



Burning Crop Residue - Nutrient Losses

Crop residue can be burned off either accidentally or deliberately as part of a controlled burn program. In some cases, burning can replace the cost of a tillage operation when residue is extra heavy. Corn residue is probably most susceptible to accidental burning, but wheat and soybean residues are also vulnerable.

Crop residue contains nutrients which can be recycled to replace part of the nutrients removed by grain harvest. Nutrient loss from the burned residue is a major concern for damage assessments. After the fire, a common question is "What went up in smoke"?

Initial amount of residue

The first step to assess nutrient loss is estimating the amount of residue that would have been present before the fire. A yield of one to two bushels of grain typically results in about a pound of residue, depending on the crop and weather conditions.

Table 1 provides a quick way to estimate the predicted residue weight. Multiply the yield as bushels per acre (bu/ac) by the index value.

For example, the grain sorghum index value is "60". If the the crop yield was 70 bu/ac, the estimated residue weight would be about 4200 pounds per acre (70 bu/ac x 60 = 4200 lb/ac). Dividing this result by "2000" yields the residue weight in "tons per acre (ton/ac)".

Residue nutrient content

The actual nutrient content of crop residue varies due to crop species, harvest yield, soil fertility level, and weathering. Table 3 gives residue nutrient values obtained from several different references. Mutlplying the nutrient content by the residue weight gives an estimated "per acre" nutrient weight.

Rainfall can remove mobile nutrient forms from the crop residue. An Iowa State study showed the potassium concentration of corn residue (after harvest) continued decreasing during the fall and early spring. The phosphorus concentration remained approximately constant under the same conditions..

The potassium loss rate from corn residue increased with increasing rainfall, but not the phosphorus loss. The potassium in the corn residue is water-soluble and the phosphorus is in mostly organic forms, which

explains the different results.

Phosphorus or potassium loss from soybean residue is rapid no matter the amount of rainfall. Most of the phosphorus and potassium is in the leaves, which drop from the plant.

Table 1. Crop residue index values	
Crop	Index
Corn	60
Soybeans	45
Wheat	100
Grain sorghum	60
Oats	55
Sunflower	1.5

Estimated available residues as pounds per acre (lb/ac) = yield as bushels per acre (bu/ac) x index value

Residue loss from burning

The exact amount of residue loss is difficult to estimate. The condition of the residue and weather conditions would determine just how much residue would be by burning.

A complete job of burning small grains would convert most of the straw and chaff to ash. Burning corn residue would remove the husks, leaves, and upper, thinner portions of the stalk. The lower stalk would tend to resist complete burning.

If cattle had been grazed the corn field before burning, some amount of the residue would already have been removed. A Nebraska grazing study showed an interaction between corn residue quantity and quality.

Cattle primarily consume the corn husk and leaf blade. These components total 26% to 28% of the residue, are the most digestible, apparently the most palatable. These parts are also most easily burned.

As grazing pressure increases, animals start to consume the leaf sheath, the cob, and - sometimes - the upper stem. The researchers found that the bottom two-thirds of the stem was about 40% of the total residue weight.

Soybean residues are likely to have lost most of the leaves, petioles, and pod tissue by harvest. Stems will make up essentially all of the residue available for burning.

Nutrient loss percentages

Nitrogen (N) and sulfur (S) might be considered “organic” nutrients because they are an integral part of plant tissue protein. The “mineral” nutrients, like phosphorus (P) and potassium (K) are typically retained after burning.

One study in Manitoba compared wheat, oat, and flax residues that were burned in an uncovered container. The residues were weighed and analyzed, burned, then reweighed and analyzed (see Table 2). There was no attempt to collect or retain smoke or floating particulates.

Much of the nitrogen and sulfur were oxidized and lost as volatile gases by burning. Losses were 98% to 100% for nitrogen and about 75% for sulfur.

Phosphorus and potassium losses from burning were lower, averaging 21% for phosphorus and 35% for potassium. These nutrients remained in the ash, so the researchers speculated that losses were due to smoke or particulates drifting away from the fire.

The actual loss on a field basis might be different because a share of the particulates would settle over the field being burned. Wind velocity, wind direction,

and air temperatures would affect the degree of drift, nutrient loss, and nutrient distribution.

References; excerpts:

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Table 2. Nutrient content in harvested straw and ash from different crop residues.				
Nutrient	Material	Spring wheat	Oats	Flax
Carbon, %C	Straw	40.0 - 42.0	39.8 - 40.1	45.7 - 46.2
	Ash	8.6 - 29.4	9.2 - 28.8	27 - 51
Nitrogen, % N	Straw	0.66 - 1.28	0.26 - 1.02	0.68 - 1.04
	Ash	0.42 - 1.76	0.25 - 0.71	0.93 - 1.87
Phosphorus, % P	Straw	0.09 - 0.19	0.04 - 0.12	0.04 - 0.10
	Ash	0.92 - 1.02	0.50 - 1.02	0.40 - 2.20
Potassium, % K	Straw	0.67 - 2.21	1.37 - 3.31	0.19 - 0.29
	Ash	3.1 - 16.6	9.35 - 29.45	2.49 - 4.97
Sulfur, % S	Straw	0.06 - 0.16	0.01 - 0.50	0.05 - 0.07
	Ash	0.05 - 0.55	0.10 - 3.30	0.11 - 0.29
Range of values = average (mean) value minus or plus one standard deviation.				

Table 3. Plant nutrient composition of different crop residues.					
Residue type	Source	pounds of plant food nutrient per ton of residue (lb/ton)			
		N	P ₂ O ₅	K ₂ O	S
Corn					
	<i>Beef magazine</i>	12.8	5.5	22.3	2.2
	<i>Nebraska</i>	17	4	34	3
	<i>Wisconsin</i>	13.2	5.2	23.4	---
	<i>Arkansas</i>	20	6	25	---
Soybeans					
	<i>Feedstuffs</i>	14.1	2.4	12.2	4.6
	<i>Arkansas</i>	12	9	4	---
	<i>Wisconsin</i>	15	4.3	26.5	---
Wheat					
	<i>Beef magazine</i>	8.7	2.5	27.4	3.1
	<i>Wisconsin</i>	14.6	6.2	29.8	---
Rice					
	<i>Beef magazine</i>	11.6	3.3	25.3	2.0
	<i>Arkansas</i>	20	6	24	---
Sorghum					
	<i>Beef magazine</i>	13.9	4.8	24.2	---
Oats					
	<i>Beef magazine</i>	11.6	2.9	52.8	4.0