GROWING MORE by Knowing More
Customer Name: PROGRESSIVE FARMER
Farm Name: HOME FARM
Field Name: ALL
Field Code: GMR32NW
Sampled: Summer 2012
Field Acres: 100.60 acres
Acres per Sample: 24
Soil Types

Land Capability Class/Subclass
- 1
- 2E
- 2S
- 2W
- 3E
- 3S
- 3W
- 4E
- 4S
- 4W
- 5E
- 5S
- 5W
- Other

GMR32NW

Acres by Soil Type

- 2656 Rockton: 30.51 acres
- 2658 Rockton: 28.53 acres
- 4726 Charbonneau: 17.90 acres
- 24 Kasson: 10.82 acres
- 3408 Whalen: 5.96 acres
- 4918 Waucoma: 3.35 acres
- 23 Skyberg: 1.37 acres
- 19 Chaseburg: 0.07 acres
- 4730 Dornet: 0.75 acres
Soil Types

Soils in Minnesota vary greatly in their capabilities to produce a given crop. The soil type map and classification table on the adjoining page was generated using the Land Capability Classification from the NRCS. It shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations for field crops, and the way they respond to management. In the capability classification system, soils are generally grouped at three levels - capability class, subclass, and unit.

Capability class, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use.

Capability subclass categories are soil groups within one class that provide information as to the kind of conservation problem or limitations involved with a soil. The subclass indicates the main limitation within a capability class. There are no subclasses in Class 1 soils because they have few limitations. The four kinds of limitations recognized at the subclass level are:

- (e); erodible
- (w); excess water
- (s); shallow or other soil limitations within the rooting zone
- (c); climatic limitation

Capability units are groups within a subclass. The soils in a capability unit are alike enough to be suited for the same crops, require similar management, and to have similar productivity.
Crop Productivity Index

Summary

56.45 is the weighted average CPI value. Field is 100.60 acres in size.

Crop productivity index ratings from the Natural Resources Conservation Service provide a relative ranking of soils based on their potential for intensive crop production.

An index can be used to rate the potential yield of one soil against that of another over a period of time. Ratings range from 0 to 100. The higher numbers indicate higher production potential.
Crop Productivity Index (CPI)

The Crop Productivity Index (CPI) is an index developed by the Natural Resources Conservation Service to be used to rate different kinds of soil for their potential row crop productivity. The ratings are based on physical and chemical properties of the soil. Slope characteristics are also major factors that determine how land should be used. Slope gradient and slope length affect potential erosion rates, water infiltration, and ease and efficiency of machine operation. CPI ratings do not take into account climatic factors, such as differences in precipitation or growing degree days.

The CPI provides a relative ranking of all soils mapped in the state of Minnesota on their potential to be utilized for intensive crop production. This index can be used to rate one soil's potential yield production against another over a period of time. The rating is not crop-specific.

The CPI considers average weather conditions as well as the frequency of use of soil in the production of row crops. Ratings range from 0 to 100. A rating of 100 indicates the soil has no physical limitations, occur on minimal slopes, and can be continuously row-cropped. A rating as low as 5 is for soils with severe limitations for row crops.

When the soils are rated, the CPI assumes:

(a) adequate management

(b) natural weather conditions (no irrigation)

(c) artificial drainage where required

(d) no frequent flooding on the lower lying soils

(e) no land leveling or terracing.

Although predicted yields are expected to change with time, the CPI for different soils is expected to remain relatively constant in relation to one another. CPIs can be used to quantify the productivity potential for individual fields, farms or larger tracts of land.
185.2 bu/acre is the average yield goal set for this field. Due to uncontrollable factors these yields can not be guaranteed. The production goal for this field is 18,627 total bushels of Corn.
Corn Yield Goals

The GrowMor program uses soil productivity and grid sampling to generate the best possible recommendation for crop's nutrient needs. Not all areas of a given field are capable of producing the same yield, therefore yield goals are assigned by productivity and recommendations are made accordingly.

The state of Minnesota has converted the soil survey data into a digital format allowing it to be used with the GrowMor program. This digitized data will be used to predict productivity for each soil type in the field.

Corn yield is measured in bushels per acre. The yield estimate for each soil type is based on; parent material, slope class, erosion class, and natural drainage class. Another influencing factor is the nature of the subsoil in terms of rooting environment. This includes subsoil depth, limiting layers, and plant available water capacity. The potential for periodic flooding and weather conditions are also factored in.

Even though it is difficult to predict yield goals from year to year, long-term averages will give definitive trends in productivity. The historical corn yields for each soil type are taken from the Soil Survey Geographic (SSURGO) Database that is established through the NRCS. With the help of your Progressive Ag Center agronomist, this yield layer may be adjusted to meet your specific field goals. These yield goals, defined by soil type, along with any adjustments that you might have made, are the base for productivity for each field and are used for determining nutrient applications.

Along with matching plant nutrition needs to specific areas of the field to maximize productivity, it is also very important to match specific hybrids to the field situation in which the hybrid will be planted. For example, soils that tend to be wet may require a completely different hybrid compared to a soil where a very high soil fertility level exists.
44.7 bu/acre is the average yield goal set for this field. Due to uncontrollable factors these yields cannot be guaranteed. The production goal for this field is 4,500 total bushels of Soybeans.
Soybean Yield Goals

Producers continually strive for higher yielding soybeans. High yielding soybeans are achieved through improved varieties and targeted management decisions. Agronomic decisions are critical since soybeans are very sensitive to stresses that can influence plant growth, nodule development, flowering and yield.

Soybean yield goals are derived much in the same way as the corn yield potential. Soybeans do tend to have more sensitivity to soil characteristics, such as internal drainage, high pH, and shallow topsoil. The soil parent material and our location in the state are also considered in these yield calculations. Like corn, these soybean yield goals can be adjusted to match your field's unique situation.

Another important test to consider is a Soybean Cyst Nematode (SCN) test. SCN is the most destructive pathogen of soybeans in the United States. First detected in 1978 in Minnesota, it is now found throughout the majority of the soybean producing areas of the state.

Factors to consider when adding an SCN Test include:

- SCN may cause 15-30% yield loss without any above ground symptoms
- SCN may take several soybean rotations to build up before it becomes a problem; therefore early detection is key for management
- There is no way to eliminate SCN once it is present. Instead, SCN management may help prevent spreading from field to field. Testing is a key component in this management strategy
Soil pH Test Levels

Statistics

MIN. 4.9
AVG. 6.2
MAX. 7.6
Soil pH

Soil pH is the measurement of positively charged hydrogen ion concentration in the soil solution. Soil pH can have a major impact on crop production and should be one of the first areas addressed if amendments are needed. Soil pH is the measure of how alkaline or acid a soil is. A pH <7 is considered acidic and a pH >7 is considered alkaline. Acid soils can be corrected by using aglime to reduce their acidity. Alkaline soils with a pH higher than 7.5 can be challenging due to their ability to tie up nutrients in forms unavailable to plants. These soils are very difficult to practically treat and it is usually not economically feasible to lower soil pH. The soils in our area range anywhere from 5.0 to 8.0 with some exceptions on either side. Soil pH in the range of 6.5-7.0 is best for corn, soybean and alfalfa production.

Soil pH can have a dramatic effect on the availability of nutrients. The chart below shows that nutrient availability for the crops we grow is optimized in the 6.5 to 7.0 range. The width of the band illustrates the approximate availability of the specific nutrient. The wider the band, the more available the nutrient. The narrower the band, the less available the nutrient to the crop.

Uniform spreading on the land surface and mixing into the plow layer are assumed when making a limestone recommendation. Because lime moves very slowly in the soil and since uniform mixing is difficult to attain, it may be several years before the lime can be completely effective in neutralizing soil acidity in the plow layer. For any cropping system, apply lime before tilling the soil.
pH Buffer Test Levels

MIN. 6.4
AVG. 6.8
MAX. 7.1
pH Buffer

Buffer pH is an index used to determine the amount of lime needed to correct an acidic soil. This is a value that is generated in the soil testing laboratory; it is not an existing feature of the soil. Buffer pH is a measurement of the amount (or potential) of soil acidity. This potential acidity is due to the hydrogen held by the negatively charged soil particles of clay and humus. Hydrogen ions on the surface of these particles are known as exchangeable ions because they can be replaced by other positively charged ions such as calcium, magnesium, or potassium.

The buffer pH is a more useful measurement for determining the lime needs of a soil than using soil pH. The buffering capacity is the soil's ability to resist a change in pH when base-forming materials such as lime are added. The buffer solution is added to the soil and replaces some of the hydrogen held by the clay and humus. The pH of this soil/buffer solution mixture is the buffer pH. The buffer pH of many soils has been calibrated with the amount of limestone (pounds of ECCE) needed to change the soil pH, and the limestone recommendations are based on this calibration.

To demonstrate how Buffer pH works, consider the following comparison: visualize that you have either a cupful or a bucketful of boiling water. The temperature of the water is the same in both containers, but the water in the pail has more total heat and more ice would be required to cool it to the same temperature. The degree of soil acidity (measured by soil pH) compares with the temperature of water, whereas the amount of acidity (measured by buffer pH) compares with the amount of water at a particular temperature. Thus, two soils may have the same soil pH, but the soil with the higher amount of clay and organic matter will have the lower buffer pH and thus the higher lime requirement.

An Example:

<table>
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<tr>
<th></th>
<th>Soil A</th>
<th>Soil B</th>
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<tr>
<td>Soil pH</td>
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<td>Texture of soil</td>
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<td>Clay Loam</td>
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<td>Buffer pH</td>
<td>6.6</td>
<td>6.2</td>
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<tr>
<td>Lime requirement to raise soil pH to 6.5 (lb. ECCE per A)</td>
<td>3640</td>
<td>7300</td>
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</table>
Phosphorus Soil Test Levels

Sampled 2012

Statistics

MIN. 7.0
AVG. 16.9
MAX. 88.0
Phosphorus

Phosphorus (P) is an essential nutrient for crop growth. Phosphorus is part of several key plant structures and also acts as a catalyst in the conversion of numerous key biological reactions in plants. Phosphorus is noted especially for its role in capturing and converting the sun’s energy into useful plant compounds. Our crops must have P to complete their normal production cycle.

Phosphorus is a vital component of DNA, the genetic "memory unit" of all living things. It is also a component of RNA, the compound that reads the DNA genetic code to build proteins and other compounds essential for plant structure, seed production, and genetic transfer. The structures of both DNA and RNA are linked together by phosphorus bonds.

Phosphorus is also a fundamental component of ATP, the "energy unit" of plants. ATP forms during photosynthesis, has phosphorus in its structure, and is essential from the beginning of seedling growth through the formation of grain and maturity.

**Phosphorus is needed for the general health and vigor of all plants. Some growth factors that have been associated with phosphorus are:**

- Promotes more rapid root and seedling development
- Increases water use efficiency
- Increases stalk and stem strength
- Improved flower formation and seed production
- More uniform and earlier crop maturity
- Increased nitrogen fixing capacity of soybeans and other legumes
- Improvements in crop quality
- Increased resistance to disease

Several characteristics of the soil affect the fate of phosphorus and its availability to crops. Abnormal pH can result in unavailable phosphorus. Typically phosphorus availability is maximized in a pH range of 6.0 to 7.0. This is one of the beneficial effects of liming acidic soils.

Phosphorus can also become less available to the plant under cold, wet, compacted conditions. Wet or compacted soils have a reduced oxygen supply, which decreases the ability of the crops roots to absorb phosphorus. Compaction also decreases the soil volume that crop roots penetrate, limiting their total access to soil phosphorus.

In most soils, phosphorus moves very little (usually less than an inch). Due to this fact, it is important to maintain adequate levels of plant accessible phosphorus to insure maximum yields. Starter fertilizers are much more likely to increase crop growth and response in these conditions.
Potassium Soil Test Levels

Statistics

<table>
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<th>Range</th>
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<tr>
<td>Very Low</td>
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<td>120.9</td>
<td>543.0</td>
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</table>

RANGES

- Very High
- High
- Medium
- Low
- Very Low
Potassium

Potassium (K) is an essential nutrient required for crop growth and reproduction. Since large amounts of potassium are absorbed from soils in the production of most agronomic crops, it is classified as a macronutrient. The chemical symbol for potassium is K, which is derived from the German word "Kalium".

While potassium is not a constituent of any plant structures or compounds, it plays a part in many important regulatory roles in the plant. It is essential in nearly all processes needed to sustain plant growth and reproduction. Potassium plays a vital role by:

- Enhances translocation of sugars and starch
- Increases protein content of plants
- Reduces respiration, preventing energy loss
- Regulation of plant stomata and efficient water use
- Improved resistance to insects and disease
- Activation of plant enzymes
- Promotes photosynthesis

Potassium is known to activate at least sixty enzymes involved in plant growth, which may be its most important function in the plant. Plants deficient in potassium are less resistant to drought, excess water, and high and low temperatures. When K is deficient, photosynthesis declines, and the plant's respiration increases.

Potassium is critical to maintaining favorable plant water status. If K becomes deficient, stomates do not function properly, inhibiting photosynthesis and interfering with plant water relations. K in the cell water allows the cells to maintain high internal water pressure. More K permits the maintenance of this pressure as the plant's environment gets drier and drier. With sufficient K, plants can continue to photosynthesize and to grow through periods of dry conditions.

Potassium's importance in disease suppression cannot be overstated. The development of disease in a plant is affected by K levels because when K is deficient, production of proteins and tissues stops and production materials accumulate, thus providing an ideal environment for disease to develop. When K helps a plant resist disease, it doesn't do it as a direct agent of control, but by strengthening the natural resistance mechanisms of the plant. Even if higher numbers of disease organisms are present, plants provided with sufficient K are less affected because of greater plant integrity.

Potassium also has important effects on crop quality by improving the feeding value of grain and forage crops. It helps increase kernel weight and kernels per ear in corn and improves oil and protein content in soybeans. It also has a positive impact on crop harvest by reducing lodging and enhancing stand persistence, longevity, and winter hardiness of alfalfa.
Organic Matter Levels

MIN. 1.3
AVG. 2.1
MAX. 3.6
Organic Matter

Organic matter (OM) is the part of the soil composed of anything that once lived. It includes partially decomposed residue of plants, animals, and other organisms. Well-decomposed organic matter forms humus, a dark brown, porous, spongy material that has a pleasant, earthy smell.

Organic matter acts as a pool of nutrients for crops. It is especially important for providing nitrogen, phosphorus, sulfur, and iron. Organic matter affects nutrient cycles by chelating (chemically holding on to) nutrients and preventing them from becoming insoluble and therefore unavailable to plants.

Initially plant residue requires nitrogen to decompose into OM. As this OM continues to decay, it will release this nitrogen for future crops. In Minnesota, decomposition rates are typically about 2% annually, resulting in a release of nitrogen ranging from 25 to 100 pounds per acre.

Organic matter behaves somewhat like a sponge as well, with the ability to absorb and hold up to 90 percent of its weight in water. A great advantage of the water holding capacity of OM is that most of the water that it absorbs will be released to the crop.

What does organic matter do?

- Improves water infiltration & decreases evaporation
- Prevents soil erosion by improving aggregation
- Reduces soil crusting by improving soil tilth
- Encourages healthy root development
- Prevents compaction
- Holds pesticides and speeds up breakdown
- Improves biological activity in soil

Organic matter results can be used in recommendations for nitrogen on corn and also many times are the determining factor on the correct rate of preplant/preemergence herbicides.

The Changing Forms of Soil Organic Matter

1. Additions. When roots and leaves die, they become part of the soil organic matter.
2. Transformations. Soil organisms continually change organic compounds from one form to another. They consume plant residue and other organic matter, and then create by-products, wastes, and cell tissue.
3. Microbes feed plants. Some of the wastes released by soil organisms are nutrients that can be used by plants. Organisms release other compounds that affect plant growth.
4. Stabilization of organic matter. Eventually, soil organic compounds become stabilized and resistant to further changes.
Cation Exchange Capacity

Statistics

MIN. 10.1
AVG. 14.2
MAX. 20.6
The Cation Exchange Capacity (CEC) of a soil is defined as the holding capacity of a particular soil for positively-charged elements (cations). Cations are nutrients such as potassium, calcium, magnesium, sodium, and hydrogen, which play a major role in crop growth and development. CEC measures the soils ability to hold and release these nutrients.

The major components of the soil that determine the CEC of a soil are organic matter and clay content. The CEC of a soil is expressed as milligram equivalents per 100 grams of soil (meq/100g). A rule of thumb for estimating CEC is:

\[(\% \text{ organic matter } \times 2) + (\% \text{ clay } \times 0.5) = \text{ CEC}\]

**Example:**

A soil with 2.5% organic matter and 20% clay would have a CEC of 15 meq/100 grams.

Cations held by soils are exchangeable, which means they can be released into the soil solution for uptake and use by crops. It also means that they can be replaced by other cations. For example, Mg++ can be exchanged for K+ and/or H+ and vice versa. Soils with high a CEC typically can retain larger amounts of cations against loss by leaching. Soils with a low CEC, such as sandy soils, retain smaller quantities. This makes timing and application rates important in planning a fertilizer plan for these soils.

The Cation Exchange Capacity of your soil could be likened to a bucket: some soils are like a big bucket (high CEC), some are like a small bucket (low CEC). Generally speaking, a sandy soil with little organic matter will have a very low CEC while a clay soil with a lot of organic matter will have a high CEC. The organic matter of the soil always has a high CEC; while the impact on the CEC from clay depends on the type of clay.

![Figure 1: Schematic of a clay particle with negative charges on the surface attracting various cations.](image)
Lime Recommendations

Applying ground limestone to soil is the most effective way to raise the pH of an acidic soil. By raising the pH to a more neutral level, many benefits are realized, such as improved nutrient availability and improved microbial activity. Rhizobia bacteria that provide nitrogen for soybeans are very sensitive to lower pH levels.

Some other benefits of liming soils are:

- Improves physical soil condition (better structure)
- Reduces possibility of manganese and aluminum toxicity
- Improves forage palatability
- Provides inexpensive source of calcium and magnesium

The lime recommendations on the following page are expressed in pounds of pure calcium carbonate, not in pounds of lime, and have no machine constraints. Lime from different quarries vary in their effectiveness to raise soil pH. This effectiveness is determined by the purity, moisture content, and the fineness index of the lime. Quarries and other liming material sources must submit representative samples annually for analysis to determine the quality and effectiveness. The results from this testing are then used to calculate the application rates needed for pH correction.

For example:

Lime recommendations in this book are expressed as 100% ECCE (effective calcium carbonate equivalent). So, if a field calls for 25 total tons of ECCE, and the lime you are using is 65% effective (1300 ECCE/ton), then take 25 tons divided by .65 as shown below.

25 tons pure calcium carbonate/.65 ECCE = 38 Tons Lime

The lime recommendation is a one-time application for the 4 year life of the samples. Machine constraints also need to be accounted for. Lime applicators usually go no lower than ½ -1 ton per acre, and no higher than 4 - 4.5 tons. Spread patterns are difficult to maintain with rates outside of these ranges.
Fertilizer Recommendations
Phosphorus and Potassium Recommendations

Profitable crop production requires appropriate phosphorus (P) and potassium (K) levels, so careful fertilization is required. Soil testing is a very important diagnostic tool on which P and K fertilization should be based. Efficient application of the correct types and amounts of fertilizers for the supply of nutrients is an important part of achieving profitable yields. Soil testing provides an inexpensive, objective foundation for making these P and K fertilization decisions.

The nutrient recommendations on the following pages are expressed in pounds of actual nutrient, not in pounds of material per acre. There are numerous fertilizer sources used to provide nutrition to the plants. These sources include commercial fertilizers, manure and other products. To customize a fertilizer program for your field, all of these sources may be calculated into the fertility program.

Much like the lime, there are machine constraints for spreading dry fertilizer products, such as MAP, DAP, and Potash. The application equipment is unable to apply properly at very low rates. Your local Progressive Ag Center agronomist will be able to explain what the machine constraints are for each of these materials. Use these pages only as a guideline as to approximately how much nutrient will be required to achieve your goals.

Phosphorus and Potassium recommendations are for 1 crop year. If making a multiple year application, the recommendations for each individual year need to be added together (example: 2 year corn/soybean rotation).

*Nutrient recommendations in the book represent individual crop year needs.
ECCE to 6.9

Olmsted
GrowMor 32

Progressive Farmer
GrowMor
Growing More by Knowing More

GMR32NW

ECCE69 Levels
- 8000 - 9000
- 7000 - 8000
- 6000 - 7000
- 5000 - 6000
- 4000 - 5000
- 3000 - 4000
- 2000 - 3000
- 1 - 2000
- 0 - 1
- All Others

UNITS
- MIN. 0.0
- AVG. 2241.12
- MAX. 6000.0

Acres 100.60
Total 225456.5
Corn Gold P

Acres 100.60
Total 9931.4

GMR32NW

MIN. 0.0
AVG. 98.72
MAX. 153.2

Acres 100.60

ChGoldP Levels
- 125 - 250
- 100 - 125
- 75 - 100
- 50 - 75
- 25 - 50
- 0.1 - 25
- 0 - 0.1
- All Others

GROWMor
Growing More by Knowing More

Progressive Farmer
Olmsted
GrowMor 32
Bean Gold K

Olmsted
GrowMor 32

Progressive Farmer

GrowMor
Growing More by Knowing More

GMR32NW

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UNITS
MIN. 0.0
AVG. 142.21
MAX. 199.7

Acres 100.60
Total 14306.3
Progressive Farmer
Olmsted
GrowMor 32

Alfalfa K 7T

GMR32NW

Alfalfa K 7T Levels
- 1000
300 - 375
225 - 300
150 - 225
75 - 150
0.01 - 75
0 - 0.01
All Others

Alfalfa K 7T

UNITs
MIN. 0.0
AVG. 274.68
MAX. 351.8

Acres 100.60
Total 27633.1
SOIL ANALYSIS REPORT

<table>
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<tr>
<th>LA</th>
<th>SAMPL</th>
<th>ORGANIC MATTER</th>
<th>POTASSIUM</th>
<th>PHOSPHORUS</th>
<th>MAGNESIUM</th>
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### SOIL ANALYSIS REPORT

**REPORT DATE:** May 31, 2012  
**REPORT NO.:** 12-152-0081  
**ACCOUNT:** 15493

**SAMPLES:**

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## Soil Analysis Report

### Neutral Ammonium Nitrate

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### SOIL ANALYSIS REPORT

**NEUTRAL AMMONIUM ACETATE**

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## SOIL ANALYSIS REPORT

### Neutral Ammonium Acetate

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**Comments:**

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