Crop residue – take it or leave it?

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Agricultural residues can be a valuable feedstock for bioenergy production; they are under-utilized from an economic perspective and utilization of crop residues does not directly impact food production. However, indiscriminate usage of agricultural residue is unsustainable and could prove to be disastrous. Until recently residues were primarily thought of as important only for minimizing soil erosion. Now, increased understanding of the countless ecosystem services residues provide has enhanced their perceived value from mere "agricultural waste" to invaluable soil input. Yet, in some regions farmers may find excess residue cover to be a nuisance. Delayed crop emergences due to slower soil warm-up in the spring and pathogen buildup are two main concerns relating to crop residue retention in the field. In these circumstances, residue removal would clearly be beneficial. The question farmers must ask is - how much residue can be removed without compromising soil quality? This involves a comprehensive assessment analyzing a farm's soil characteristics and current agronomic practices. Once these variables are accounted for a rate of sustainable residue removal (or SRR) can be estimated.

How is SRR calculated?

SRR is the difference between crop residues produced and how much must be returned to maintain soil function. Central to maintaining soil is the upkeep of soil organic matter (SOM). If SOM is maintained then a soil will remain healthy, resist erosion, have reduced input need, and produce higher yields as compared to a soil with less SOM (all other variables being equal) (Kludze et al. 2010). SOM levels are constantly in flux and are dictated by formation and decomposition rates. SRR is directly linked to these rates and is maximized if a high SOM formation rate exists with a low decomposition rate. In this case formation of SOM is high, but minimal SOM is lost since decomposition rates are low. On the other hand, SRR may not be possible for economic or ecological reasons if SOM formation rate is low and decomposition rate is high.

Kludze et al. 2010 re-enforces that asides from SOM dynamics the characteristics of crops produced are also important in assessing SRR potential; specifically crop yields, harvest indices, and root-to-shoot ratios. These variables allow accurate estimates of carbon inputs to the soil, both above and below ground. Maintaining soil organic carbon (SOC) is critical for soil function, since carbon makes up about 58% of SOM (Kludze et al. 2010). Harvest index is the ratio between above ground residue biomass and grain. For example, for corn, soy and wheat it is about a 1:1 ratio, meaning residue (only above ground) and grain weight are about equal. Root-to-shoot ratio is simply the ratio between above ground biomass and below ground biomass, for corn it is 1:1, for soy it is 6:5 (or 20% more below ground) and for winter wheat it is 8:5 (or 60% more below ground)(Kludze et al. 2010).

Determining below ground biomass is important since it also contributes to SOM formation. For example, if 8000 kg of corn is produced per hectare what portion of below ground biomass is present? If the harvest index is 1:1 then grain and above ground residue are equal, meaning with 8000 kg/ha of grain there should also be 8000kg/ha of above ground residue. If the root-to-shoot ratio is 1:1 then there will be an additional 8000 kg/ha of biomass below ground as well. In this case, after grain harvest there is 16000 kg/ha of biomass added to the soil. Simple enough, but with other crops it is more complicated.

For example, what amount of below ground residue would be produced in a hectare of wheat yielding 4500 kg/ha? Assuming a harvest index of 1:1 and a root-to-shoot ratio of 8:5: 4500 kg/ha grain yield x 1 (harvest index) = 4500 kg/ha above ground residue x 1.6 (root-to-shoot ratio) = 7200 kg/ha below ground residue. Therefore, 11,700 kg/ha of biomass is added to the soil every year with a winter wheat grain harvest of 4500 kg/ha.

So how much of this residue can be removed? This of course depends on SOM formation and decomposition rates. Kludze et al. 2010 suggest in Ontario, average SOM formation rates are around 15% and average decomposition rates are around 2.5%. If a soil has 3% SOM in the plough layer (15-18cm) then this results in approximately 67,200 kg/ha. If 2.5% of this is lost per year through decomposition then this means 1680 kg/ha of SOM must be replaced annually to maintain a SOM level of 3%. And if SOM formation is 15%, then 11,200 kg/ha of new organic material must be added annually (1680/15% = 11,200 kg/ha). Thus, from the examples above 4800 kg/ha of corn residue (16000 kg/ha of residue – 11,200 kg/ha) could be harvested sustainably, but only 500 kg/ha of wheat residue (11,700kg/ha of residue – 11,200 kg/ha) could be harvested sustainably.

To learn more about SRR and how to calculate it for your farm please check out "**Determining how much crop residue to remove on your farm**".

Data and information from: Kludze, H., Deen, B., Weersink, A., van Acker, R., Janovicek, K., & De Laporte, A. (2010). *Assessment of the availability of agricultural biomass for heat and energy production in ontario*. Crop Science, University of Guelph: Ontario Ministry of Agriculture, Food and Rural Affairs.