Answering the Call:

Improved Nutrient Efficiency and Organic Matter Build-up

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THE American crop farmer, wherever possible, combines the use of conservation tillage with improved soil fertility management practices. The integration of these two best management practices (BMPs) increases grain yields, crop residues, nutrient use efficiency, and carbon (C) assimilation. It also improves the soil medium for sequestering C and the build-up of organic matter.

- Crop residues totaled 513 million tons in 1992, 186 million tons more than in 1973.
- Crop residues contained 232 million tons of C in 1992 . . . 85 million tons more than in 1973.
- Commercial fertilizer accounts for 35 percent of grain and crop residue yield, or 81 million tons of the 232 million tons of C in 1992 crop residues.
- Nitrogen (N) efficiency on corn (bu/lb N applied) was 1.03 in 1992, an increase from 0.87 in 1982.
- Phosphorus (P) efficiency on corn was (bu/lb P_2O_5 applied) 2.80 in 1992, an increase from 2.01 in 1982.
- The ratio (nutrient uptake/nutrients applied) on corn was 1.82 in 1992. That compares to a ratio of 1.42 a decade earlier.
- In 1992 a total of 7.0 million tons of plant nutrients was exported off farms through grain sales. That compares to 6.1 million tons in 1982.

Studies have shown that soil organic C content is a linear function of the amount of crop residue added to soils. Crop residue production is increasing on North American farms as yields have increased, as shown in **Figure 1**.

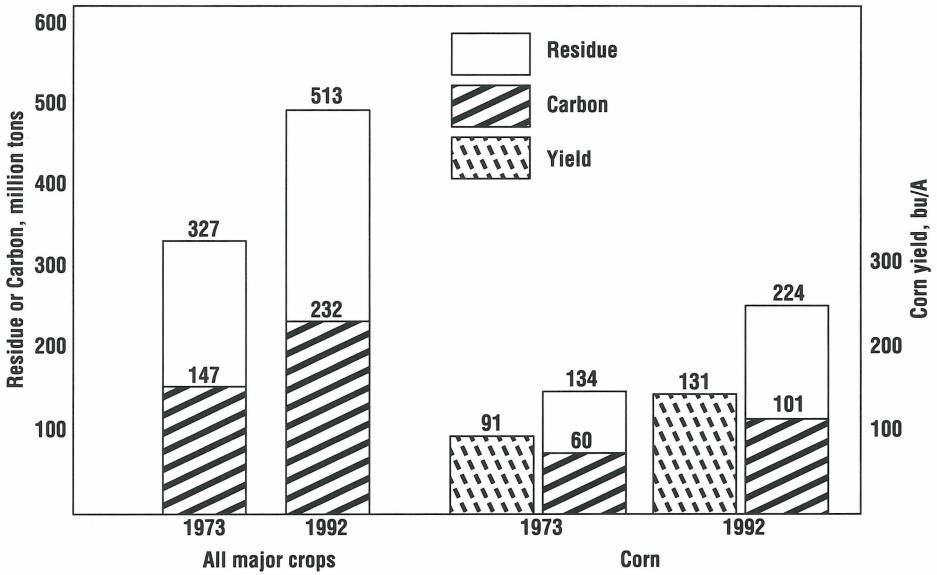

Figure 1. Crop residue and organic carbon production by all major crops and a comparison with corn (1973 versus 1992).

During the past 20 years, residues produced by the major crops in the U.S. have increased more than 50 percent, from 327 to 513 million tons. Corn residue accounts for approximately 44 percent of the total crop residue produced. Increased crop residue production parallels the improvement in grain yields. Corn yields, for example, increased 40 bu/A in this 20-year time span. Total crop acreage in 1973 and 1992 was about the same . . . 236 and 242 million acres, respectively (not shown in **Figure 1**). Approximately 45 percent of crop residue dry matter is C. In 1992, crop residues contained approximately 232 million tons of C which was potentially available for sequestering into soils and organic matter build-up.

Several long-term experiments and farmer experiences have shown that the three management practices most closely associated with the build-up and maintenance of organic matter are: 1) conservation tillage practices, 2) an adequate and balanced soil fertility program, and 3) crop rotations.

Commercial fertilizer use accounts for approximately 35 percent of grain and crop residue yields annually, or 81 million of the 232 million tons of C in 1992. Dr. Ron Follett, USDA/ARS said, "Soil fertility is essential for plants to grow and sequester carbon in soils. Conversely, the soil carbon level is often an indicator of a soil's fertility."

Through the continual development of better agronomic and conservation BMPs and the implementation of new technology by crop farmers, soil nutrient storage capacity, nutrient efficiency, and the production and environmental benefits associated with these factors are all increasing. Comparisons of corn yields, corn residue and C production, and fertilizer use efficiency for 1982 and 1992 are shown in **Table 1**.

It is estimated that crop yield potential increases more than 20 percent for each 1 percent increase in soil C content. Corn yields and residue production increased substantially during the period from 1982 to 1992. Higher amounts and better management of crop residue improve the soil medium for sequestering C and building organic matter. As a result, a soil's capacity to retain plant nutrients in the rooting zone is enhanced.

The increased soil nutrient storage capacity is a partial explanation for the gradual increase in crop yield potential, higher nutrient use efficiency, organic matter build-up, and reduced environmental problems associated with higher crop yields.

However, plant nutrients exported off the farm have also increased as grain yields increased. This depletion, particularly for P and K, unless restored by plant nutrient sources outside the system, will reverse the positive soil/fertilizer/yield/environment relationships now taking place on North American grain farms. ■

Table 1. A comparison of corn grain yield, residue and C production and their relationship to fertilizer use and efficiency in 1982 and 1992.

		1982	1992
Corn acreage, million		73.2	72.1
Yield, bu/A		114	131
Corn stover residue, million tons		197	224
Carbon in corn residue, million tons		89	101
Fertilizer use per acre:			
(USDA)	N	131	128
	P_2O_5	57	47
	K_2O	72	57
Fertilizer efficiency, bu/lb applied:			
	N	0.87	1.03
	P_2O_5	2.01	2.80
	K_2O	1.59	2.31
Nutrients (NPK) removed in grain, million tons		6.1	7.0
Nutrients (NPK) remaining in residue, million tons		7.4	8.3
Total nutrient uptake, million tons		13.5	15.3
Total nutrients applied, million tons		9.5	8.4
Ratio nutrient uptake/nutrient applied		1.42	1.82