Corn residue does have nutrients to recycle
- Corn residue decreases soil erosion, if left on the surface

Collin jensen photos