FFF Review

Water Use Efficiency Key to MSP

Requires rebuilding soil to spongy structure over a period of years.

Agronomists often talk about the importance of water use efficiency (WUE), which is measured in bushels of grain per inch of precipitation. Imagine a giant sponge 24 inches thick that covers an acre of ground. A cellulose sponge this size would absorb 10 inches of rain and store it. What does this have to do with farming? Plenty. You can rebuild your soil structure to do the same thing. A reservoir of water will be there when the dry summer months hit and hot winds begin to buffet thirsty crops. The big payoff is increased WUE that can produce higher yields and increase profits.

Forty years ago, U.S. farmers produced an average of 60 bushels of corn per acre. At an annual precipitation rate of 30 inches or so per year that means they achieved an average WUE of only two bushels per inch of rain. In those days farmers, who planted corn in rows up and down hillsides, used very little fertilizer and couldn't control weeds and insects. Fact is they wasted more rainfall than they used to grow the row crop.

Establishing a reservoir

It did not take long for farmers to smarten up, however, and begin to concentrate on how to make the most of rain and snow. Table 1 shows how two farmers within the last couple of decades have used good management to increase WUE.

Because the single most precious natural resource in the Corn Belt that determines crop yield is water, its availability and amount through rainfall, and the frequency of that rainfall, is critical to our future. Ways to make the most of this resource and improve WUE are several: 1) use a balanced fertility program to grow a

healthy plant with a vigorous root system that explores the deep soil profile for water, 2) use conservation-till, leaving residue on the surface to catch water and reduce erosion, 3) control weeds and insects that compete with crops, 4) use narrow rows, select a good hybrid, and plant in time to reduce stress at pollination.

Modifying soil structure

The secret to WUE? Build a deep soil structure high in organic matter that will absorb and hold water until needed in the peak usage period of July and August. Why must we do this? Because precipitation does not occur evenly during the growing season to coincide with plant usage. The problem is further compounded by those "gullywashers" (thunderstorms—40% of the time) and the 10 to 15 percent that falls as snow.

Although total annual precipitation increases as we move east from the Corn Belt—from 29 inches in Omaha, Nebraska, to 38 inches in Columbus, Ohio—every farm has the same water deficit when only about 8 inches falls (that's right—Omaha to Columbus) in the July-August period when a corn crop needs 12 to 18 inches. Thus, a corn crop must draw from a reservoir to stay healthy and produce a maximum yield. Table 2 shows that an absorbent, spongy soil, whose structure has been modified and is high in organic matter, can store up to 10 inches of water in the top four feet.

Figure 1 shows what kind of water management is required to raise 300

TABLE 1. Good management raises WUE to produce 300+ bu/A corn yields on 2 U.S. farms.

State	Yield bu/A	Rainfall Inches	WUE bu/inch
South Dakota	145	21.0	6.9
Iowa	108	17.0	6.3
Illinois	338	30.0	11.2
Michigan	352	32.2	10.9

TABLE 2. Average available water on different U.S. soils and at different depths.

Soil Texture	Inches Water 2 ft*	4 ft*
Loamy	2.5	4.8
Sandy Loam	3.2	6.2
Silt Loam	5.1	10.1
Silty Clay Loam	4.9	9.4

*soil depth

bushels of dryland corn in the Corn Belt. This level of production is no pipe dream, as we've pointed out in other issues of the Fluid Journal. Note that the soil must hold at least 10 inches of water. The computations are, of course, estimates that would be quite different if the year was not "normal." Though it has been a long time since we've had a normal year, the illustration should suffice for purposes of this discussion.

Patience required

Rebuilding soil structure to achieve MSP is not a one- or two-year project. It is a long-term commitment that takes 10 to 15 years. It involves using residue from a corn crop to collect water and control erosion. Much of the residue is also incorporated into the soil with fertilizer that helps digest the residue into organic matter. Deep tillage finally moves the organic matter down into the soil profile.

The end result is higher organic matter changes soil properties, increasing water-holding capacity. tilth and infiltration rate. The higher organic matter also provides additional nutrients to the crop during the growing season. Once organic matter is worked into the subsoil, roots can proliferate into the deeper profile, making higher plant populations possible. The payoff is higher yields and WUE. Table 3 shows how a farmer could build soil quality by using residue of the corn crop.

TABLE 3. Building soil tilth with crop residue and fertilizer.

Corn Yield (bu/A)	Net Tons Dry Residue, Ears Removed*	Possible Addition in Organic Matter Reserve (%/A) (0-6" Zone)	Estimate of Additional Nutrients Required (lbs/A**)		
			N	P_2O_5	S
160	3.9	0.14	86	27	12
200	5.2	0.18	114	36	16
260	6.9	0.25	152	48	21
300	8.3	0.30	183	58	25

* Including tops, roots, less amount of residue needed to control erosion.
** Additional amounts of nutrients for residue only. Other nutrients would be needed to produce the estimated yield goal.

FIGURE 1. Proper water management program to grow a 300 bu/A crop in the Corn Belt (assuming a 10 bu/inch of precipitation).