1989 AGRONOMIC IMPLICATIONS OF THE 1988 DROUGHT

Dr. Harold F. Reetz, Jr.[1/]

Historical Perspective

Grain marketing analysts have a rule of thumb that says, "A short crop has a long tail". From the agronomist's point of view, a similar statement could be made for the agronomic implications of the 1988 drought. And coming on the heals of several years of depressed prices, there are some psychological effects that must be considered in working out management plans for farmers for the 1989 growing season.

Since the 1988 season broke all previous records for extent and duration of drought stress in many areas of the Midwest, and since the closest similar situation occurred over 50 years ago, we have little experience upon which to draw.

The management situation was so different in the drought periods of the 1930's that there is little information of relevance from that period either. It was before the widespread use of hybrid corn---in fact the drought of the 1930's was a key factor in the rapid acceptance of hybrid corn for many farmers. Commercial fertilizer use was minimal. Most corn was grown in rotation with forages and small grains. Plant populations, weed pressure, insect problems, etc., were all quite different form today's situation.

Planning for a Good Year

The best approach to planning for the 1989 season is to plan for a good year. Weather records show that their is no trend for two drought years to occur in succession. The probability for 1989 to be a wet year is just as good as for it to be dry. And even if a continuation of the drought period were to occur, most of the central Corn Belt would have adequate moisture to recharge the soil profile during the winter months to the point that it would support the 1989 crop through a normal rainfall season.

Soil Moisture Recharge

Most of the central Corn Belt entered the fall with a seasonal moisture deficit of 6 to 8". A good silt loam soil will generally hold about 2.4" of plant available soil moisture per foot of depth, or about 12" in the top 5 feet. For example, a Drummer soil, common in central Illinois, holds about 11" of water in the top 60" of the soil profile. Sandy soils will hold less water, typically in the range of 1.2" per foot. Water supply in sands recharges faster and is used up faster.

Expected rainfall in central Illinois, central Indiana, and central Ohio would provide 13" of rainfall from November 1 through April 1. Assuming 1/3 is lost to runoff, 2/3 (or 8") would be available to recharge the soil moisture. This would be adequate to bring most soils back to field capacity by next spring. The dry condition of the soil, with large cracks to increase infiltration, will help increase the efficiency so that as much as 90% of the rainfall might be absorbed this winter...at least until the ground freezes. Efficiency will obviously depend upon crop cover, slope, compaction, and other factors for any given field.

Even given one of the driest 10% of the years on record, there would be enough rainfall by April 1 to provide a 75% recharge, which would be adequate to sustain a crop through a normal growing season.

Moving north in the Midwest, the majority of the winter moisture comes as snow, which drifts off unless trapped by crop residue or windbreaks. More of the winter moisture falls on frozen ground and

[1/] Westcentral Director, Potash & Phosphate Institute, R.R.#2, Box 13,Monticello, Illinois 61856

is not absorbed as efficiently. Thus fields in Minnesota, North Dakota, South Dakota, and parts of Wisconsin are less likely to get a full recharge of soil moisture.

For the western Corn Belt and the Great Plains, the annual rainfall is lower and the probability for full recharge is lower, so there is a higher risk for the drought to continue into 1989. But drought in western areas was not as severe in 1988.

<u>Groundwater and Surface Water Recharge</u>

Recharge of groundwater, lakes, and rivers for 1989 is not as likely. The soil recharge will take up most of the available water given normal precipitation. The 1989 crop will have the "first shot" at the water supply. The 1/3 that goes to runoff and percolation would supply only 4" of the 13" in the example above to recharge groundwater and surface water supplies. Full recharge would occur only if we were to get on of the 10% wettest years on record.

Weather for 1989 is uncertain, but we always live with that uncertainty. The important point in planning for next year's crop is that *planning for a good year will provide the opportunity to take advantage of good weather patterns that do occur.* If less than ideal conditions continue, good management practices will provide the best opportunity for the crop to survive. Planning for a bad year in 1989---cutting back on seed, fertilizer, and chemical inputs---will almost insure low yields, even if good weather occurs.

<u>Management to Improve Water Use Efficiency</u>

Steps can be taken this fall to help increase the efficiency of storage of rainfall. Level or gently sloping fields that are tilled and left rough with about a 30% cover of crop residue will trap most of the rain that falls. Smooth and compacted surfaces are more subject to runoff losses. Crop residue on sloping fields helps slow runoff and improve infiltration.

Fall tillage should be especially helpful this year in breaking up compacted soil layers, because the dry soil will fracture more easily. Fall tillage can help incorporate fertilizer and lime, increase water use efficiency, and help reduce some herbicide carryover problems. (*Of course where fall tillage does not fit the soil type or topography, this is not a viable option.*) On soybean stubble, it may be best to avoid tillage, because the soil is generally loose and will readily absorb rainfall.

The past few years have been especially favorable for spring field work. *Long-term weather records show that wet spring weather is a common problem in the Midwest.* We normally do not get as many rain-free days in the spring as we have had in the past two to three years. A return to normal spring rainfall could mean problems in getting spring fertilization and tillage done in a timely manner. This is another reason for fall fertilization and tillage where it is practical.

Fertility Carryover Projections

The reduced yields due to drought in many areas of the Midwest in 1988 have raised the question of how much credit can be taken for fertilizer applied for the 1988 crop, but not utilized. This is an important consideration for planning the 1989 fertilization program.

The lack of rainfall not only limited yields, but also reduced movement of nutrients into the soil. Surface- or shallow-applied fertilizer materials remain concentrated near the soil surface.

Because the drought started early in the season, plant roots have grown deep into the soil profile wherever possible. This means some of the nutrients taken up by the plants may be deposited lower in the profile as these roots die. It also means that there were relatively few roots near the surface to take up nutrients from this year's fertilizer application.

There is tremendous variation from one field to the next in depth of rooting, amount of crop growth, and grain yield. There will be similar variation in nutrient utilization and carryover. Hybrid/variety differences in stress tolerance, differences in soil compaction, and variation cultural practices such as tillage, planting date, etc., will also affect the potential carryover. So there is no simple answer.

The following guidelines have been developed on the basis of the recommendations from researchers and extension specialists throughout the Midwest. They should provide a sound basis for adjusting fertilizer recommendations for the 1989 season. Weather patterns between now and next spring must also be considered in determining final crop and fertility plans.

SOIL TEST

The first step is to get recent soil test information, or take a soil test, to "take inventory" of nutrient levels in the soil. Be especially careful in taking samples to a uniform depth. Most soil test calibrations are based upon a 6 to 7 inch sampling depth.

Taking samples from a shallower depth is tempting when the soil is dry and hard, but it will give erroneous results, usually lower pH and higher P and K readings than you would get from a standard 6-7 inch sample.

P and K CARRYOVER

Fertilizer P and K will usually move very little from the point of application. So uptake is determined by the amount of roots growing into the fertilized zone and coming in contact with the fertilizer material. Adequate moisture for dissolving the nutrients and absorption by the roots is also essential.

If soil tests are high and maintenance applications were made for the 1988 crop, you can assume that P and K applied beyond the amounts removed in the 1988 crop will be available for 1989. Sloping fields, sandy soils, or soils with a high fixation rate for P or K may have less carryover available.

Where soil tests are medium or low, consider the extra carryover as part of the build-up program and plan fertilizer application to meet needs of additional build-up requirement and maintenance for the 1989 crop. If soil tests are low and the financial status is tight, consider row fertilizer, or banded placement to get the most efficiency.

As a general guideline, fertilizer applied beyond the amount removed by the harvested crop will increase soil test P_1 levels by 1 lb. for every 8 to 10 pounds of P_2O_5 and soil test K levels by 1 lb. for every 4 to 6 pounds of K_2O.

For example,

1. Assume a 1988 fertilizer application for a yield goal of 150 bushels of corn per acre, with initial soil test levels of 40 lb/A P_1 and 200 lb/A K.

2. The University of Illinois *Agronomy Handbook* suggests a fertilizer application of the following:

180 lb/A total N

22 lb/A P_2O_5 as build-up*
64 lb/A P_2O_5 as maintenance

---

86 lb/A total P_2O_5

100 lb/A K_2O as build-up*
42 lb/A K_2O as maintenance

---

142 lb/A total K_2O

***Assumes a 4-year build-up schedule.**

3. Crop removal would be:

$$0.44 \text{ lb } P_2O_5/\text{bu} \quad \text{and} \quad 0.29 \text{ lb } K_2O/\text{bu}$$

4. If only 50 bu/A of corn was harvested in 1988, the fertilizer *balance sheet* would be:

86 lb/A P_2O_5 applied
22 lb/A removed in crop
----
64 lb/A P_2O_5 left for build-up

142 lb/A K_2O applied
14 lb/A removed in crop
----
128 lb/A K_2O left for build-up

Based upon an average build-up rate of 9 lb P_2O_5 to raise the soil test P_1 by 1 lb, and 4 lb K_2O to raise the soil test K by 1 lb, the *expected* increase in soil tests would be:

P_1 = (64/9) = 7 lb/A (P)

K = (128/4) = 32 lb/A (K)

Unfortunately, the balance sheet approach to fertilizer applications is not very accurate, especially when dealing with unusual weather effects. *Some university agronomists are suggesting that only half of the carryover P and K should be considered in determining fertilizer needs for 1989.*

Initial soil test level, soil type, and weather conditions will affect the actual soil test change from build-up applications. But overall, don't expect soil test P and K levels to be changed very much due to carryover of nutrients from the 1988 season.

Summary: Follow normal procedure and base 1989 fertilizer applications on soil tests. Where 1988 yields were low, the expected increase in soil test levels from carryover P and K will be small.

Nitrogen Carryover

Nitrogen carryover for 1989 crops is very dependent upon the weather between harvest and planting next spring. Extended warm weather and/or excessive rainfall will substantially reduce the amount of N that is carried over to next year. If possible, delay decision of the total N program until spring. If you expect some carryover, but want to fall apply N, allow for the anticipated carryover, but be prepared to make additional applications if conditions favorable for substantial losses occur before spring.

For corn following soybeans, a rule of thumb is to allow 1 lb/A of N for each bushel of soybeans harvested, with a minimum credit of 15 lb/A and a maximum credit of 40 lb/A. So credits for different yields would be:

Soybean Yield	N Credit
10 bu/A	15 lb/A
20 bu/A	20 lb/A
40 bu/A	40 lb/A
60 bu/A	40 lb/A

Where corn follows corn, *potential* N credit can be estimated by starting with the pounds of N applied for 1988, subtracting 1 lb/A for each bushel of corn harvested, and dividing the difference by 2. For example, if the 1988 N rate was 200 lb/A, and the 1988 corn yield was 100 bu/A, the *potential* carryover N credit would be:

$$\frac{200 - 100}{2} = 50 \text{ lb/A}$$

If the normal rotation would be to follow corn with soybeans, don't change plans to take advantage of the N credit. It may be lost anyway, and the benefits of rotation will very likely outweigh the potential N credit. If there is some carryover, the soybeans may benefit from the N early in the season.

Use of a nitrification inhibitor is a wise investment with fall or early-spring applications of ammonia-N, or in other cases where potential for N loss from denitrification or leaching is high.

Summary: Carryover of N will be determined by winter and spring rainfall. Delay final decisions on N until spring if possible. If fall-applied ammonia is part of your N program, consider using a nitrification inhibitor.

K Deficiency

Visible K deficiency in corn and soybeans was common in the Midwest this year. The drought was partly to blame, but K applications the past few years have not kept pace with crop removal. The drought just increased the effect of the problem.

Since potassium is the key element in water use efficiency, and N use efficiency, fields with low K soil tests were more severely damaged by this year's drought. *A few dollars saved on lower K rates the past few years were lost many times over in reduced yields in 1988.*

Plants with insufficient K cannot control transpiration loss of water from the leaves. Adequate K allows the pores (stomata) in the leaves to close, and prevent excessive water loss.

Forage Fertilization

The 1988 drought caused considerable stress to perennial forage crops, too. Fall fertilization, particularly with potash, is important to keeping stands healthy, and to reducing potential for winter kill. Potash is very important to cold tolerance. Soil tests are important for determining P and K needs and pH, all of which are important management factors for profitable forage production.

Winter Wheat Fertilization

Getting wheat off to a healthy, vigorous start in the fall and cold tolerance during winter months depends upon sound fertility practices. To capitalize on the investment in P and K and insure optimum efficiency, topdressing with N is a good practice. Be sure your total N program provide 2 to 2.4 lb of N per bushel based upon the yield goal for soft red winter wheat; 2.4 to 2.7 lb of N per bushel for hard red winter and hard red spring wheat.

Herbicide Carryover Problems

There is justification for concern about herbicide carryover for the 1989 crop, particularly for corn following soybeans. Herbicide degradation generally takes a proper combination of temperature, moisture, and time. Whether chemical degradation processes or biological degradation through action of micro-organisms is involved for a particular herbicide, the proper moisture and temperature combinations may not have occurred for a long enough time period during 1988 to get the process complete.

Any situations where overlapping occurred, or where over-application is known or suspected to have occurred, should be noted in making plans for 1989. Hybrids/varieties known to be susceptible to herbicide carryover should be used cautiously.

These guidelines to help avoid herbicide carryover problems have been suggested by University of Illinois extension agronomists:

1. Use bioassays to determine potential carryover problems. This can be done during late winter in window-sill container tests using soil from fields suspected of carryover problems compared with soil from fields known to be free of the herbicide. Plant seed of the intended crop in the window-sill pots to see if any early growth problems occur. This same kind of test can be run in the field later in the spring, a few weeks before planting to see if any chemical problems remain. Laboratory tests can be run on the soils, but they are very expensive and difficult to interpret.

2. Plant as much corn as possible after set-aside, small grain, or forages where herbicide carryover is less likely. If corn must be planted after soybeans where carryover is a concern, then use a corn herbicide program that will allow replanting to soybeans if problems in corn emergence occur. Depend upon post-emergence herbicides to round out the corn herbicide program after a good stand of corn is established.

3. Use suspect fields for set-aside acreage if possible. The cover crop may also help break down herbicide residue.

4. Tillage may help dilute the herbicide, but avoid tillage where soil erosion problems are likely. "Hot spots" may remain even after tillage.

5. Seed a winter cover crop to aid in degradation of the herbicide. Rye or wheat cover crops may help remove the herbicide problem, but will also use up some of the soil moisture for next year's crop.

6. Plant suspect fields last to allow maximum time for degradation.

7. Use tolerant hybrids/varieties if possible, but this kind of information is not readily available for many genotypes.

8. Consider planting the same crop again. This may help reduce herbicide carryover concerns, but may also result in sacrifice in potential yield due to losing the rotation effect.

9. Be careful of potential additive effects of herbicides used in 1989. For example, using metribuzin on soybeans following atrazine used on the 1988 corn crop could result in an additive triazine effect.

10. Good tilth will encourage rapid root growth---getting the roots through the chemical zone quickly---which will reduce potential injury. Fall tillage to incorporate crop residue and fertilizer materials will help improve tilth, speed up soil warming in the spring, and reduce compaction. Most Midwest soils are dry enough this fall for good shattering action with deep chiselling, but the power requirement may be higher than usual.

11. Apply herbicides for 1989 carefully, following label recommendations. Keep accurate records.

12. Hope for a late fall and early spring to increase the time, temperature, and moisture available for degradation.

New herbicides used on Midwest farms require more careful management to avoid problems. The 1988 season has provided some good lessons on the importance of following label directions and good common sense.

Summary

Planning for a good year in 1989 is the best approach. Using the best management pratices for a good year will likely prove most profitable regardless of the 1989 weather patterns. Learn from any mistakes made in 1988, but don't over-react to effects attributable to the drought. Develop a *reasonable*, but not too conservative, yield goal for 1989 crops, and a *management plan* that will support that goal. Choose the best seed, maintain high soil nutrient tests, avoid compacting the soil, plant early, and control pests. Years like 1988 will return again (*not frequently, we hope*), but we cannot predict them. To plan for them would mean a lot of missed profit opportunities in all the good years in between.

PROCEEDINGS OF THE EIGHTEENTH

NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY WORKSHOP

9-10, November 1988, Holiday Inn St. Louis Airport North

Bridgeton, Missouri

Volume 4

Program Chairman:

K. A. Kelling

Department of Soil Science
University of Wisconsin-Madison

CREDITS

The professionalism shown by Ms. Barbara Brown in typing portions of this document and in helping organize its preparation is acknowledged and appreciated.

Department of Soil Science
University of Wisconsin-Madison

and

Potash and Phosphate Institute
2805 Claflin Road
Suite 200
Manhattan, Kansas