NUTRIENT MANAGEMENT FOLLOWING CRP: CONCERNS AND ON-GOING PROJECTS

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INTRODUCTION

The future of the Conservation Reserve Program (CRP) is uncertain as this paper is being prepared, however, most agree that at some point a significant acreage currently in CRP will be brought back into production. The peak of contract expirations for the 36 million acres of CRP will occur in the fall of 1996 with the first contracts originally due to expire in 1995 (Figure 1). Many of the Northcentral states have substantial CRP acreage's making post-CRP management an important topic for this region (Table 1).

Figure 1. CRP Contract Expiration

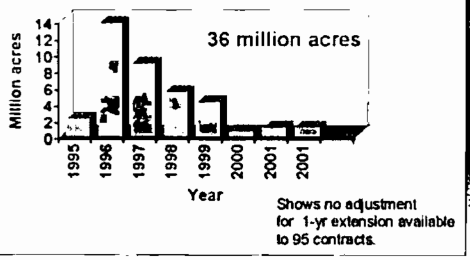

Table 1. Top 12 CRP States

	Acreage, thousands		
State	Total	Wheat	Corn
TX	4150	1313	78
ND	3181	1138	134
KS	2938	1303	60
MT	2854	1052	5
IA	2225	42	1201
SD	2120	631	195
CO	1978	815	26
MN	1929	412	436
MO	1727	422	251
NE	1425	327	358
OK	1193	721	5
WA	1047	401	2

Source: USDA ASCS

The objectives of this report are to describe the nutrient related concerns of post CRP management, summarize current management suggestions, and list some of the relevant on-going studies. Nutrient management will not be the major challenge faced by most farmers in bringing CRP land back into production. However, the potential for nutritional problems does exist and could reduce profitability and/or contribute to water quality problems.

NUTRIENT MANAGEMENT CONCERNS

The major nutrient concerns center on the effects of organic plant residues on N management. The quantity of residue accumulated in CRP fields can be very large. For example, Nebraska researchers have estimated above-ground levels of 4 to 5 tons/A for a bromegrass CRP field in northeast Nebraska (Shapiro et al., 1995). Grass residues grown in low N environments usually have wide carbon to nitrogen ratios (C:N) compared to soil microorganisms or stable organic matter (Table 2). If the C:N ratio is greater than 30:1, soil or fertilizer N can be temporarily immobilized during residue decomposition.

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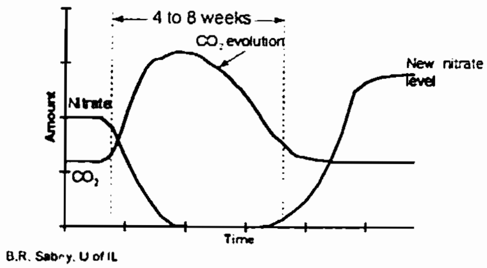
The traditional illustration of this concept was developed by Sabey (Figure 2). Initially, the increase in energy supply caused by the residue addition stimulates microbial activity as indicated by the increased CO_2 evolution. The growing population of heterotrophic microorganisms removes nitrate from the soil and the nitrate level is depressed until the energy supply is exhausted. At this point, the microbes die and their decomposing bodies gradually return soil nitrate to a level higher than it was initially.

Table 2. C to N ratios of organic materials.

Organic substances	C/N
Soil microorganisms	8:1
Soil organic matter	10:1
Young sweet clover	12:1
Rotted barnyard manure	20:1
Clover residues	23:1
Green rye	36:1
Corn/sorghum stalks	60:1
Grain straw	80:1
Timothy	80:1
Sawdust	400:1

Figure 2. Changes in soil nitrate levels during decomposition of low N residues.



The overall contribution of the residue to plant available N is positive, but a period of depressed N availability occurs along the way. The critical question related to N management following CRP is how deep is the depression period and how long does it last. Even though Figure 2 shows 4 to 8 weeks, the actual duration is probably much more variable. Depth and duration will depend primarily on the quantity of residue, the actual C:N ratio of the above and below ground residue as well as its particle size, degree of soil incorporation or tillage, and soil moisture and temperature conditions following killing of the sod. Fortunately, some studies are far enough along to offer examples of the timing of the process for specific sets of conditions. Much more data will be available during the next couple years.

Often data are available on N response following plowing of native prairie. One such study was conducted in southeastern Minnesota on a Nicollet clay loam soil (Fenster et al., 1978). The virgin soil had 7.1% organic matter compared to 4.6% for an adjacent field that had been farmed for many years. The first year following fall moldboard plowing showed response to the first rate of N in the study, 50 lb/A, but no response to higher levels and no response to any level for the remaining 5 years of the experiment. First year corn yields were 179 bu/A with no N applied and 190 bu/A for the 50 lb/A rate. Check plots contained 97 lb/A nitrate-N in the top 2 feet in the fall of the first year of production. Studies such as these must be interpreted with due consideration to the potentially large differences existing between 10 years of CRP and land that has never been tilled containing 40 to 60% higher organic matter levels.

Primary tillage had a marked effect on fertilizer response by corn following 6 years of an alfalfa/smooth brome sod in east central South Dakota (Bly, 1992). If the sod was plowed, no yield response was measured to use of a starter fertilizer plus sidedress UAN, modest response was measured with a chisel system and a 32 bu/A response occurred under no-till (Table 3). By the spring of the second year, soil nitrate levels had increased to approximately 200 lb/A in the top 2 feet in MP and CH systems where fertilizer had been applied. Second year responses were

Table 3. Influence of tillage on fertilizer response following CRP in east central SD.

Tillage	1990 Fertilizer[1] no	1990 Fertilizer[1] yes	1990 Resp.	Spring 1991 NO_3N[2]	1991 Fertilizer[1] No	1991 Fertilizer[1] Yes	1991 Resp
		bu/A		lb/A-2ft		bu/A	
MP	122	124	+2	210	156	158	+2
CH	112	126	+14	196	143	161	+18
NT1	82	114	+32	124	120	161	+41
NT2	CRP	CRP	CRP	58	160	183	+23

[1]13-33-13 as a starter in 90 & 91; in 1990 48 lb/A N sidedress on all tillage, in 1991 none on MP&CH, 20 on NT1 and 40 on NT2. [2] From fertilized treatments. Bly, SDSU

similar to the first year responses even though no N was sidedressed on MP and CH systems and only 20 lb/A in NT. A second no-till treatment was initiated in 1991 and again showed good fertilizer response. Successful no-till breakout was very dependent on fertilization at this location where the initial sod was composed of more alfalfa than grass and plowed plots showed no fertilizer response.

Table 4. Rotation effects on corn yield and N relationships in SW Minnesota in 1994.

Rotation	Prim. tillage	Fert N	Yield	Fall NO_3-N '93	Fall NO_3-N '94	Tile loss	Rotation effect[1]
		lb/A	bu/A	lb/A-10 ft		N, lb/A	
Cont. corn	MP	147	164	150	165	13	-15
Corn soy	none	95	172	118	103	12	+6
Soy corn	MP	0	45	94	99	12	-
Corn alfalfa	MP	15	170	46	36	3	+73
Corn CRP	MP	158	177	41	58	1	-22
LSD 0.05			8			0.7	

[1](N uptake + Tile loss - Fall 94 nitrate - Fall 93 nitrate - Fertilizer N) Klossner et al. 1995 Univ. of MN

When differences in initial soil nitrate were taken into account, continuous corn and first year corn following CRP appeared to have similar N fertilizer requirements in a study being conducted in southwestern Minnesota (Table 4). Somewhat greater N was applied following CRP than following continuous corn due to the lower initial nitrate levels of the CRP plots. The cropping systems were established in 1988 with the CRP sod consisting of nearly all grass for the last 3 years. All corn received 15 lb/A of starter N at planting with the remaining N broadcast as urea in early June and incorporated by cultivation. Nitrate measured in tile drainage from each of the crop rotations was the lowest following CRP. A "rotation effect" for N requirement was calculated as shown in footnote 1 of Table 4 to estimate the apparent contribution of soil organic matter combined with any N losses in addition to those measured in tile drainage. This calculated rotation effect was similar for CRP and continuous corn, both being negative. Negative numbers indicate that either net immobilization occurred or that N losses exceeded the contribution from organic matter for the season. Preliminary evaluation of this ongoing study indicates that N rates following CRP for similar soil/climate conditions could be based on the preplant nitrate test.

Soil collected from a southwest Iowa CRP field brought into production using no-till, mineralized 1.9 lb nitrate-N/A/day from the top foot under ideal temperature and moisture conditions in the laboratory (Gilley et al., 1995). The sod was 60% brome, 25% orchardgrass, 10% weeds, and 5% legumes. This rate of nitrate production suggests that sufficient N could be available for optimum corn growth, even with no-till if conditions for mineralization were ideal. Results of this study when combined with measured field responses highlights the large impact weather will have on actual N fertilizer needs following CRP.

CURRENT MANAGEMENT GUIDELINES

The following set of guidelines was developed from responses received from scientists when contacted concerning nutrient management following CRP in their states. A special thank you to the following: Anthony Bly, John Doran, Dave Franzen, Ron Gelderman, Ardell Halvorson, Dave

Huggins, Jay Johnson, Doug Karlen, Keith Kelling, Randy Killorn, Ray Lamond, Lloyd Murdock, George Rehm, Alan Schlegel, Charles Shapiro, and Ed Varsa.

Yield goal. Anticipated yield is frequently a factor in determining N needs and is critical in developing an economically sound management plan. It of course needs to be realistic, taking into account the challenges of pest management and surface roughness for the specific field, but should also consider the positive changes that have likely occurred in soil physical properties during the 10 years of sod. In most cases, improvements in surface organic matter, infiltration rate, field water holding capacity, aggregate stability, and air filled porosity are likely. Subsoil properties may have improved in some cases. In more arid areas, depletion of water in the soil profile by the deep-rooted sod may be a negative factor if precipitation is insufficient for profile recharge (Halvorson et al., 1993).

Soil testing. Often the first recommendation for developing CRP land is to soil test (Ebelhar, et al., 1995; Kelling, 1995; Shapiro et al., 1995). After a decade of CRP, the status of immobile nutrients like P, K, or Zinc (Zn) can only be determined with a soil test. Soil test levels will likely be similar to the levels before CRP, however, haying or grazing without fertilization or manuring could cause levels to decline. In some cases, such as calcareous soils of western Nebraska, declines in P or Zn levels may have occurred due to reversion of these nutrients to insoluble forms (Shapiro et al., 1995). Early observations of CRP fields in Illinois indicate fairly low P and K levels (Ebelhar, Univ. of IL, personal com.). Others suggest that P and K levels near the soil surface may have increased substantially during the CRP years due to removal of nutrients from the entire root zone and deposition at the surface (Frye & Murdock, 1995). The only way to know for sure is to soil test.

Liming. If soil tests indicated a need for lime it should be applied before the land is taken out of CRP. For no-till, the lime should be applied as soon as possible using finely ground limestone because it will take several years to move the lime down into the soil(Ebelhar, Univ. of IL, Personal communication). Depth of tillage should always be taken into account when lime needs are estimated. In no-till, assume a 2-inch depth if no cultivation is used for weeds or a 3 inch depth if cultivation is used (Voss & Killorn, 1995).

P and K. Starter P and/or K is often suggested to provide nutrients early in the season when roots may not be able to obtain adequate nutrition from the soil or decaying residues. If a single tillage operation is planned for the first year out of CRP followed by no-till, a single large P or K application to increase soil test levels to the optimum prior to the tillage operation is recommended. If the CRP land is to be no-tilled and P and/or K soil tests are low or very low, band application is recommended (Voss & Killorn, 1995). At higher soil test levels, method of application is less important.

In Ohio, agronomists suggest that soil test based P and K recommendations may need to be adjusted downward to compensate for the contribution of these nutrients from the sod during the first growing season (Louix et al., 1995). They suggest that P and K application during the first year be based on likely crop removal rates and fields retested at the end of the first year.

Inoculation. Soybeans should be inoculated the first time they are grown following CRP.

Nitrogen. The nitrate level in the soil profile shortly after tillage or herbicide application has consistently been low to very low causing starter N to be a common recommendation. Knife applications are often recommended for no-till to reduce immobilization tie up and volatilization losses. Many individuals contributing to this section were uncertain about optimum N rates and greater differences were noted among states than for other aspects. Also, the potential exists for significant regional variation due to soil, cultural and climatic factors. Therefore, N rate guidelines received were summarized in tabular form by state. Several states will be collecting their first yield data from experiments this fall and indicated that their guidelines may be modified and get more specific as more information becomes available.

Table 5. Summary of nutrient management guidelines by state.

State	Guidelines & Observations
IA	Preferred approach is to apply 50 to 67% of the anticipated needed N and use the late spring soil nitrate test to determine additional sidedress need.
IL	Tillage will likely be an important factor influencing N needs. Studies are underway to determine appropriate N recommendations.
KS	N fertilizer needs may be reduced for a year or more especially with conventional tillage.
KT	N rate should be decreased by 50 lb/A for fields coming out of a good sod compared to continuous corn. More N will be released in plowed systems than under no-till.
MN	Production of nitrate may exceed crop N uptake in the latter part of the first growing season. N rate guidelines are not yet available. Soil nitrate test in subsequent years should measure any excess N.
ND	Unless there is a high level of alfalfa in the field, no N credit is given for N mineralization of the CRP residue. Standard recommendations based on soil nitrate levels will be used.
NE	Apply 75-80% of the N rate normally recommended for given crops based on soil organic matter and then monitor the crop or soil to determine if more N is needed. Apply 20 to 40 lb/A of the needed N as a starter.
OH	Up to 50 to 80 lb/A of N may be available for the first year following grass/legume sods.
WI	Since much of the CRP land was seeded with a legume mixture, standard forage N credits are suggested of 40 to 130 lb N/A depending on amount of regrowth at the time of stand death and whether the soil is a sand or a heavier soil. An alternative is to use the presidedress N test to determine the amount of N to sidedress.

STUDIES RELEVANT TO NUTRIENT MANAGEMENT FOLLOWING CRP

The following is an incomplete list of ongoing studies that are relevant to nutrient management following CRP. The individual listed is the contact given for the project. In several cases others are involved in the research.

Kansas State University. Dr. Alan Schlegel (316-376-4761). Evaluation of burning, mowing, tillage and crop in southwest KS. Established spring of 1995.

National Soil Tilth Lab. Dr. Doug Karlen (515-294-3336). Soil N parameters are being monitored following CRP in Southwest IA.

South Dakota State University. Dr. Tom Schumacher (605-688-4762). One study initiated at 2 sites in the summer of 1994 in western SD is comparing tillage and crop rotations following CRP. Soil property changes with time will be monitored. A similar study is being conducted at Morris, MN.

Southern Illinois University. Dr. Ed Varsa. (618-453-2496). Studies at 2 sites in southern Illinois evaluating the need for inoculating soybeans grown in no-till CRP. Includes a comparison of in-furrow lime application.

University of Kentucky. Dr. Lloyd Murdock (502-365-7541). Soil nutrient and organic matter survey of 50 CRP fields where soil test results from samples collected before and after CRP will be compared. A separate study will compare the N mineralized in no-till and conventional-till systems in a CRP field that had been in fescue sod for 8 years.

University of Illinois. Dr. Steve Ebelhar (618-695-2790). Studies are at 4 locations in southern Illinois with 2 sites coming out of tall fescue and 2 coming out of redtop. The treatments compare N rates, sources (including urea + NBPT), and placement for no-till corn. Study was initiated in the spring of 1995. A second study is being conducted on soybean inoculation in cooperation with Southern Illinois University.

University of Minnesota. Dr. Dave Huggins (507-752-7322). Southwestern MN study measuring the nitrate losses through subsurface tile drains following CRP, alfalfa, continuous corn, and corn/soybean rotations. Cropping systems initiated in the spring of 1988 with the CRP treatment plowed in the fall of 1993 and corn grown in 1994. Soil N and biomass measurements are taken through the season. Study is on-going.

University of Nebraska. Dr. Charles Shapiro (402-584-2261). Smooth bromegrass CRP land in northeast Nebraska with several rates of N as UAN either broadcast or knifed. Also evaluating starter P response. Established spring of 1995.

USDA, Mandan, ND. Dr. Don Tanaka (701-667-3010). Study of CRP land near Mandan having tillage and N variables. Initiated in spring of 1995.

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