Saskatchewan
Soil Conservation
Association

Soil Facts

Value of Cereal Straw

Too minimize transportation costs, large "square" bales are preferred by companies commercially harvesting crop residues.

In the last 100 years of Saskatchewan crop production, producers have gained an appreciation for the "trash" in their production systems. In the days of threshing and ploughing, producers saw value only in the grain. The tillage tool of choice for many years was the plough and later the one-way disc which buried much of the remaining trash. Soil conservation research began to point to the need to retain plant material on the soil surface to protect the soil from erosion. Machinery like the combine and the cultivator made it easier to keep a layer of residue more evenly spread over the surface of the soil. The concept of the value of above ground plant material has become so wide spread that the term "residue" instead of trash is now widely accepted among crop producers. Vast portions of crop land are now seeded with low disturbance one pass seeding methods (LDS) to take advantage of the benefits of residue such as protection from soil erosion, conserving moisture and building soil organic matter.

In the past few years, a process has been developed that utilizes cereal straw for the production of ethanol. As well, a straw board industry is developing in Saskatchewan that utilizes wheat straw for the production of particle board, and more recently its use for an OSB type of board. This has raised many questions as to the real value of straw.

Cereal straw contains plant nutrients that will be exported from the land if cereal straw is harvested. Producers need to be compensated for those nutrients as they will, at some time in the future, have to be replaced. One of these nutrients is nitrogen (N). One of the difficulties with N in the soil ecosystem is that it can be lost by leaching and gassing off to the atmosphere before the crop has a chance to use it. These losses, as well as the temporary tie up (immobilization) from soil microbes, are indicated by the level of crop recovery in the year of fertilizer application. Dr. Jeff Schoenau with the U of S suggests that crop recovery of nitrogen fertilizer in the year of application is typically around 50% but that with careful attention to rates, timing and using precision placement like most LDS producers use, recoveries as high as 60 to 70% might be attained. The availability of N contained in cereal straw in the year of application will depend upon the C:N ratio of the straw. Microbial activity breaking down cereal straw can actually reduce the supplies of available nitrogen in the soil in the first few months following addition. There is not enough N in the straw to meet their needs so they take extra from the soil available N pool. Therefore, typically in the year of application, the release of N from the straw into plant available forms is limited. However, the nitrogen immobilized in microbial bodies is eventually released back into available forms with further decomposition. Pulse residue has higher N content so that tie-up of available N during decomposition is reduced or eliminated. Eventually the N from the straw will be released (mineralized) along with any soil or fertilizer N that was tied up. As the N from the straw is slowly released by decomposition over a number of years, crop recovery of this N over the years may actually be higher than from inorganic fertilizer N sources. We can generalize that for every pound (lb) of nitrogen exported in the straw, another lb of fertilizer N will eventually have to be added to maintain the soil N balance.

Other nutrients exported in the straw that have to be considered are phosphorus (P), potassium (K), and sulfur (S). Nearly all of the K in cereal is water soluble so it will be readily washed out of the straw and therefore be available again for crop utilization. About 50% of the P in cereal straw and some of the S is water soluble so this component will be readily released into the soil as well. In general, apart from crop harvest, export, and erosion, P, K, and S are not easily lost from the soil ecosystem. To be precise, a net present value should be calculated as these nutrients are not all available the year following harvest.

Research at AAFC-Indian Head has found that only 25 – 30% of above ground plant material other than grain ends up in a straw bale. The rest either remains standing or is part of the chaff.

The growth stage of the cereal when cut or harvested, the fertility status of the soil in which it was grown, and environmental conditions will also influence straw nutrient concentration. The concentration of nutrient in straw multiplied by the yield/acre = total lbs/acre of nutrient exported. Young plants grown on soil of high nutrient availability will tend to have higher straw nutrient concentrations than straw from mature plants grown under nutrient deficient conditions. Weathering of straw by exposure to the elements such as rain and snowmelt will also affect nutrient concentration. Many soil testing laboratories offer plant analysis services that will provide nutrient concentrations in samples of straw that are submitted. See Table 1 for average nutrient concentrations of wheat, barley and oat straw and an indication of the range or variance of nutrient concentrations in cereals determined from feed samples. There is wide variation in the value of nutrients in straw. These samples indicate a low value of about $8 in a tonne (t) of wheat straw to a high value of $28

Table 1. Cereal Straw Nutrient Values

– 1990-99 Nutrient concentration averages from feed samples

-Norwest Labs Lethbridge Feed Test Concentrations

- Spring 2006 Approximate Retail Fertilizer Prices

	Wheat		Barley		Oats	
% Moisture	14.2%		15.3%		15%	
	Average	Std. Dev.*	Average	Std. Dev.*	Average	Std. Dev.*
N	$7.90	$3.10	$7.19	$2.98	$7.61	$3.75
P	$1.29	$0.86	$1.44	$0.86	$1.87	$1.14
K	$5.50	$2.20	$7.36	$2.39	$9.08	$2.72
S	$0.71	$0.24	$0.77	$0.24	$0.77	$0.30
Total	$14.27	$6.40	$16.76	$6.47	$19.33	$8.06

*The Standard Deviation on these samples. A normal standard deviation is the range on either side of the average containing about 67% of the values. For example, the range for barley indicates that about 67% of the samples would have a 2006 retail value between $10.29 and $23.23.

From Norwest Labs A New Bodycote Company

Table 2 Runoff & soil loss with simulated rainfall events. First event - 30 mm in 1hr; second event - 24 hours later - 30mm in 30 min; , and the third event - 30 min. later - 30mm in 30 min.

Tillage System	Residue Level (kg/ha)	Peak Run-off Rate (mm/hr)	Runoff Volume (mm)	Soil Loss (kg/ha)
No-Till	0	17	4.5	72
	750	9	2.6	11
	1500	1	0.2	7
Conventional	0	51	35.5	2812
	750	34	32.7	1001
	1500	26	18	513

Mostaghimi,S., Younos, T.M. and Tim, U.S., 1992 Crop residue effects on nitrogen yield in water and sediment runoff from two tillage systems. Agric. Ecosystems Enviro., 39:187-196.

in a tonne (t) of oat straw.

Other factors to consider when selling cereal straw are the cost of dealing with that straw if you do not drop it for baling. First is the cost of chopping and spreading it. Depending on the amount of straw, moisture content and other factors, Gary Redekop with Redekop Manufacturing says it takes about 60 – 80 hp to run their Maximum Air Velocity (MAV) chopper. At 60 hp on a 300 hp class 7 combine, 20% of the fuel burned is used to chop and spread that straw. Using Sask. Ag & Food's 2004 Custom Rate Guide with an updated farm gate diesel value of $0.68.5/L, a Class 7 combine will burn $24 of fuel per hour. It will cut 12 ac/hr. That equals $0.40 /ac of fuel to deal with the straw in one acre. Maintenance costs on that chopper are mostly the cost of the knives on the rotor. Replacing knives costs about $600 and in average chopping conditions, one set of knives will give 6000 acres of service. That equals $0.10 /ac for knife maintenance costs. The chopper will do a very good job of chopping and spreading straw even in heavy straw conditions. If heavy harrowing is deemed necessary, the cost of that operation is estimated at $1.75/ac at the above fuel price.

Stewart Walker coordinates the purchasing, baling and hauling of straw for the Above Board straw board plant at Kamsack. He says that baling behind rotary combines results in significantly less tonnage because the straw is too short to hold in a big square bale. They are looking for straw pieces 4 inches in length to produce an OSB type of board so they generally buy straw harvested by conventional combines. Straw dropped by a conventional combine and baled into big square bales yields about 1 tonne (t)/ac. In contrast, straw from rotary combines yields only 0.2-0.5 t/ac. The plant pays $6/t preferring straw dropped by a conventional combine.

In addition to the nutrient content of straw, it also has a value in building soil organic matter. It is more difficult to assign a dollar value to this benefit. A research project started in 1958 at the Indian Head Research Farm compared 3 treatments in a wheat – wheat – fallow rotation. One treatment was fertilized and the straw removed; one was fertilized and the straw spread; while the third treatment was unfertilized with the straw spread In a 1987study on these treatments conducted by Campbell et. al., soil sampling revealed that removing the straw with fertilization did not reduce soil organic carbon (C). Soil organic C is a direct measurement of soil organic matter. They did find that soil N was slightly lower when straw was removed but it was still greater than the unfertilized rotation. They hypothesized that root material had a greater influence on building organic matter than the above ground residue. Other research projects have not concurred with this finding but on closer examination, most of these trials were small plot treatments where all the straw was removed - not just the material that could be put in a bale.

Dr. Guy Lafond, researcher at the Indian Head Research Farm completed a 4 year study quantifying straw removal through baling. The straw was baled and removed each year of the study. Upon measuring different fractions of above ground residue, Lafond found that only about 25 – 30% of above ground plant material other than grain (MOG) ends up in a straw bale when cutting stubble 6 to 8 inches high. The chaff component of wheat coming off the sieve makes up another 25 – 30% of MOG. Since most fields in the black and gray soil zones are baled only every third or fourth year, with adequate fertilization, there should be no concerns with depleting soil organic matter.

Protecting the soil from erosion is another consideration when planning to bale straw. A number of studies have been completed examining the amount of residue cover needed to reduce soil erosion. The importance of standing stubble as part of that residue component cannot be overemphasized. The research project in Table 3 shows that no-till without any residue had 9 times less soil loss from water erosion than a conventionally tilled system with 1500 kg/ha of residue cover. These findings are even more significant given that the no-till treatments in this project were on land with an average slope of 12% while the average slope of the tilled treatments was 9%.

Soil loss by wind erosion is mostly a function of soil aggregate size and standing stubble. Soil particles under one mm are highly erodible. Since most soils have particles this size, fields need to be protected with larger stable aggregates and residue. Direct seeding ensures plant material cover throughout the year. In the northeast part of the province, producers using LDS seeding methods have found wind erosion to be virtually nil.

Another benefit of retaining cereal straw is soil moisture retention. Certainly in drier springs, residue cover and standing stubble help to reduce soil moisture evaporation. As previously discussed, baling straw removes only a portion of the previous crop residue so there will be some evaporation protection following baling. Early seeding can reduce a field's drying time. It is important for fields with low residue cover to be seeded near the beginning of the seeding season to reduce drying. Some broadleaf crops produce a fair amount of residue so those fields can be left to later seeding.

In summary, cereal residue can be baled in rotation once every 3 or 4 years without detrimental soil or yield effects as long as the field is adequately fertilized and stubble is at least 6 plus inches in height. In dry springs, producers must seed baled fields as early as possible to reduce yield loss as the surface soil dries.

How to place a value on straw in order to make a dollar when selling it? Firstly, producers need to evaluate their own straw samples to determine what nutrients are actually being exported off their farms. The calculations in Table 1 can be used (with updated fertilizer prices) to convert plant analysis concentrations to dollar values. These nutrients aren't all available for the following crop so that must be considered. The bottom line is that, in the long term, producers must get value for the nutrients carried off with the straw plus a margin. However, producers who are really struggling to deal with straw may be able to afford to let it go for less than the value of the nutrient content, because they are not spending money to chop, spread and harrow it.

For More Information

1-800-213-4287 or www.ssca.ca

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