TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN

AGRONOMY #28
SUBJECT: Preparing the Crop Nutrient Budget
DATE: July 1990

To: All Offices

From: James R. Stacey, State Resource Conservationist

Map Crop History

Take individual soil samples. Record the crop history, manure applications and prior legume crops from each soil mapping unit. Air dry and ship to an ASCS approved laboratory. For fields in conservation tillage 4 years or longer, suggest a sample depth of 0-6 inches for testing.

Soil Test

Begin with the Agricultural Stabilization and Conservation Service's (ASCS) aerial photo, soil survey and field observations to develop a soil sampling map based on old field borders, location to livestock facilities, soil series and past cropping patterns.

Nutrient Budget

Prepare a nutrient budget for each field when the soil test results are received back from the lab. See attached Crop Nutrient Budgets.

Set Yield Goal

Develop a realistic yield goal based on MSU E-550 "Fertilizer Recommendations for Field Crops" or the MSU Fertilizer Program, Version 2.0; soil management groups; county plot data; and farmer records.

Balance Nutrients

Balance the nutrient needs for each crop and credit manure applications as well as legumes grown in rotation. Use one of the Nutrient Budget Worksheets for each field. Build up phosphorus and potassium when less than a high soil test. However, consult MSU E-550 in regards to nutrient placement and maximum starter fertilizer rates for the crop to be grown.

TABLE 1 - DESCRIPTION OF NITROGEN FERTILIZERS AND OTHER MATERIALS

Nitrogen Fertilizer	Chemical Form of Nitrogen %NH_4^+	%NO_3^-	Total %N	Comments
Anhydrous ammonia (NH_3) 82-0-0	100	0	82	A high-pressure liquid that turns into a gas when released. Must be injected 6 to 8 inches deep on friable, moist soil. N loss by volatilization can occur if not properly injected or if soil is too wet or too dry at application.
Urea (NH_2-CO-NH_2) 46-0-0	1/	0	45-46	A dry material in granular or prilled form. Used for direct application, in mixed fertilizers and in liquid nitrogen. N at application is present as urea-N. Within 1 day after application, about 66 percent of urea-N is hydrolyzed to ammonia-N; all within 1 week. When not incorporated, significant N loss by volatilization can occur until approximately 0.5 inch of rain has fall. Not recommended for starter use. Broadcast (incorporated) or sidedress.
Ammonium nitrate (NH_4NO_3) 33-0-0	50	50	33-34	A dry material in granular or prilled form. Used for direct application and in the production of nitrogen solutions (see below). Broadcast or sidedress. Can be left on surface or incorporated into soil.
Nitrogen solutions (UAN) (Urea + NH_4NO_3 + Water) 28%	75 1/	25	28-32	A mixture of ammonium nitrate urea and water. Urea supplies about half of the N that may be subject to volatilization loss - read comments above for urea. The other half of N is supplied by ammonium nitrate - read comments above for ammonium nitrate. Once applied, nitrogen solution behaves exactly like dry urea and ammonium nitrate. To minimize N loss, incorporate into soil as soon as possible after application. Caution should be used when spraying as leaf burn can occur. To minimize injury, do not spray on vegetation. For post-emergence application, use a directed spray or dribble between the rows.
Ammonium sulfate $(NH_4)_2SO_4$ 21-0-0	100	0	21	A dry crystalline material. Produced by two methods - byproduct and synthetic. Used for direct application and blended complete fertilizers. Broadcast or sidedress. Can be left on surface or incorporated into soil. Contains 24% sulfur.
Diammonium phosphate (DAP) $(NH_4)_2HPO_4$ 18-46-0	100	0	18-21	A dry granular or crystalline material. Also contains 46-53% P_2O_5. Common analysis is 18-46-0. Used for direct application and in blended fertilizers. Starter fertilizers containing DAP should be used with caution; be sure to band at least 2 inches to the side and 2 inches below the seed.
Monoammonium phosphate (MAP) $NH_4H_2PO_4$ 11-52-0	100	0	11-13	A dry granular material. Also contains 48-52% P_2O_5. Common analyses are 11-48-0 and 13-52-0. Used for direct application and in blended fertilizers. Makes an excellent starter fertilzer, either alone or with a small amount of potash.
Ammonium polyphosphate (APP) 10-34-0	100	0	10	A liquid solution (10-34-0). Contains 34% P_2O_5. The agronomic effectiveness of APP is similar to that of MAP. Sequesters some micronutrients and impurities in fluid fertilizers, keeping them in solution. Also produced as a solid material (11-55-0) similar to MAP.
	Anaylsis	P_2O_5	K_2O	
Calcium Nitrate	15.5	0	0	-
Triple super phosphate	0	46	0	-
Potash Sources				
Muriate of potash	0	0	60	-
Potassium sulfate	0	0	60	-
Potassium hydroxide	0	0	70	-

1/ Urea-N [illegible]ly hydrolyzes to NH_4^+

TABLE 2 - NITROGEN CONVERSION - APPROXIMATE POUNDS OF MATERIALS REQUIRED PER ACRE TO SUPPLY RATES OF NITROGEN RECOMMENDED PER ACRE

For a Nitrogen Recommendation of ...	Anhydrous Ammonia (82% N)	Ammonium Nitrate (33.5% N)	Ammonium Sulfate (21% N)	Liquid Nitrogen (30% N)	Urea (46% N)
lb/A					
30	37	90	143	100	65
40	49	120	190	133	87
50	61	149	238	167	109
60	73	179	286	200	130
70	85	209	333	233	152
80	98	239	381	267	174
90	110	269	429	300	196
100	122	299	476	333	217
110	134	328	524	367	239
120	146	358	571	400	261
130	158	388	619	433	283
140	171	418	667	467	304
160	195	478	762	533	348
180	220	537	857	600	391
Actual N lb/T	1,640	670	420	600	920

To compare nitrogen costs for these materials, convert the prices to a per-unit-of-actual-nitrogen basis by dividing the price per ton of fertilizer by the pounds of actual nitrogen in a ton of each material 1/. This figure is given at the bottom of the table. Example:

Compare urea at $220 per ton with ammonium nitrate at $175 per ton.
Urea: $220/920 lb N = $0.24 per pound of nitrogen.
Ammonium nitrate: $175/670 lb N = $0.26 per pound of nitrogen.

In this example, urea would be the best buy. Other factors such as suitability of the material, convenience, method of application and other fertilizer properties should also be considered.

1/ Actual N lb/T = 2,000 x N analysis (as a decimal).
Example: Calculation of the pounds of N per ton of 28% liquid nitrogen.
Actual N lb/T = 2,000 x 0.28 = 560 lb N/T.

TABLE 3 - RESIDUAL NITROGEN CONTRIBUTIONS FROM LEGUMES FOR CORN PRODUCTION

Alfalfa	
First year after alfalfa	
50-75% stand	110 lb/ac
25-49% stand	80 lb/ac
Less than 25% stand	40 lb/ac
Second year after alfalfa	
50-75% stand	50 lb/ac
Red Clover and Trefoil	
First year after clover or trefoil	
Greater than 50% stand	100 lb/ac
25-49% stand	70 lb/ac
Less than 25% stand	40 lb/ac
Soybeans	
First year after soybeans harvested for grain	1 lb/bu soybeans

TABLE 4 - TOTAL PLANT NUTRIENT VALUES FROM MANURE

Kind	Manure Daily Production (lb/1000 lb live wt)	Approximate Total Nutrient Content (lb/ton unless otherwise noted)		
		N 1/	P_2O_5	K_2O
Cattle				
Fresh (85% water)	82	10	4	8
Liquid (lb/100 gal)	-	2.75	1.25	2.50
Poultry, layers				
Fresh, wet sticky (75% water)	61	30	20	10
Moist, crumbly to sticky (50% water)	32	40	40	20
Crumbly (30% water)	22	60	55	30
Dry (15% water)	18	100	70	40
Liquid (95% water)	300	10	7	3
Sheep	40	23	8	20
Horses	50	12	5	9
Swine				
Solid	100	14	11	11
Liquid (lb/100 gal)	-	3.5	2	1.5

1/ Important: Only a portion of the total nitrogen is available to crops in the year in which it is applied. The actual amount available depends on handling (see Table 5).

TABLE 5 - NITROGEN AVAILABILITY FROM MANURE

Application Method	N Availability Factor 1/		% Potential Loss of Available N	
	Poultry	Other	Poultry	Other
Immediate incorporation	0.75	0.50	0	0
Incorporation after 2 days	0.45	0.35	40	30
Incorporation after 4 days	0.30	0.30	60	40
Incorporation after 7 days or no corportaion	0.15	0.20	80	60
Previous fall	0.15	0.20	80	60
One year ago	0.03	0.06	-	-
Two years ago	0.01	0.02	-	-

1/ Use these factors and total nitrogen values from Table 4 or a manure analysis to calculate available nitrogen as follows:
Available N = (total N) x (N availability factor).

NUTRIENT BUDGET EXAMPLES

PROBLEM: 20 acre field with soil mapping as follows from soil survey:

Soil	Soil Management Group	Soil Sample	Acres
Ph - Parkhill loam	2.5c	1A	5
CAc - Capac loam	2.5b	1B	13

Prepare Crop Nutrient Budget - Example 1: Without Legume or Manure

Example: Partial Copy of Soil Test Report

Field Number 1 - from MSU or other lab test results

Crop	Soil Sample	Acres	Yield Goal bu/ac	Soil Test Results P	K	pH	Soil Management Group
C	1A	5	160	80	250	6.8	2.5c
C	1B	13	160	60	200	6.5	2.5b

Soil fertility recommendations - Use MSU Fertilizer Program, Version 2.0

Sample	Lime	N	P_2O_5	K_2O	Mg	S	Zn	Mn	Fe	Cu	B
1A	0	200	20	40							
1B	0	200	50	100							

Prepare a fertilizer program to match soil fertility recommendations.

Sample	FERTILIZER PLAN Fertilizer Material	Needs	NUTRIENT BUDGET FROM FERTILIZER PROGRAM N	P_2O_5	K_2O
1A	11-52-0	50 lbs	6	26	0
	0-0-60	100 lbs	0	0	60
	46-0-0	50 lbs	23	0	0
	82-0-0	200 lbs	164		
		Totals -	193	26	60
	From MSU Fertilizer Program Needs -		200	20	40
1B	11-52-0	100 lbs	11	52	0
	0-0-60	200 lbs	0	0	120
	46-0-0	50 lbs	23	0	0
	82-0-0	200 lbs	164		
		Totals -	198	52	120
	From MSU Fertilizer Program Needs -		200	50	120

Problem: Two different potash rates. Two different phosphate rates of fertilizer needed in the same field. What starter do you use?

Since 1B needs more phosphate and potash, use a starter fertilizer that meets the needs of 1A. Broadcast the balance of potash and phosphate to meet crop needs.

For example, farmer would use:

200 lbs 15-13-30 starter - 20 acres
Total nutrients - 30 lbs N, 26 lbs phosphate, 60 lbs potash
Additional nutrients needed for 1B

Calculate needed phosphate - 52 - 26 = 26 lbs P_2O_5
Calculate needed potash - 120 - 60 = 60 lbs K_2O

		N	P_2O_5	K_2O/ac
Broadcast -	50 lbs 11-52-0	6	26	0
	+ 100 lbs 0-0-60	0	0	60

OR

Broadcast - 150 lbs 8-17-40 on 13 acres

Crop Nutrient Budget - Example 2: With Legumes

Corn first year after alfalfa less than 25 percent stand (From: Table 3 - Residual Nitrogen Contribution from Legumes for Corn Production)

N credit - 40 lbs/ac

From previous example - 200 lbs
- 40 lbs credit for alfalfa
160 lbs total need

Solution: Drop urea from starter. Use 50 lbs MAP (11-52-0) and 100 lbs muriate of potash (0-0-60). This gives a starter analysis of 150 lbs/ac of 4-18-40.

Total N before anhydrous: 6 lbs from 4-18-40 plus 40 lbs from alfalfa equals 46 lbs/ac. Total N need 200 lbs - 46 = 154 as anhydrous ammonia or 190 lbs - 82-0-0 sidedress. Follow same fertilizer program. Broadcast on 1B as in Example 1, except would use less starter and less anhydrous sidedress on whole field.

Crop Nutrient Budget - Example 3: With Manure

Corn after corn with 1,000 gal. liquid cattle manure (From Table 4 - Total Plant Nutrient Values from Manure or Lab Analysis).

Nutrient Credits lbs/ac	N	P_2O_5	K_2O	
1,000 gal manure/ac	27.5	12.5	25	Total Nutrients

Nitrogen availability from manure: (Table 5)

Application Method Immediate
N availability factor 50%
N credit 14 lbs/ac Calculation: (28 x 0.50 = 14)

FERTILIZER RECOMMENTATIONS

	N	P_2O_5	K_2O
1A	200	20	40
less manure credit	- 14	- 13	- 25
Total fertilizer needs	- 186	7	15
1B	200	50	100
less manure credit	- 14	- 13	- 25
Total fertilizer needs	- 186	37	75

Sample 1A

Starter needs 7 lbs P_2O_5; how much 11-52-0 will it take?

$$\frac{7 \text{ lbs}}{x} P_2O_5 : \frac{52 \text{ lbs}}{100 \text{ lbs}} P_2O_5 = x = 13.5 \text{ lbs/ac}$$

Use 15 lbs/ac 11-52-0 (MAP)

How much potash (0-0-60) will it take?

$$\frac{15 \text{ lbs}}{x} = \frac{60}{100} \qquad x = 25 \text{ lbs/ac}$$

Use 25 lbs/ac (0-0-60) muriate of potash

The blend starter would require 15 lbs of 11-52-0 and 25 lbs of potash, or a total of 40 lbs fertilizer. However, many planters will apply a minimum of 100 lbs per acre. Therefore, this blend could be adjusted by adding more potash or nitrogen material to get a 100 lb mixture. This should be credited in the nitogen portion of the nutrient budget.

Use urea - 60 lbs/ac for a total of 100 lbs starter.
lbs of N = 60 x 46 = 27.6 or 28 lbs N/ac.

Sample 2B - Nutrient Budget With Manure Credit

	N	P_2O_5	K_2O	
Crop needs	200	50	100	
Less manure credit	- 14	- 13	- 25	Adjust nitrogen via Table 5
less starter 1A				
60 lbs urea	- 28			
15 lbs 11-52-0	- 2	- 8		
40 lbs 0-0-60			- 24	
Sample 2B needs	156	29	51	

Calculate additional P_2O_5 to be broadcast:

How much 18-46-0? $\frac{29}{x} : \frac{46}{100}$ $x = 63$

Apply 65 lbs 18-46-0/ac

How much 0-0-60 - $\frac{51}{x} : \frac{60}{100}$ $x = 85$

Apply 85 lbs 0-0-60/ac

These are mixed into a blend of 65 lbs DAP and 85 lbs of potash. Broadcast 150 lbs of fertilizer to Sample 1B area. For field 1 - 100 lbs of starter fertilizer 30-8-24 would be used through the planter and 1,000 gal. liquid manure is injected or broadcast. An additional 156 lbs of nitogen is needed. See MSU Extension Bulletin WQ 25, Nutrient Management to Protect Water Quality, for guidance or application timing based on soil type and crop needs. Calculate and credit available nitrogen based on nitrate testing or Tables 4 and 5 in this technical note or the agricultural waste bulletins or manuals available to you.

References:

Pennsylvania State Agronomy Guide, Fertility Section, Pennsylvania State University, Cooperative Extension Publication.

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