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The Nutrient Value of Straw

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Figure 1. A 1,000 lb. straw bale following grain harvest.

The mature and dried stem, leaves, and chaff remaining after barley and wheat are harvested is known as straw. Many farmers around Virginia harvest straw by baling in small bales, large round bales, or large square bales that range in weight from 40 to 1,000 lbs. plus per bale. The straw is used as bedding material for livestock, as a media base for mushroom production, for erosion control measures, as a mulch cover for newly planted grass, among other uses. Regardless of use, straw is a valuable resource to both the buyer and end-user, but also to the farmer and the land. Straw is an excellent carbon source for increasing soil organic carbon and contains valuable nutrients that would be available for the next crop. Therefore, straw has value to the production system and this value should be considered before removing it from the field.

Average straw fertilizer equivalent nutrient concentrations for nitrogen (N), phosphorus (P_2O_5), potassium (K_2O), and sulfur (S) are represented in Table 1. Virginia research demonstrated that over two growing seasons the wheat straw K_2O concentration averaged 1.34% at harvest (Stewart, 2015). Summarized research from other studies found that N, P_2O_5, and S averaged 0.81, 0.12, and 0.04%, respectively (Table 1). Overall, the nutrients removed in the greatest amounts were N at 16.2 lbs./ton and K_2O at 26.8 lbs./ton. These numbers can be used as an average; however, research in Virginia has found that values for K_2O specifically may reach 60 lbs. K_2O/ton depending on environmental conditions surrounding the crop.

Research in Kentucky demonstrated that straw yields decreased with planting date (Lee and Grove, 2005). In other words, the later you plant wheat in the fall the less your straw production. Straw yield will also decrease as you increase the cutting height of the grain

platform, as expected. In a two year study in Kentucky, the authors found that straw production ranged from 0.74 to 1.92 tons/acre for wheat. In Virginia, we found that high yielding wheat (86 bu./acre) yielded 2.01 ton straw/acre when averaged across 75 varieties in the state variety trial (Thomason et al., 2005). From the Virginia variety data, a straw harvest index value of 80% was developed. Meaning, the straw yield is approximately 80% of grain yield.

Knowing your straw yield is imperative to correctly calculating your nutrient removal and may vary significantly with each field, with variety, and with year. Nutrients such as potassium are readily leached from the plant biomass with rain, so the more rain that occurs after maturity will lower straw potassium concentrations. Other nutrients, such as phosphorus, are bound to the plant material and are not readily leached with rain so would change little with time. As a rough estimate with properly baled straw with less than 20% moisture, the bale bulk density is approximately 7 to 9 lbs. per cubic foot. Another methodology to roughly calculate your straw yield is based on grain yield. Multiply your yield in bushels/acre by 60 lbs./bushel to determine pounds of grain produced per acre. Straw yield equals about 80% of grain yield. So, a grain yield of 85 bushels/acre × 60 lbs./bushel = 5,100 lbs./grain × 80% = 4,080 lbs. of straw per acre, or about 2 tons/acre.

To calculate the value of straw, simply multiply nutrients removed per ton (Table 1) or per acre (Table 2) by the current fertilizer prices. In our example, each ton of straw removed is worth $25.29 according to the 5-year price average for common macronutrients (Tables 1 and 3). This straw value could be as low as $17.22 for low yielding straw fields of ¾ ton/acre or as high as $50.58 for a 2 ton/acre yielding field (Table 2). It is important to note that these price projections do not include any other micronutrients that would also be removed (zinc, manganese, boron, etc.) and does not include a value for the soil building carbon that is removed. Increasing soil organic matter via plant biomass additions is the quickest and easiest way to increase soil water holding capacity, soil aggregation, and so forth.

Figure 2. Stack of straw containing valuable nutrients. This stack of 66 bales weighing about 1,000 lbs./bale contains 535 lbs. N, 80 lbs. P_2O_5, 885 lbs. K_2O, and 25 lbs. S valued at $835 (5-year fertilizer price average; USDA-ERS, 2015).

In conclusion, straw is a valuable commodity and should be treated as a commodity versus a waste. If you decide to bale your straw, make sure you are compensating yourself for the nutrients removed along with other costs associated with baling such as labor, fuel, and equipment. Overtime, the nutrients you are baling will need to be replaced by a fertilizer source to ensure continued crop productivity.

Table 1. Average wheat straw nutrient concentrations, pounds of nutrients removed per ton, and 5-year and high price fertilizer equivalent values.

Nutrient‡	Nutrient Concentration§	Nutrient	5-Year Average† Price	5-Year Average† Value	High Price† Price	High Price† Value
	--%--	--lbs./ton--	--$/lb.--	--$/ton--	--$/lb.--	--$/ton--
Nitrogen	0.81	16.2	0.58	9.40	0.67	10.85
Phosphorus	0.12	2.4	0.58	1.39	0.76	1.82
Potassium	1.34	26.8	0.53	14.20	0.71	19.03
Sulfur	0.04	0.8	0.37	0.30	0.49	0.39
Total	---	---	---	**25.29**	---	**32.10**

†USDA-Economic Research Service, 2015.
‡Nitrogen as N, phosphorus as P_2O_5, potassium as K_2O, and sulfur as S.
§Bauder, 2000; Tarkalson et al., 2009; Stewart, 2015.

Table 2. Average straw values per acre based on low and high straw harvest potentials, based on 5-year nutrient price averages†.

Nutrient	Straw Nutrient Concentration	Straw biomass removed (tons/acre) 3/4	2	3/4	2
	--%--	------lbs. nutrient/acre------		---------$/acre---------	
Nitrogen	0.81	12.2	32.4	7.05	18.79
Phosphorus	0.12	1.8	4.8	1.04	2.78
Potassium	1.34	20.1	53.6	10.65	28.41
Sulfur	0.04	0.6	1.6	0.22	0.59
Total	---	---	---	**17.22**	**50.58**

†Nitrogen = $0.58/lb.; P_2O_5 = $0.58/lb.; K_2O = $0.53/lb.; and S = $0.37/lb. (USDA-ERS, 2015).

Table 3. Fertilizer prices used in calculations for 5-year average and highest recorded price.

Fertilizer	5-year average price†	Highest price†
	----------$/ton----------	
Ammonium sulfate	420	522
Diammonium phosphate	643	850
Muriate of potash	641	853
Triple super phosphate	629	800
Urea	521	592
Urea-ammonium nitrate, 30% N	347	410

†Based on average USA price from March/April each year (USDA-ERS, 2015).

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