DEPARTMENT OF AGRONOMY

Wheat Stubble: What is its Value?

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The saying: You don't know what you have until it is gone, is true when considering wheat stubble. Most of the time, wheat growers do not think about the monetary value of wheat residue. However, wheat stubble provides many benefits and can have a substantial value.

Wheat stubble reduces soil erosion, preserves soil moisture, and increases productivity through higher yields. Residue acts as a buffer to stop the damaging impact of raindrops and as a collection site for snow accumulation.

In fact, wheat stubble may be the most important conservation weapon a producer has against the battle with nature's forces—wind, snow, and rain. The beneficial aspects are often taken for granted until an accidental burn or a displaced livestock herd damages the standing residue. When it is gone, the farmer is left wondering what it was worth.

In determining the value of wheat stubble, several factors must be considered:

1. Crop residue contains nutrients

Per bushel of grain harvested, wheat residue remaining on the field after harvest contains several pounds of the following nutrients nitrogen, phosphate, potassium, calcium, magnesium, sulfur, and lesser amounts of plant micro nutrients (see Table 1). If this residue were burned, about a third of the nitrogen and sulfur would volatilize. The remaining nutrients in the ash would remain for use by the crop—provided the ash has not blown or washed away.

2. Crop residue catches snow

Similar to the action of a tree windbreak or a snow fence, standing crop residue will do a better job of catching snow than residue lying flat on the ground. Snow can account for 10 to 20 percent of the annual precipitation in western Kansas (Havlin et al., 1995). Part of the snowfall on a field covered with standing residue will blow away or vaporize and be lost to the atmosphere, but a portion will melt and infiltrate into the soil. Wheat straw will slow down evaporation of stored soil water from snow melt.

Overall, wheat straw is more than 66 percent effective in storing and conserving water from melted snow (Greb, 1967). If residue is not present when snow falls, it could mean a loss of up to 10 percent or more of annual precipitation.

This extra water usually translates into higher yields, depending on the crop. For example, one inch of water produces about 6 bushels of wheat.

3. Crop residue enhances rainfall infiltration into the soil

Wheat residue enhances soil moisture by increasing rainfall infiltration into the soil. One study found water intake at the end of one hour was 0.3 inches for bare fallow ground, 1.20 inches for grassland, and 2.26 inches for stubble mulch (Barnes, 1958). A surface mulch has been shown to be more important than soil organic matter in increasing water infiltration (McCalla, 1961). An unmulched soil had an intake of 0.44 inches per hour, while the mulched subsoil infiltration rate was 0.76 inches per hour for the same period. Rainfall simulator demonstrations in Kansas during 1991 to 1996 revealed that 0.5 to 3.0 more inches of rain could infiltrate a soil covered with wheat straw than a bare soil before runoff occurred.

4. Crop residue reduces evaporation losses

Wheat residue on the surface of the soil reduces water evaporation, which increases the amount of water available for plant use. In a study of the effectiveness of

Nutrient	Per Bushel of harvested wheat	Amount left per acre after 40 bushel wheat harvest
N	0.53 lbs	21 lbs
P	0.2	8
K	0.9	36
Ca	0.15	6
Mg	0.08	3
S	0.12	5

Table 1. Amounts of nurients remaining in wheat stubble.

stubble-mulch farming on water conservation during the fallow period, mulches were found to conserve water during long, hot and dry periods (Unger, 1968). Straw on the soil surface reduced evaporation from soil during a 16-week period by 57 percent compared to a tilled surface with residue mixed in. Other findings in Nebraska, Colorado, and Montana showed a significant increase in fallow moisture efficiency with 1,500 and 6,000 pounds per acre of surface straw mulch compared with bare fallow.

5. Crop residue reduces water erosion

The main factors determining the erosive potential of rainstorms include the size and velocity of the raindrops and the frequency, intensity, and duration of the storm. A storm producing 1 inch of rain in 1 hour is more detrimental than a gentle rain that produces 1 inch of rainfall during 24 hours.

Bare soil seals up quickly during a rainstorm. When this happens, water does not infiltrate but runs off the field and takes the topsoil with it. For instance, on land that has been classified as highly erodible land (HEL) to water erosion by the USDA-Natural Resources Conservation Service (NRCS), water erosion can cause losses of 40 tons of topsoil per acre per year or higher under bare soil conditions. Crop residue intercepts falling raindrops and absorb the impact of the drop before it reaches the soil surface. This allows the soil pores to stay open and water to infiltrate the soil.

6. Crop residue reduces wind erosion

Soil erosion in the central Great Plains is generally caused by wind. Adequate ground cover is the first line of defense in erosion control. Vegetative cover slows the wind at ground level, protects the soil particles from being detached, and traps blowing soil. Wheat residue is an excellent means to reduce wind erosion. When wheat straw mulch on the soil surface exceeds 980 pounds per acre, soil loss from wind erosion averages 0.9 tons per acre compared to 14.3 tons of soil loss per acre on bare soil (Moldenhauer, 1983).

During severe wind storms, the entire topsoil can be blown off a field if it is not protected by residue. Losses of 40 tons per acre per year or more are not uncommon on ground determined to be HEL. Bare soil conditions may require costly emergency tillage to stop wind erosion.

7. Crop residue increases organic matter

Organic matter is vital to soil life. Since tillage began 100 or more years ago, between 50 and 75 percent of the organic matter has been lost from the Great Plains soils. Between 1942 and 1960, soil organic matter in South Dakota declined 15,000 pounds per acre for continuous corn where residues were removed, compared to a decline of 2,900 pounds in a corn-oats-wheat rotation with retained residues. The retained residue increased yield for the three crops grown in rotation between 10 to 18 percent. When plowing was the main tillage method, the resulting residue removal decreased wheat yields by 2 bushels per acre (Fenster, 1980).

Most soils in western Kansas contain 1 to 1.5 percent organic matter, down from 3 to 4 percent at breakout. In a study in Garden City, Kansas, residue removal or burning lowered the organic matter content, increased pH, and lowered potassium levels in the soil (Hooker, 1982). To bring soils back to higher organic matter levels, residues must be retained on the soil surface.

8. Crop residue might be required on highly erodible land (HEL)

With the introduction of the 1990 Farm Bill, farmers electing to remain in the federal farm programs needed to have a conservation compliance plan in effect by January 1, 1995 on HEL. The 1996 Farm Bill continued this requirement. This plan could include terraces, waterways, diversions, or residue management. Because of cost involved with implementing some of these practices, many farmers chose to include residue management in their conservation compliance plans. Without the proper amount of residue on the surface, farmers could be forced out of the governmental program and thus denied federal farm payments.

How much residue was lost?

Harvest is the time to start managing crop residues. The optimum goal for soil conservation purposes is to leave a protective layer of crop residue spread evenly on the field. Some researchers believe residue could better stand up to long fallow periods if it were doing just that—standing up.

Standing residue decomposes 30 to 50 percent during the fallow period, while flat residue decomposes almost completely. Standing residue is also more effective in reducing wind erosion.

Measuring Residue

There are a number of ways to measure the amount of residue cover on the field. These methods include the following: line-transect method, field-picture comparison, and calculation.

The line-transect method (Figure 1) is an easy and effective way to measure residue levels. All one needs is a 100-foot tape. After harvest, stretch the tape across the field diagonal to the rows. Follow the tape and look at each one-foot mark. If a piece of residue intersects a one-foot mark on the right side of the tape, count it. If it does not, do not count it. Total the number of pieces of residue that intersect the one-foot mark in 100 feet of tape. Do this several times and calculate the average of the findings. This is the percent residue remaining on the field. For example, 40 “hits” on the 100-foot tape means 40 percent residue. Do not manipulate the tape to achieve a higher residue count.

The field-picture comparison uses photographs showing known amounts of crop residue. The pictures are taken into the field and compared to the actual amount of residue in the field to estimate the amount of residue present. This method requires a lot of experience, is highly subjective, and is generally inaccurate. K-State Extension publication L-781 gives examples of wheat residue photographs (Hickman, 1989).

The easiest way to estimate the amount of residue is by calculation. Wheat produces about 100 pounds of residue per bushel of grain. For example, at a yield of 35 bushels per acre, there will be about 3,500 pounds per acre of standing crop residue remaining on the field after harvest. This translates to 88 percent of the ground covered by wheat straw. (Gregory, 1982, Kok, 1994).

Tillage done after harvest reduces the amount of residue on the surface. Scientists at Kansas State University developed a computer program to calculate the amount of residue after tillage and to translate percent residue cover to pounds of residue on a field. It is called "*RES-N-TILL*™" and can be ordered for $10 from your local Extension office or from the Department of Agronomy, Kansas State University, 2014 Throckmorton Hall, Manhattan, KS 66506.

Other uses of wheat straw

Straw often has been used in cattle rations to increase fill in the rumen. Cattlemen also sometimes use ammoniated straw to stretch feed supplies. Ammoniating wheat straw usually doubles crude protein, improves Total Digestible Nutrients (TDN) by 8 to 15 percent, and boosts feed intake 15 to 20 percent (Kuhl, 1993). Some farmers remove wheat straw for bedding or for use in building materials.

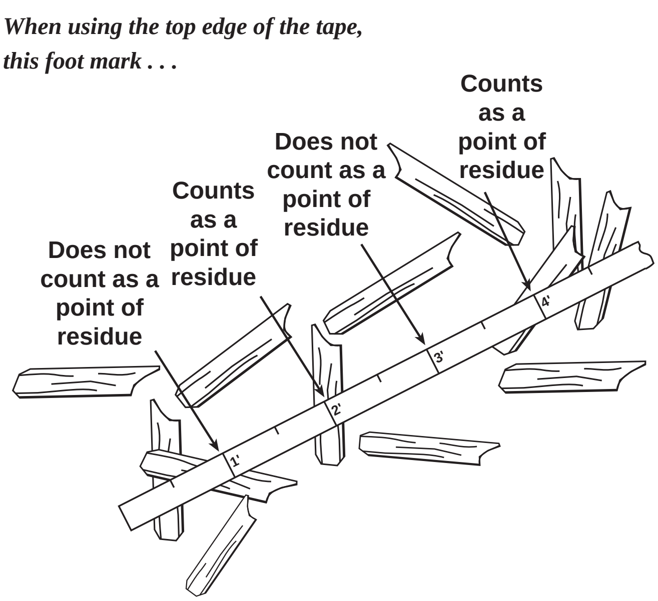

Figure 1. *The line-transect method of measuring residue*

However, removal of straw generally offers only a short-term financial benefit at the expense of erosion protection or long-term soil quality.

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Guide to calculating economic value of wheat straw

Assume that a stubble field was accidentally burned after a 35-bushel wheat harvest. How many dollars were lost?

1) Nutrient loss

Assume one-third of the N and S are lost, which means 0.18 pounds of N and 0.04 pounds of S per bushel of grain
$35 \times 0.18 = 6$ lbs. of N per acre
$35 \times 0.04 = 1.4$ lbs. of S per acre

➥ Multiply this by the cost to replace these nutrients

Maximum nutrient loss would occur if all the ash washes or blows away, which can often happen on bare fields.
35 bushels × 0.53 lbs. per bushel of N = 19 lbs of N
35 bushels × 0.2 lbs. per bushel of P = 7 lbs. of P

35 bushels × 0.9 lbs. per bushel of K = 31 lbs. of K
35 bushels × 0.15 lbs. per bushel of Ca = 5 lbs. of Ca
35 bushels × 0.08 lbs. per bushels of Mg = 3 lbs. of Mg
35 bushels × 0.12 lbs. per bushels of S = 4 lbs. of S

➥ Multiply this by the cost to replace each of the nutrients.

2) Water loss

If the stubble is lost before the winter, only small amounts of snow will be caught on the field. This can account for a loss of 2 to 3 inches of soil water available to the next crop. Rainfall infiltration will be reduced and evaporation of soil water will increase.

Altogether, this could account for a yield reduction in wheat of 12 to 18 bushels.

➥ Multiply dollars lost per bushel of wheat by bushels lost.

3) Soil loss

Bare soil erodes significantly more than covered soil. Find out the erosion potential on your field from your local NRCS office.
Example: HEL field in western Kansas
Wind erosion potential with stubble cover = 4 tons per acre per year
Wind erosion potential without stubble cover = 40 tons per acre per year

Potential loss due to stubble burn is 36 tons per acre. A value often used for topsoil is $5 per ton. Rather than using the potential loss of 40 tons per acre without stubble cover, it would be more accurate to determine the actual losses by wind and water due to the lack of residue. Subtract loss of soil that would have occurred if the crop residue would have remained on the field. Multiply the difference by $5 per ton.

4) Organic matter

One burn will not significantly reduce the organic matter content of a soil.

5) Amount of stubble lost

Multiply harvest yield by 100, for example, 35 bushels of wheat leaves about 3,500 pounds of residue per acre.

6) Loss of potential revenue

Multiply the pounds of residue by its potential revenue if sold for bedding, cattle feed, or building material. If you use a dollar value in section 6 you cannot use a dollar value in sections 1 through 4.

7) Add dollar values of the above sections to calculate the dollar amount lost due to the accidental burn.

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