

Chapter 12: Estimating Nutrient Removal in Wheat Grain and Straw



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The mining of soil nutrients (soil organic C, N, P, K, Cl, and S) constitutes a grave concern for the long-term sustainability of South Dakota soils. This section provides examples that demonstrate how to calculate the amount of nutrients removed (on a per unit basis) in wheat grain and straw. While N losses will be illustrated, other nutrient losses can be estimated using these techniques.

Crop removal can be estimated based on data provided in Table 12.1. Mining is the difference between nutrient applied and crop removal. If the removal rate exceeds the application rate, then the soil nutrient is being mined. The extent of soil mining can be estimated by subtracting the nutrients removed in the grain and straw from the amount of fertilizer applied (Table 12.3).

Table 12.1. Nutrients contained in wheat grain and straw. (<http://ppi-store.stores.yahoo.net/maandcaforag.html>)

Type	Measurement		Removal/	Unit (lbs/unit)			
	Unit	N	P ₂ O ₅	K ₂ O	Mg	S	Cl
Wheat grain	Bu	1.5	0.6	0.34	0.15	0.1	0.026
Wheat straw	Bu	0.7	0.16	1.2	0.1	0.14	ND
Wheat straw	Ton	14	3.3	24	2	2.8	--

Nutrients are removed from the 'soil bank' every time grain or straw is removed from the field (Tables 12.1 and 12.2). Harvesting both grain and residue will remove more nutrients than the grain alone. The amount of straw contained in a field can be estimated with the harvest index, which is the ratio of grain divided by grain plus straw.

Table 12.2. Estimating N removal rates.

Removal = Yield • nutrient content/unit measure

N in grain

If 1 bushel wheat contains 1.5 lbs of N, how much N is removed in 40 bu (at 13.5% moisture)?

$$\frac{40 \text{ bushels}}{\text{acre}} \cdot \frac{1.5 \text{ lbs}}{1 \text{ bushel}} = 60 \text{ lbs/acre}$$

N in straw

If 1 lb of dry (0% moisture) grain produces 1.35 lbs of dry straw, and 1 bushel of wheat at 13.5% and 0% moisture, they would weigh 60 and 51.9 lbs each.

$$\frac{40 \text{ bushels}}{\text{acre}} \cdot \frac{51.9 \text{ dry lb wheat}}{1 \text{ bu}} \cdot \frac{1.35 \text{ lb straw}}{1 \text{ lbs dry wheat}} \cdot \frac{\text{ton}}{2000 \text{ lbs}} \cdot \frac{14 \text{ lb N}}{\text{ton}} = 19.6 \text{ lb N/acre}$$

Total N removed in grain plus straw

$$60 \text{ lb N/a} + 19.6 \text{ lb N/a} = 79.6 \text{ lb N/acre}$$

Table 12.3. Calculating N mining amounts.

Mined N = N added – N removed

Based on Table 12.2, N removal is 79.6 lbN/acre

N added is 100 lb/acre of urea

N in urea is $100 \times 0.46 \text{ lb N/lb urea} = 46 \text{ lbs N/acre}$

Mined N = $46 - 79.6 = -33.6 \text{ lbs N/acre}$. Based on this calculation, 34 lbs is being mined from the soil annually.

Generally, wheat produces (on a dry weight basis) 1.3 to 1.4 lbs straw per 1 lb dry grain. Sample removal rate calculations are in Table 12.2. Additional information is available at:

- <http://www.back-to-basics.net/assets/agribriefs/Winter2003-2.pdf>
- [http://njveg.rutgers.edu/assets/pdfs/soil/fs014-jhNutrient Removal Values for Field and Forage Crops FS014.pdf](http://njveg.rutgers.edu/assets/pdfs/soil/fs014-jhNutrient%20Removal%20Values%20for%20Field%20and%20Forage%20Crops%20FS014.pdf)

For a complete nutrient balance, the entire rotation as well as the fertilizers and manures added to the system must be considered.

Additional information and references

Clay, D.E., S.A. Clay, C.G. Carlson, and S. Murrell. 2010. Mathematics and Calculations for Agronomists and Soil Scientists. International Plant Nutrition Institute. Available at <http://ppi-store.stores.yahoo.net/maandcaforag.html>.

Acknowledgements

Support for this chapter was provided by South Dakota State University, South Dakota Corn Utilization Council, USDA-NIFA South Dakota 2010 research program, South Dakota Wheat Commission, and South Dakota Soybean Board.

Clay, D.E., and C.G. Carlson. 2012. Estimating nutrient removal in wheat grain and straw. In Clay, D.E., C.G. Carlson, and K. Dalsted (eds). iGrow Wheat: Best Management Practices for Wheat Production. South Dakota State University, SDSU Extension, Brookings, SD.

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