Reprinted January, 1959 Extension Bulletin 357

Fertilizers for Ohio Farms

1. The Ohio Soil Testing Service
2. Fertilizer Grades and Ratios
3. Equivalent Amounts of Nutrients
4. Building Fertility Reserves
5. Liquid Fertilizers
6. Trace Elements

General Recommendations For:

7. Corn
8. Small Grains
9. Soybeans
10. Sugar Beets
11. Tomatoes
12. Tobacco
13. Legumes-Grass
14. Permanent Pastures

By Orlo L. Musgrave and George R. Gist
Extension Agronomists, The Ohio State University

High crop yields and efficient production bring the highest farm incomes. However, high yielding crops require large amounts of plant nutrients, which must be supplied, in proper balance, from the soil or from commercial fertilizers. Soil tests measure the nutrients available in the soil and serve as the farmer's best guide to profitable use of commercial fertilizers.

Soil fertility is only one of the factors which limit crop yields. The availability of nutrients to plants is affected by soil tilth, degree of acidity or alkalinity, organic matter, drainage and moisture. High yields are possible only where adequate fertility and good soil management are accompanied by recommended crop production practices such as the use of adapted varieties or hybrids, planting at proper dates and rates, adequate weed control and timely harvesting. Other good management practices, including erosion control and the use of adapted crop rotations, are also essential to high crop yields.

This bulletin contains general recommendations. Farmers desiring exceptionally high crop yields should fertilize at rates higher than those suggested. Where crop production is limited by factors such as poor tilth, poor drainage, excess soil acidity, or lack of moisture, yield response to fertilizers will be less than under optimum conditions.

Fertilizer recommendations for a specific field and crop situation should be based on soil tests. Therefore, where the recommendations given in this bulletin and those based on soil tests are different the recommendations based on soil tests should be followed.

1/59—10M

The Ohio State University and the U. S. Department of Agriculture cooperating
Agricultural Extension Service, W. B. Wood, Director, Columbus, 10, Ohio
Printed and distributed in furtherance of acts of May 8 and June 30, 1914

1. The Ohio Soil Testing Service

Farm soils change constantly. Plant nutrients are removed in harvested crops and lost by leaching; others become available from the soil and are added from manure or fertilizers. Lime is lost by leaching and used by growing crops.

A soil test is the best means of determining the plant nutrient, lime, and organic matter level of soils. Such tests furnish a sound basis for soil building and crop fertilization programs.

The Agricultural Extension Service, in cooperation with the Agronomy department of The Ohio State University, operates the Ohio soil testing laboratory. Its services are available through the County Agricultural Extension Office in each Ohio county, in some counties through the Agricultural Conservation and Stabilization committee, and through some lime and fertilizer dealers.

The soil testing laboratory is very busy just before planting time and reports may thus be delayed. Therefore, soil samples should be taken well in advance of the time of ordering fertilizers.

The sampling procedure is highly important. Soil samples should correctly represent the area to be tested. Directions for taking soil samples are available at all County Extension offices.

Most soil samples receive the "standard" group of tests. This standard group includes determinations of pH, lime requirement, available phosphorus and potassium, organic matter content, soil color and texture.

The report of each soil test includes the results of the laboratory tests and recommendations for lime and for the fertilization of each crop in the rotation.

A second group of tests, known as the "optional" or "trace element" tests, may be secured. The optional group includes determination of the soil content of magnesium, manganese and boron.

The third group of tests is the "greenhouse" group. This group includes tests for nitrates and soluble salts. There is a small fee for each of these tests.

2. Fertilizer Grades and Ratios

The plant nutrient content of commercial fertilizer is shown by a series of numbers—the fertilizer grade. These numbers indicate the guaranteed analysis of nitrogen (N), phosphate (P_2O_5) and potash (K_2O) in the fertilizer. For example, a 4–16–16 grade of fertilizer contains 4 pounds of nitrogen, 16 pounds of phosphate and 16 pounds of potash in each 100 pounds of the fertilizer material. This 4–16–16 grade is a 1–4–4 ratio, which means that it contains 1 unit of nitrogen to each 4 units of phosphate and 4 units of potash.

Fertilizer ratios and minimum grades recommended for use in Ohio:

Ratios	Minimum Grades
0–1–1	0–20–20
0–1–3	0–10–30
0–2–1	0–20–10
1–1–1	10–10–10
1–4–2	4–16– 8
1–4–4	4–16–16
1–3–6	3– 9–18
1–2–2	6–12–12
1–2–3	5–10–15
2–1–1	14– 7– 7
1–4–0	8–32– 0

The cost per unit of plant food is often less in high than in low analysis fertilizers. Therefore, the use of high analysis fertilizers often results in decreased fertilizer costs.

3. Equivalent Amounts of Nutrients in Various Fertilizer Grades

The fertilizer grades recommended on soil test reports are the minimum grades recommended for use in Ohio. It may be desirable to use other grades when the grade recommended is not readily obtainable or when the same amount of nutrients can be purchased more cheaply in other grades. The following tables of equivalent materials should be used to determine the amounts of alternate grades to be used.

Minimum Recommended Grade	Higher Analysis Grades		Below Minimum Recommended Grade
4–16–16	**5–20–20**	**6–24–24**	**3–12–12**
	Equivalent Amounts—Pounds		
300	240	200	400
350	280	233	466
400	320	266	533
450	360	300	600
6–12–12	**8–16–16**	**10–20–20**	**5–10–10**
200	150	120	240
250	187	150	300
300	225	180	360
350	265	210	420
400	300	240	480
10–10–10	**12–12–12**	**14–14–14**	**8–8–8**
200	166	143	250
250	208	178	312
300	250	213	375
350	293	250	437
400	332	286	500

Minimum Recommended Grade	Higher Analysis Grades	Equivalent Nutrients from other grades
4–16–8	6–24–12	5–20–10	6–12–12 + 0–20–0
300	200	240	200 + 120
350	233	280	233 + 140
400	266	320	266 + 160
450	300	360	300 + 180

4. Building Fertility Reserves in the Soil

When soil tests reveal low levels of available phosphate and/or potash in the soil, these levels should be raised.

Phosphate can be stored in the soil with little loss except by removal in harvested crops. Potash also can be stored in most soils without serious loss from leaching; however, it may be lost by leaching from sandy soils. When potash levels are high, legume crops take up more potash than is needed for maximum growth; most of this potash is recovered in manure when the legumes are fed to livestock on the farm.

Maintaining soil fertility at medium or higher levels is a desirable long-term soil fertility program. It sets the stage for high yields and the use of labor saving practices in fertilizer usage. Continued high crop yields are most certain when soils contain abundant, well-balanced supplies of available phosphate and potash. With high levels of phosphate and potash in the soil, smaller amounts of starter fertilizers are needed at the time of planting each crop.

Nitrogen may be lost by leaching; therefore, nitrogen fertilizers should be applied on an annual basis. Nitrogen can be stored in the soil for long periods of time when it is combined in organic matter. Organic matter releases nitrogen as it decomposes. Nitrogen from commercial fertilizers has its greatest effect within the growing season of its application.

Levels of phosphate and potash in the soil may be raised and brought into proper balance by either of two plans:

1) For a gradual build-up, apply each year more of the deficient element than is removed by the growing crop.
2) For a rapid build-up, make large applications of the deficient element once or twice during each rotation, and follow with maintenance fertilization for each crop in the rotation.

Example A. A four year rotation on a soil very low in both phosphate and potash:

Plan 1

Crop	Fertilizer Lbs.	Fertilizer Grade	Phosphate Lbs.	Potash Lbs.
Corn	300	4–16–16	48	48
Wheat	450	4–16–16	72	72
Meadow (1st yr.)	350	0–20–20	70	70
Meadow (2nd yr.)	400	0–20–20	80	80
TOTAL for rotation			270	270

Plan 2

Crop	Fertilizer Lbs.	Fertilizer Grade	Phosphate Lbs.	Potash Lbs.
Build-up application	700	0–20–20	140	140
Corn	150	4–16–16	24	24
Wheat	200	4–16–16	32	32
Meadow (1st yr.)	200	0–20–20	40	40
Meadow (2nd yr.)	200	0–20–20	40	40
TOTAL for rotation			276	276

In Plan 2, the build-up application may be made all at one time or may be made in two smaller applications. For example, 700 pounds of 0–20–20 may be plowed down for corn, or 300 pounds may be plowed down for corn and the remaining 400 pounds applied at wheat seeding time or after wheat harvest. Fertilizer for the meadow may be applied in one 400 pound application or in two 200 pound applications.

Example B. A four year rotation on a soil very low in phosphate and high in potash.

Plan 1

Crop	Fertilizer Lbs.	Fertilizer Grade	Phosphate Lbs.	Potash Lbs.
Corn	300	4–16– 8	48	24
Wheat	450	4–16– 8	72	36
Meadow (1st yr.)	350	0–20– 0	70	0
Meadow (2nd yr.)	400	0–20–10	80	40
TOTAL for rotation			270	100

Plan 2

Crop	Fertilizer Lbs.	Fertilizer Grade	Phosphate Lbs.	Potash Lbs.
Build-up application	900	0–20– 0	180	0
Corn	150	4–16–16	24	24
Wheat	200	4–16–16	32	32
Meadow (1st or 2nd yr.)	200	0–20–20	40	40
TOTAL for rotation			276	96

In plan 2, the build-up application may be made all at one time or may be made in two smaller applications. For example, 900 pounds of 0–20–0 may be plowed down for corn, or 400 pounds may be plowed down for corn and the remaining 500 pounds applied on wheat or on the meadow.

5. Liquid Fertilizers

Several kinds of liquid fertilizer are manufactured and sold in Ohio. These include nitrogen solutions and complete liquid fertilizers. Liquid fertilizers may supply a major part of the plant food needs of the crop or may be used to supplement other fertilizers as in the use of starter solutions for tomatoes, and other horticultural or special crops.

Liquid fertilizers may be used in place of dry fertilizers. The same number of pounds of each plant nutrient should be applied per acre whether liquid or dry fertilizers are used. Foliar applications of liquid fertilizers on field crops are not recommended.

6. Trace Elements

With the exception of manganese, most Ohio soils contain sufficient amounts of the trace elements for good crop growth. Manganese deficiencies are most prevalent on the lake bed soils of northwestern Ohio. The deficiencies are spotty on the sandy soils and are more widespread on the heavy soils of this area.

Manganese deficiencies are most frequently detected in soybeans; however, deficiencies may occur in other crops including oats, wheat and alfalfa.

The common manganese deficiency symptoms in soybeans are light green to yellow leaves with distinctly green veins. In severe cases, brown spots appear on the leaves, and the leaves drop prematurely.

Manganese deficiencies may be corrected by spraying the foliage with manganese sulfate. The recommended application is 5 to 10 pounds of spray-grade manganese sulfate per acre in 10 to 20 gallons of water. The spray should be applied as soon as leaf discolorations appear.

General Fertilizer Recommendations for Major Field Crops

(To be followed when soil tests have not been made)

In the following sections, general fertilizer recommendations are made for two soil fertility conditions. These are: 1) high levels of soil nitrogen, phosphate and potash; and 2) low levels of soil nitrogen, phosphate and potash. These two conditions are the extremes; many others also occur. For example, a soil may be high in potash and low in phosphate; in this situation, fertilizers such as 4–16–8 and 0–20–10 should be used. If a soil is low in potash and high in phosphate, fertilizers such as 3–9–18 and 0–10–30 would be best.

The relative levels of soil phosphate and potash are revealed by soil tests. Without tests it is difficult to determine which is present in the greatest relative amount. Therefore, only fertilizer grades containing equal quantities of phosphate and potash are included in the general recommendations.

7. Corn

Following a legume sod—green manure or meadow:

	SOILS HIGH in Nitrogen, Phosphate and Potash				SOILS LOW in Nitrogen, Phosphate and Potash			
	USE	TO SUPPLY			USE	TO SUPPLY		
	Fertilizer* Lbs./A	Grade	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Fertilizer* Lbs./A	Grade	Nitrogen N	Phosphate P_2O_5	Potash K_2O
In row	250	6–12–12	15	30	30	300	4–16–16	12	48	48
Broadcast	None		0	0	0		Nitrogen Materials	30	0	0
TOTAL			15	30	30			42	48	48

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

Following corn, soybeans, small grain or grass sod:

	SOILS HIGH in Nitrogen, Phosphate and Potash					SOILS LOW in Nitrogen, Phosphate and Potash				
	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
In row	250	6–12–12	15	30	30	300	4–16–16	12	48	48
Broadcast		Nitrogen Materials	55	0	0		Nitrogen Materials	90	0	0
TOTAL			70	30	30			102	48	48

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

Fertilizer Placement—Germinating corn may be seriously damaged or killed when too much fertilizer is placed too close to the germinating seed. Fertilizer injury results in poor stands of corn and uneven growth of the young plants. The injury is greater in dry than in wet seasons. For best results, fertilizer for corn should be drilled in bands 2 inches to the side and slightly below the seed. In no case should the fertilizer come into direct contact with the seed. Improper planter adjustment or excessive ground speed may result in the placement of fertilizer too close to the seed. Corn planters should be checked in the field to be sure the proper fertilizer placement is obtained. With proper placement, a total of 60 pounds per acre of nitrogen and/or potash may safely be applied at planting time (300 pounds of a 4–16–16 fertilizer contains 12 pounds of nitrogen and 48 pounds of potash—a total of 60 pounds of the two materials). Hill applications of fertilizer should not exceed 25 pounds of nitrogen and potash.

When the amount of fertilizer, which can safely be applied in the row, is not sufficient to achieve the desired yields, supplementary fertilizer should be plowed down prior to planting.

Supplemental Nitrogen—Nitrogen should be broadcast before plowing, or sidedressed when corn is 6 to 12 inches high. Deep sidedressing close to the corn will damage corn roots and may reduce yields.

Rate of Planting—Corn planting rates should be adjusted to the soil fertility level and yield goal.

Yield Goal Bu. per acre	PLANTING RATE Kernels per acre	Distance between kernels in 40 inch rows
95 or higher	19,600	8 inches
70–90	15,680	10 inches

8. Small Grains

	SOILS HIGH in Nitrogen, Phosphate and Potash					SOILS LOW in Nitrogen, Phosphate and Potash				
	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
Forage crop seeded in the grain	300	6–12–12	18	36	36	450	4–16–16	18	72	72
Without forage seeding	200†	6–12–12	12	24	24	350	10–10–10	35	35	35

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.
† Where lodging is not a factor 250 pounds of 10–10–10 in place of 200 pounds of 6–12–12 is recommended.

Wheat—Wheat which is making poor growth in the spring will often give a profitable response to supplementary nitrogen. Extra nitrogen is most likely to be needed on the less productive soils and where wheat is seeded late, following corn or soybeans.

When needed, 20 to 30 pounds of nitrogen per acre should be broadcast during March in southern Ohio, and between March 15 and April 15 in northern Ohio. When fall fertilization of wheat was less than recommended, 200 or 300 pounds per acre of 10–10–10 should be used to supply supplemental nitrogen, plus additional phosphate and potash.

On productive soils, too much nitrogen will cause wheat to lodge. Where lodging may be expected, supplemental nitrogen should not be applied. On highly productive soils where wheat is likely to lodge, an 0–20–20 or 0–20–10 analysis should be used.

Winter Barley—Fertility requirements of barley are similar to those of wheat, and the fertilizer recommendations for wheat apply to winter barley. Barley is, however, more susceptible to lodging than wheat, and extra nitrogen should be applied only where its need is clearly indicated and where lodging is not expected.

Oats—On soils very low in nitrogen and organic matter, oats may give a profitable response to more nitrogen than is suggested in the general recommendations. Where oats follow corn, with corn stalks disked or plowed down, an additional 20 to 30 pounds of nitrogen per acre should be applied. This extra nitrogen may be supplied from applications of 10–10–10 or other high-nitrogen complete fertilizers or from straight nitrogen materials.

As with winter wheat and barley, too much nitrogen may cause oats to lodge, thus reducing the harvested yield and damaging the meadow seedings.

9. Soybeans

SOILS HIGH in Nitrogen, Phosphate and Potash				SOILS LOW in Nitrogen, Phosphate and Potash			
USE Fertilizer* Lbs./A Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
None	0	0	0	200 0–20–20	0	40	40

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

Soybeans grown on soils low in phosphate and/or potash generally respond to fertilizers containing these nutrients. However, soybeans grown on soils medium or high in phosphate and potash often do not respond to fertilizer treatment. In general, soybeans give less response to direct fertilization than do other major field crops.

On high fertility soils where manganese deficiencies have been observed, a row application of 100 to 200 pounds per acre of 0–20–0 is suggested. Where the manganese deficiency is slight, this phosphate application often prevents the appearance of a manganese deficiency in soybeans. If manganese deficiency symptoms do appear, 5 to 10 pounds of spray-grade manganese sulfate per acre in 10 to 20 gallons of water, applied to foliage, is recommended.

10. Sugar Beets

Following a legume sod—green manure or meadow:

	SOILS HIGH in Nitrogen, Phosphate and Potash				SOILS LOW in Nitrogen, Phosphate and Potash			
	USE Fertilizer* Lbs./A Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
In row	300 6–12–12	18	36	36	400 4–16–16	16	64	64
Broadcast	Nitrogen Materials	20	0	0	Nitrogen Materials	40	0	0
TOTAL		38	36	36		56	64	64

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

Following corn, soybeans, small grain or grass sod:

	SOILS HIGH in Nitrogen, Phosphate and Potash				SOILS LOW in Nitrogen, Phosphate and Potash			
	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
In row	300	6–12–12	18	36	36	400	4–16–16	16	64	64
Broadcast		Nitrogen Materials	60	0	0		Nitrogen Materials	100	0	0
TOTAL			78	36	36			116	64	64

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

For maximum yield, sugar beets require a fertile soil with greater than average water-holding capacity, a granular texture and a pH of not less than 6.5. Soils possessing these characteristics are the dark colored clays, clay loams, silty clay loams and loams. The best place for beets in the rotation is following a 2-year-old grass-legume sod.

11. Tomatoes

An application of 600 to 1200 pounds of fertilizer per acre should be plowed down or disked into the soil after plowing. On highly fertile soils or where legumes have been grown regularly, a 4–16–16 or similar analysis fertilizer should be used. A 6–12–12 or similar grade fertilizer is recommended for light colored soils where few legumes have been grown or where no manure has been applied. On light colored soils where corn stalks, straw or other low nitrogen materials are plowed under, 500 to 700 pounds of 10–10–10 per acre are suggested. Maximum applications are recommended only for soils in good tilth.

Nitrogen sidedressing is not generally recommended. However, on sandy or light colored soils, 20 to 30 pounds of nitrogen per acre, applied at the last cultivation, may give a profitable response.

For direct seeded tomatoes, the recommended application is 200 pounds of 0–20–20, 4–16–16 or a similar grade fertilizer in the row, two inches below the seed. When transplanting, a high phosphate fertilizer such as 10–52–17, 13–26–13, 15–30–15 or similar grade should be used in the transplanter water.

12. Tobacco

Fertilizer for tobacco should range from 600 to 1400 pounds of 5–10–15 plus 20 to 40 pounds of nitrogen per acre. Up to 600 pounds per acre of 5–10–15 can safely be banded in the row.

The potash in tobacco fertilizers should be predominantly in the sulfate form.

For continuous tobacco, the green manure crop should receive 200 pounds of 4–16–16, 4–16–8 or 3–9–18. An application of 8 to 10 tons of well-rotted manure is advisable, particularly on soils low in organic matter.

Tobacco needs about 120 pounds of nitrogen per acre for good growth. Part of this can be supplied by plowing down manure and a legume sod. Generally, 60 to 100 pounds of commercial nitrogen should be applied, depending upon the quality of the manure and legume sod. Nitrogen should be applied to the green manure or sod crop just before plowing.

13. Legume-Grass Mixtures

For meadow or rotation pasture:

	SOILS HIGH in Nitrogen, Phosphate and Potash					SOILS LOW in Nitrogen, Phosphate and Potash				
	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
Seeding with small grain companion crop	300	6–12–12	18	36	36	450	4–16–16	18	72	72
Seeding without small grain companion crop	225	4–16–16	9	36	36	450	4–16–16	18	72	72
Maintenance										
First year (broadcast)	None		0	0	0	350	0–20–20	0	70	70
Each succeeding year (broadcast)	200	0–20–20†	0	40	40	400	0–20–20	0	80	80

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.
† or 400 pounds 0-20-20 every 2 years.

Meadows and rotation pastures may be topdressed during the fall, early spring or following any harvest. Adequate fertilization and proper management are essential to the maintenance of legume stands.

Meadows containing less than 30 percent legumes should be topdressed during the fall or early spring with 60 to 80 pounds of nitrogen. This nitrogen may be obtained from a 10–10–10 or similar analysis fertilizer or from straight nitrogen fertilizers.

Seedings in wheat, winter barley or rye—On soils very low in phosphate seedings in wheat, winter barley or rye are often benefited by applications of extra phosphate fertilizer at the time of making the seeding. The recommended application is 200 pounds of 0–20–0 or 125 pounds of 0–20–20 or 0–20–10 per acre with the legume seed. The amount of potash applied with the legume seed should not exceed 25 pounds per acre.

Band seeding—Band seeding is recommended for seedings with oats and those made without a companion grain crop. In order to band seed, the hose or tubes from the seed box should be so arranged that the legume seeds fall 10 to 12 inches behind the disks and directly over the band of fertilizer. Nothing is gained if the legume seed falls one-half inch or more to one side of the fertilizer band.

14. Permanent Pasture

(Bluegrass—White clover)

	SOILS HIGH in Phosphate and Potash					SOILS LOW in Phosphate and High in Potash				
	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O	USE Fertilizer* Lbs./A	Grade	TO SUPPLY Nitrogen N	Phosphate P_2O_5	Potash K_2O
Apply every 2 or 3 years	200	0–20–20	0	40	40	500	0–20– 0	0	100	0

* The fertilizer grades listed in this table are the minimum grades recommended for use in Ohio. See Section 3 for equivalent amounts of other fertilizer grades.

An application of 40 to 60 pounds per acre of nitrogen on fair to good sods will advance early spring grazing by 2 weeks and will greatly increase spring growth. This application may be made in the fall or early spring. The acreage treated should not exceed one-third acre for each cow to be grazed. Where all fertilizer nutrients are needed, an application of 500 pounds per acre of 10–10–10 or 14–7–7 is suggested.

Acknowledgement: The following members of the Extension staff in agronomy, Earl Jones, Everett Reed, Gordon Ryder, Harold Shoemaker and John A. Slipher, and staff members of the Agronomy department of Ohio State University and the Ohio Agricultural Experiment Station gave valuable assistance in the preparation of this bulletin.