USDA United States Department of Agriculture

590 - Nutrient Management Guidance Document

Purpose

This Guidance Document covers what is needed to meet the 590 Standard in Iowa. The Iowa 590 Standard follows the National 590 standard and meets or is more restrictive than Iowa State Law. It also gives considerations, recommendations, and supporting data for Conservation Planners to consider in planning and evaluation of this standard.

The guide addresses the following resource concerns:

1. **Plant Productivity and Health**
2. **Water**
    a. **Nutrients transported to surface water and ground water**
    b. **Pathogens and chemicals from manure, biosolids, or compost applications transported to surface and ground water**
3. **Air**
    a. **Emission of particulate matter (PM) and PM precursors**
    b. **Emission of greenhouse gases (GHGs)**
    c. **Emission of ozone precursors**
    d. **Objectionable odors**
    e. **Emission of airborne reactive nitrogen**
4. *This guide doesn't cover the Air Resource Concerns as part of the 590 standard*

The 590 standard is used:

1. **To develop nutrient management plans which limit offsite nutrient losses while optimizing plant productivity and health. This includes nutrient management plans (DIA 157) written by TSPs and other partners under NRCS agreements.**
2. **For evaluation of existing nutrient management systems and supporting water quality practices that are part of the system.**
3. **To make recommendations for the successful implementation of Pasture and Hay Planting (512) and Prescribed Grazing (528). The recommendations are required for implementing CPS 512.**

The Guidance Document has five Sections

Section 1: Phosphorous (P), Potassium (K), and pH
Section 2: Nitrogen
Section 3: Sensitive Areas
Section 4: Additional Information when Manure is applied as a nutrient
Section 5: Additional Information for 512 and 528 standards

Phosphorus (P), Potassium (K), and pH *(Section 1 of 5)*

A. Soil Sampling – Refer to (ISU) CROP 3108 "Take a Good Soil Sample to Help Make Good Fertilization Decisions".

- Soil tests for initial nutrient management plans must not be older than 2 years.
- Soil testing must be completed every 4 years.
  - *Testing is recommended every 2 years for Continuous Corn and Corn/Soybean rotations and every 3 years for a three-year rotation (e.g., C-B-small grain).*
  - *When hay is in the rotation (e.g., CBOMMM), recommended minimum soil sampling is 2-3 times in the rotation.*
- All soil samples taken (grid and mgmt. zones) must have a minimum of 10 cores per sample at a 6" depth.
  - *Recommend 15 - 20 or more cores per sample be taken.*
- Management / Soil Map Zones: must not exceed 10 acres in size. These zones are created based on a uniform area that considers a combination of factors including soil types, soil properties, yield maps, management history, etc.
  - *Recommend cores are taken in a random zigzag pattern "W" across the zone, avoiding odd areas.*
- Grid sampling: grids must not exceed 5.0 acres in size when they aren't adjusted for soil types, soil properties, yield maps, and history.
  - *2.5-acre grids are recommended, especially where variability in test values over a short distance is expected.*
  - Cores should be taken in a random pattern from a sample point at least 50' in diameter.

B. Soil Testing

- Tests must include analysis for: P, K, pH, buffer pH *(when needed).*
  - *Testing for organic matter is recommended to evaluate soil conditions and for the agronomist and/or producer when making pesticide recommendations.*
    - *Other soil health tests (e.g., active carbon) can be better indicators of soil health trends in the short term.*
- Acceptable soil tests (*recognized by ISU*) include:
  - Phosphorous (P): Bray P1, Olsen P, Mehlich-3 (*all with standard colorimetric determination of extracted P),* and Mehlich-3 ICP.
    - When pH values are greater than 7.3 (*calcareous soils*), **Bray P1 will not be used**. *Plant available P is often underestimated in these soils. Labs need to run the appropriate P test when this pH is reached.*
    - If Bray P1 was used:
      - make a note to use the correct test the next time sampled if P levels are H or VH
      - ask lab to rerun the soil sample with appropriate test
      - Conservation Planner may waive if just a few grids and they are considered outliers
  - Potassium (K): Ammonium acetate *(field moist or dried samples)* and Mehlich-3
    - The field moist sample is recommended for fine-textured soils classified as moderately poor to very poor drainage irrespective of tile drainage presence.
  - Zinc (Zn): DTPA, *not required.*
- Note:
  - Soil tests in Iowa are expressed as ppm P, K, or Zn.
  - Some states have test results expressed as lbs./ac. To convert from lbs./ac of P or K to ppm, multiply by 0.5.
  - Fertilizer recommendations are in lbs. of Phosphorus oxide (P_2O_5) and Potassium oxide (K_20).

- Testing labs must be certified by the Iowa Soil Testing Laboratory Certification Program, Commercial Feed and Fertilizer Bureau of the Iowa Department of Agriculture and Land Stewardship (IDALS).
    - To determine if a lab is certified go to: https://iowaagriculture.gov/commercial-feed-and-fertilizer-bureau/commercial-fertilizer. Go the link "Certified Soil Testing Laboratories".

C. P & K Analysis and Rate – Refer to (ISU) PM 1688 "General Guide for Crop Nutrient and Limestone Recommendations in Iowa".

- PM 1688 Table 1 - soil test ppm categories for P for all crops except wheat & alfalfa and for K for all crops.

Soil Test Category	Phosphorus (Bray-1 or Mehlich-3 P colorimetric)	Potassium (Ammonium Acetate & Mehlich-3; dried samples)
Very Low (VL)	0 - 9	0 - 125
Low (L)	10 - 17	126 - 170
Optimum	18 - 25	171- 220
High (H)	26 - 34	221 - 270
Very High (VH)	35+	271+

*Refer to PM 1688 to determine the soil test category for the Olsen P and Mehlich-3 ICP P tests, P interpretations for wheat and alfalfa, and K tests using the field-moist or slurry.

- Complete P Index when phosphorus is being applied.
    - Planner discretion is needed to determine the number of P Index assessments necessary to run to determine the worst-case scenario for the tract when the assessment will be carried across the tract.
    - The national standard states the P Index must be ran when the site-specific conditions equating to low risk of P loss have not been determined by the NRCS in cooperation with the state water quality control authority (IDNR). See the IA 590 Standard for more details.

Determining Rate:

- Use **(ISU) PM 1688** to determine recommended rates for P & K when the soil test is Very Low or Low.
- When the soil test is in the optimum category, base P & K on average nutrient removal (maintenance rates) used.
    - To determine **removal amounts** for specific crops, yields, and rotations, use **PM 1688 page 4, Table 2**.
    - Use realistic yield goals in determining maintenance rates. Determine the typical yields for each crop for the tract or use the maintenance values given in the table below.

Maintenance rates for specific crop & yield/ac		
Yield	**P**	**K**
Corn - 210 bu.	67	46
Soybeans – 70 bu.	50	84
CB 2 yr. rotation	*117*	*130*
Oat Grain - 80 bu.	25	15
Wheat Grain - 55 bu.	30	15
Alfalfa – 5.5 tons	72	235

- Nutrients may be applied lower than recommended rates if the grower's objectives are met unless it's part of a 512 planting (*Section 5*) when NRCS is providing financial assistance.
- Note: in a CB 2-year rotation when no fertilizer is applied, soil ppm of P drops an average of 5-6 ppm and K drops an average of 11-12 ppm, but this can vary by 2-fold in actual field situations.

Phosphorus (P), Potassium (K), and pH (continued) *(Section 1 of 5)*

- Considerations for applying P & K on soil testing in the High category:
  - PM 1688 allows ½ the estimated crop removal rate of P & K on High testing soils when applying for multiple years and it will be 2 years until the next soil test.
- When wheat or alfalfa is in the rotation the optimum soil test category for P is 5 ppm higher, *refer to table 1 of PM 1688.*
- For a field spread rate (*not variable rate application*) the following can be used to determine rate:
  - If 2/3 of the field is not over applied, consider it to meet the minimum standard requirements.
  - Fields less than 10 acres may be applied as field rate based on the lowest ppm soil sample.
  - The field median of the soil samples can be used to determine the field spread rate.
    - When there is an even number of samples take the average of the two middle samples.
  - Other considerations when field spreading:
    - P & K should not be applied to VH testing soils when at all possible.
    - When VH testing soils are present within a field, a soil sampling plan may need to be developed to further determine the boundaries of those areas.
  - If P & K are applied above the recommended rate for a given soil sample area, justification must be documented.
  - *Recommend grid sampling on 2.5-acre grid and spread by Variable Rate Technology (VRT) as needed for each grid.*
- Starter Fertilizer Application – applicable only for corn, wheat or sorghum
  - N-P-K starter for corn may be beneficial under certain conditions:
    - Limited soil drainage
    - Cold soils (*early planting*)
    - Crop residues left on soil surface (*no-till*)
    - Soil tests are VL or L
    - When cover crops are used before corn
  - Starter is defined as a rate and formulation that is available for early plant growth (i.e., corn roots will be able to uptake the P or K for early development, corn emergence to V-3). Starter is typically placed near the seed during the planting operation. It may be applied in a different pass than the planter if it is applied no more than 2 weeks before planting and with GPS guidance for accuracy, placing the seed and starter within 4 inches of each other.
  - When applying starter, no more than 25lbs P_2O_5/Ac and 25lbs K_20/Ac will be considered starter.
    - Starter must be accounted for in the P & K recommendations.
  - Starter can be applied on all soil test levels.

Economic Considerations:

- Fertilizer recommendations for low testing soils are intended to maximize yields and slowly build soil test values. Economic return with fertilization is likely for all price scenarios when soil test levels are VL or L.

Likelihood of Yield Response with P & K application for each soil test category based on PM 1688.	
Soil Test Category	**% Likelihood of Yield Response**
Very Low (VL)	80%
Low (L)	55%
Optimum	25%
High (H)	5%
Very High (VH)	< 1 %

- Applying P & K maintenance fertilization in the optimum range is often in the break-even range, dependent on cost of the fertilizer and grain. There is typically less than 25% chance of having an economic return.
- Luxury consumption of potassium in the plant increases as soil test ppm increases. This should be considered as an economic loss and it could cause issues with nutritional value of the feed.

D. Timing

- No commercial nutrients shall be applied to frozen, snow covered ground, or saturated soil.
  - State of Iowa definition: "snow covered ground means soil covered by 1" or more of snow or soil covered by ½" or more of ice."
- Note: There is risk of losing P & K by surface runoff when broadcasted and not incorporated, followed by a heavy rain.
  - To lower the risk of runoff, apply P & K in the fall on corn stalks or on established cover crops in a no- till system.
  - Spring application provides better potential utilization of the nitrogen component for the corn crop.

E. pH Analysis – Refer to (ISU) PM 1688 Table 16 page 11 to determine rate of lime needed for the pH goal.

- Trigger and Target pH:
  - Corn and Beans: if the soil pH is 6.0 or lower, lime to target pH of 6.5.
    - Exception: areas with high-pH (calcareous) subsoils, a target pH of 6.0 for corn and beans is sufficient. *This includes soil associations of: Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Monona-Ida-Hamburg, Marshall, and Luton-Onawa-Salix.*
  - Alfalfa: if the soil pH is 6.5 or lower, lime to target pH of 6.9.
  - Other legumes, grasses, mixes, pastures: if the soil pH is 5.5 or lower, lime to target pH of 6.0.
- Note:
  - Soil pH is used to determine the need to lime. The buffer pH is used to determine how much Effective Calcium Carbonate Equivalent (ECCE) lime material to apply to move the pH to the desired level.
  - Lime recommendations are given in lbs. of ECCE. Lime is sold in bulk lbs. of quarry lime.
  - E.g., a ton of quarry lime (*bulk product*) will always have less than 2,000 lbs. of ECCE. The ECCE value for quarry lime varies between quarries, often from 30-70% ECCE.

    Example calculation

    Producer is to put on the recommended amount of 1,100lbs of ECCE lime/ac. Quarry lime they will be using has an ECCE of 1,200lbs / ton or 60%. How much bulk quarry lime is needed?

    $$1{,}100\text{lbs ECCE lime needed} * \frac{1\text{ ton bulk}}{1{,}200\text{lbs ECCE}} = .92\text{ tons/ac bulk quarry lime}$$

    $$.92\text{ tons} * \frac{2{,}000\text{lbs}}{1\text{ ton}} = 1{,}833\text{lbs of bulk quarry lime}$$

  - Pelletized Lime has a high ECCE percent and is usually applied at lower rates than quarry lime. The rate should be based on the recommended lbs. of ECCE per acre.
  - Lime may be applied lower than the recommended rates if the grower's objectives are met unless it's part of a (512) Pasture & Hayland Planting (*Section 5*) where NRCS is providing financial assistance.

Phosphorus (P), Potassium (K), and pH (continued) *(Section 1 of 5)*

F. Resource Concern – Water: Nutrients transported to surface water

- Potassium and pH levels are not considered to directly impact environmental resource concerns to water quality. They can have an indirect affect by reducing plant health when not managed correctly.
    - Liming not completed or that doesn't follow ISU recommendations will not be considered when determining if the 590 standard is met. Liming recommendations do need to be met for NRCS 590 practices (*see Section 5).*
    - Potassium application over ISU recommendations for commercial fertilizer will not meet the 590 standard.
- Phosphorus field loss is a resource concern in Iowa. It is most often the limiting nutrient for plant growth within Iowa's freshwater systems.
    - Over enrichment of P in our water bodies causes algae blooms resulting in reduction of dissolved oxygen (eutrophication).
    - Algae blooms can also cause excessive cyanobacteria (blue-green algae) that can release toxins called microcystin, which leads to death of fish and domestic animals. This is the reason beaches are often closed to swimming in the summer.
- Soil loss is often the greatest cause for phosphorus loading into water bodies.
    - P bonds tightly with the soil (*immobile*), so P offsite movement is reduced when soil erosion is minimized.
    - Statewide, approximately 80% of P loading into surface water is from particulate P (attached to sediment) and 20% is from soluble P. This ratio varies from Major Land Resource Area (MLRA) to MLRA.
    - Soluble phosphorus starts to be a greater concern when soil test levels are in the VH (35+ ppm) soil test category. The risk of soluble P loss increases as ppm of P increases.
- Use **(ISU) SP 435A "Reducing Nutrient Loss: Science Shows What Works"** for practice recommendations to reduce phosphorous offsite movement.

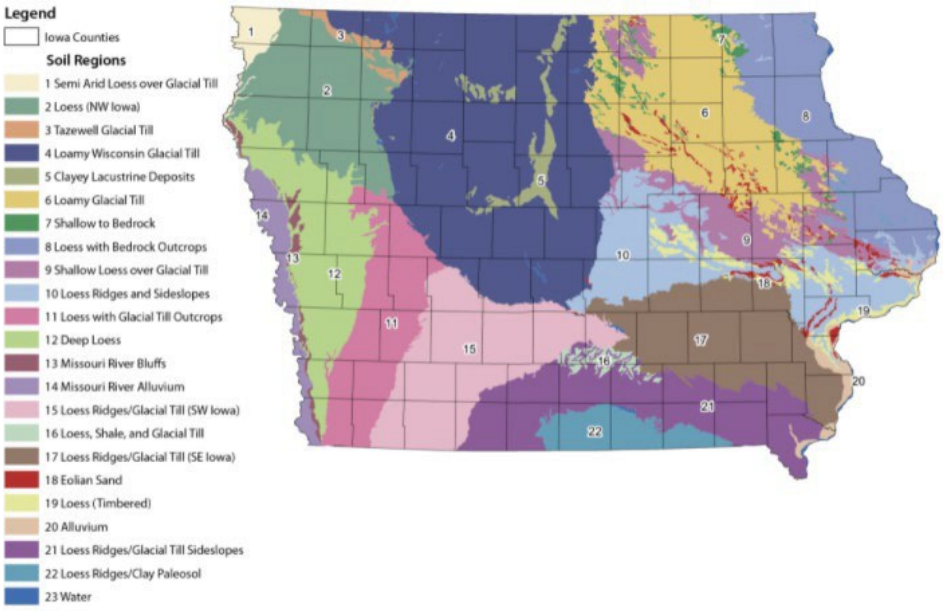
A. Rate

- **Corn after Corn or Soybeans**
  - Refer to **(ISU) CROP 3073** "Nitrogen Use in Iowa Corn Production and **(ISU) PM 2015** "Concepts and Rationale for / Regional Nitrogen Rate Guidelines for Corn".
  - Use **Corn Nitrogen Rate Calculator (CNRC)** (http://cnrc.agron.iastate.edu/) to determine the recommended nitrogen rate for corn following a soybean or corn crop.
    - Determines N fertilization range based on price of lb. N and price of a bu. of corn.
    - Based on optimizing long term profits for the producer.
    - Regional tool used in IA, IL, IN, MI, MN, IL, OH, and WI, but yield data is specific to Iowa.
    - Calculator recommendations are based on Economic Optimum Nitrogen Rate (EONR).
      - Gives the Low, Optimum, and High N ranges based on being within $1.00/acre of the maximum economic return.
    - High yielding environments do not require more N.
  - *Recommend the producer's cost of N and their target corn price is used to determine the N rate when using the CNRC.*
  - **To meet the 590 standard the N rates applied must not exceed the N rates using the ratios below in the Corn Nitrogen Rate Calculator.**
    - **Commercial N: 0.08** (e.g., $0.40/lb. N and $5.00/bu for corn)
    - **Manure N: 0.05** (e.g., $0.20/lb. N and $4.00/ bu for corn)
      - A lower price ratio for manure is utilized to account for variability within manure sources.
      - Manure N rate is based on available N. *See 590 Guide Sheet section 4: Manure.*
      - *Use the weighted average when more than 50lbs./acre commercial N is used with the manure.*

CNRC Runs, *dated September 2022*

Main Part of IA		
Commercial Nitrogen (0.10 price ratio)	**Commercial Nitrogen (0.08 price ratio)**	**Manure (0.05 price ratio)**
e.g., N: $0.40 / corn $4.00	*e.g., N: $0.40 / corn $5.*	*e.g., N: $0.20 / corn $4.00*
Corn following Soybeans (134- **147** - **159**)	Corn following Soybeans (140 - **154** - **167**)	Corn following Soybeans (151 - **167**- **182**)
Corn following Corn (177 - **190** – **205**)	Corn following Corn (184 – **199** - **214**)	Corn following Corn (197 - **211** – **231**)

SE IA Region, **see map next page*		
Commercial Nitrogen (0.10 price ratio)	**Commercial Nitrogen (0.08 price ratio)**	**Manure (0.05 price ratio)**
e.g., N: $0.40 / corn $4.00	*e.g., N: $0.40 / corn $5.*	*e.g., N: $0.20 / corn $4.00*
Corn following Soybeans (143 - **157** - **170**)	Corn following Soybeans (150 - **164** - **180**)	Corn following Soybeans (163 - **180**- **201**)
Corn following Corn (195 - **212** - **229**)	Corn following Corn (206 - **224** - **240**)	Corn following Corn (218 - **239** - **240**)



**SE Iowa region for the CNRC consists of the entire 21 and 22 Soil Regions and the southern half of 17.*

- Soils for trial sites in the Southeast region include poorly drained soils like Haig, Kalona, Macksburg, Mahaska, Nira, Otley, Richwood, Taintor, and other similar soils. If soils in the Southeast region are better drained, then use the main Iowa region.

- **(ISU) CROP 3140** "Late-Spring Soil Nitrate Soil Test" and **(ISU) PM-2026 "**Leaf Chlorophyll Values" can also be used to determine N rate for corn.
  - These tests are typically used to determine N rate needed for the second application of a split applied program. Often 50 – 100lbs of N are applied before or near planting in the first application.
  - More information for these tests can be found in this section under D, Nitrogen Program Evaluation.

- **Corn after Alfalfa**
  - When the alfalfa stand is 3 years or older, the recommended rate is 0 – 30lbs N/acre.
    - This is based on a stand of alfalfa or alfalfa/grass stand (*when the grass component makes up 0 – 50% of the stand*).
    - Optional: Complete the Late-Spring Soil Nitrate Soil Test **(ISU) CROP 3140** for additional information.
  - Second year corn after alfalfa use same rate as corn following soybeans.
  - For additional information for corn following alfalfa see **(ISU) CROP 3073, page 7, table 2.**

- **Corn after Small Grain**
  - Iowa State University does not have a recommendation currently.
  - It is permissible to follow neighboring states N rates for corn following small grains but document.
  - *Recommend using the same recommended rate for corn when it follows soybeans. (Wisconsin A2809 Nutrient …. Table 6.1 recommends the same rate of N following soybeans for small grain). If following these recommendations, no further documentation is necessary.*

- Small grain has a high C:N ratio but due to the crop reaching physiological maturity in July the microbes have more time to break down the residue and release the N for the next crop.

- **Other Notes concerning nitrogen and corn production:**
  - High yielding corn accumulates approximately 275lbs of N in the plant per acre.
  - About 2/3 of the N will be in the grain and the remaining 1/3 in the plant residue.
  - About ½ of the N for a given corn crop comes from the commercial fertilizer and ½ from the soil (mineralization of OM, previous crop residues, etc.).
  - High C:N ratio in corn stover affects the availability of the N for the next crop. *The soil microbes utilize the soil nitrogen (tie up) as they eat the carbon.*

- **Small Grain** (cereal rye, oats, triticale, wheat, etc.)
  - Iowa State University does not have a recommendation currently.
  - It is permissible to follow neighboring states N rates for small grains but document.
  - *Recommend not to exceed 90lbs regardless of the crop followed, based on* **(ISU) AG 202** "Spring Wheat in Iowa". *If following these recommendations, no further documentation is necessary.*

- **Soybeans**
  - No N is recommended.
  - Soybean crop uses more N than a corn crop.
    - Soybean: 3.8 lbs. N /bu., 55bu = 209 lbs.
    - Corn: 0.85 lbs. N/ bu., 180bu = 153 lbs.
  - Being a legume, it fixes the N (*N-fixation*) it needs but is also a good scavenger of N. It will scavenge N before fixing N.
  - Producers can apply MAP/ DAP before soybean crops and meet the 590 standard.
  - Nitrate soil levels in the fall after a soybean crop are similar to soil nitrate levels after a corn crop.

- **Grass Hay Crop**
  - Cool Season tall grass hay: Refer to **Section 5 of the 590 Guide** and **(ISU) PM 869** "Fertilizing Pasture" for nitrogen recommendations.

- **Other Considerations for N Rate**
  - **Inventory for all N sources when determining total rate.**

____ anhydrous ammonia
____ manure sources (amount, analysis used, credits given)
____ N with MAP (11-52-0), *maintenance P level for 200bu corn & 60bu beans = 107lbs phosphate (=206lbs MAP) = 23lbs N/ac*
____ N with DAP (18-46-0), *maintenance P level for 200bu corn & 60bu beans = 107lbs phosphate (=233lbs DAP) = 42lbs N/ac*
____ N with Ammonium Sulfate fertilizer (AMS) used for the Sulfur content. *e.g., 10lbs Sulfur would give us 9lbs N.*
• *AMS is often used as an adjuvant (water conditioner) for herbicide spraying. Don't count this as an N source, its negligible.*
____ Liquid N (28 & 32%) used as carrier with preemergent herbicide, e.g., 10gal/ac 28% is *approximately 30lbs/ac* Urea
____ (46-0-0)
____ post applied N, e.g., side dressed N
____ Planter applied N
____ Other

- **Variable Rate Technology (VRT) used for MAP or DAP** application must account for the nitrogen.
    - Options include:
        - Variably apply N to account for the N applied to each grid with MAP or DAP *(Best Option)*
        - Apply MAP or DAP on cropland going to soybeans.
            - *Soybeans will scavenge available N before fixing nitrogen.*
            - Recommend when applied before beans to apply over a growing cover crop.
        - Take the average N applied to the field by VRT and reduce from total N planned.
        - Use triple superphosphate (0-46-0). *Great option if available.*
        - Use MAP rather than DAP. MAP (11-52-0) has almost half the nitrogen of DAP (18-46-0).

B. **Timing**

- Fall application for anhydrous is allowed but only after the mid-day soil temperature at 4" soil depth is below 50° F and trending cooler.
    - Spring application is recommended.
    - No other commercial N principal products (urea, UAN, ammonia nitrate, etc.) are allowed for fall application unless a living crop is growing, e.g., wheat.
        - Cover crop is not considered a crop
        - MAP and DAP can be applied but the N is at risk of loss.
- Anhydrous Ammonia: takes time to be converted to nitrate where it can be readily lost. The product is knifed in as a gas and quickly converts to liquid as it takes moisture. This creates a toxic zone environment to the soil microbes. The microbes must work from the outside edge of the zone to convert it from NH4+ to NO3-. NH4+ is held onto the soil and not vulnerable to loss. Cold soil temps reduce microbial activity thereby slowing the process.
- MAP/DAP: can be applied in the fall, but like other N commercial fertilizers *(that aren't anhydrous)* the N is converted quickly to nitrate where it is vulnerable to loss. The conversion usually occurs inside of a 2-week period but varies some on product form and temperatures.
    - Substantial risk of loss when fall applied.
        - To meet the 590 standard a minimum of ½ of the N from MAP or DAP must be included in the nitrogen total when it is fall applied.
        - *Spring application is recommended*
        - *When fall applied recommended to apply on a growing cover crop*
    - Triple superphosphate (TSP) (0-46-0) has no N component. If available, it's a good phosphorus fertilizer option when potential for N loss is high.
- Manure: risk to loss varies with source and type. Liquid swine manure is quickly converted to nitrate and vulnerable to loss. *For more information on manure go to* ***Section 4****.*

C. **Products to reduce nitrogen loss** (i.e., enhanced N efficiency fertilizer)
**Products below have been evaluated and are recommended by Iowa State University (ISU) and are not required to meet the 590 standard.*

- Nitrapyrin *(e.g., N Serve, Instinct)*: recommended to use with fall applied anhydrous.
    - Application timing must still wait for 4" soil temperature to be 50° F and cooling.
    - It further slows the process by inhibiting nitrification, the process that goes from ammonia (NH3) to **ammonium (NH4+)** to nitrite (NO2-) to **nitrate (NO3-)**. Anhydrous applied stays longer in the NH4+ form where it attached to the soil. Once microbes convert it into the NO3- form it becomes soluble in solution and can be lost.
    - ISU doesn't recommend Nitrapyrin for use in spring applied anhydrous due to unlikely economic benefit.

- Nitrification Inhibitors with other forms of nitrogen:
  - Active ingredient containing *Nitrapyrin, Dicyandiamide (DCD).*
  - Applied to UAN (urea ammonium nitrate in a 28 or 32% solution) and to solid Urea.
  - Nitrification inhibitors are most useful with preplant nitrogen application on sandy (excessively drained) soils prone to leaching or on poorly drained soils subject to denitrification.
- Polymer coated urea:
  - A physical barrier which controls its release into the soil which allows time for incorporation into the soil via rainfall or tillage thus reducing the risk to volatilization.
- Urease inhibitors:
  - Known as NBPT *N-(n-butyl)* and NPPT *n-propy*l
  - It reduces the break-down from Urea to ammonia for a short period of time, which gives additional time for incorporation into the soil via rainfall or tillage thus reducing the risk to volatilization.
  - Benefits are greatest when urea is surface applied on high residue, high pH soils, and when there is a delay of incorporation for several days after application from a rainfall event (1/2"), irrigation or tillage.
- Use of these products does not allow for higher than recommended amounts of N to be used.
- NRCS only recognizes (*able to use in NRCS programs)* products that ISU recommends.

D. **Nitrogen Program Evaluation**

- **In Season "Rescue" & Evaluation Tools**
  - Additional N can be applied, *above the CNRC rate*, if one of the following ISU approved tests below indicates that additional nitrogen is needed.
    - **(ISU) CROP 3140** "Late-Spring Soil Nitrate Soil Test". This 12"soil test (15 cores) is taken when the corn plant is 6" to 12" tall at the whorl (~V-5 to V-6). First 100 acres take 5 samples and then minimum of 2 samples for each additional 100 acres of corn. See **(ISU) CROP 3140** for details. *(e.g., if a producer has 200 acres of corn take 7 samples, for 600 acres of corn take 15 samples).*
    - **(ISU) PM-2026 "**Leaf Chlorophyll Values"**.** This test is taken by reading a corn leaf at V-10 (typically waist high) and comparing to an over applied nitrogen strip in the field. The strip through the field needs to have 50-100% higher N rate than the rest of the field. The meter will compare values from the over applied strip with the rest of field. Corn that is adequately fertilized or corn that is over applied will have the same darkness of green. Therefore, the meter can't measure if the corn has more N than is necessary. If corn is found deficient the additional N must be applied as soon as possible but before V-T (*tassel*). A highboy may be necessary to apply the extra N. *On years of excessive rain fall in April – June (50% above normal) the test can be used and compared to the darkest corn in the field that is the same variety.*
    - **Springtime Rainfall Totals (*ISU ICM News 6/2/21*) -** 1 out of 4 years Iowa has experienced excessive rainfall that may warrant additional nitrogen due to loss.
      - SE Iowa (*south of 80, east of 35*): when rainfall exceeds 17.8 inches in March – June.
      - Rest of Iowa: when rainfall exceeds 15.5 inches in March - June.
      - Once rainfall totals are met additional N can be applied. If rainfall totals are not met but are getting close (*within 2-3"*) in early June, then consider applying additional N.
        - Decision usually needs to be made in the first ½ of June unless a high boy applicator is used.
      - If additional N is applied, no more than 50lbs should be applied when the initial rate was close to the CNRC rate. Unless 1 of the two tests above show more lbs. are justified.
      - Local weather station data is need for rainfall verification. *Go to FOTG – Section 2 – Climatic Data – AgACIS*

- www.wunderground.com put in location, then go to wundermap tab (*make sure weather stations is clicked on right*) then click on the closest weather station (*need to zoom in to see them all*), then click on the blue name, then go down the page and you can look up different days or by month.

- When a rescue treatment is applied, evaluate the likely causes and what alternatives could be adopted to lessen future N losses and document.
- *Recommended to:*
  - *Leave a test strip to determine if there was a yield benefit.*
  - *Complete corn stalk nitrate test in the test strips and where additional N was applied to determine if extra N was justified.*

- **End of Season Evaluation**
  - **(ISU) CROP 3154** "Use of the End-of-Season Corn Stalk Nitrate Test". Test is taken after the corn plant is physiologically mature (1 – 3 weeks after black layer).
    - ppm of nitrate is measured in the stalk.
    - A sample consists of (15) 8" segments of the corn stalk, between 6" and 14" from the ground.
    - Corn plants randomly selected need to have an ear and not be severely damage by disease or insects.
    - Plants must not have prematurely died.
    - Test Levels:
      - Low (less than 250 ppm) – *N may have been limiting or it was cut very close.*
      - Sufficient (250-2,000 ppm)
      - High (greater than 2,000 ppm) – excess N, *this could be a result of drought where yields were reduced, and less N was taken into the kernels.*
    - Sample Numbers required: First 100 acres take 5 samples and then minimum of 2 samples for each additional 100 acres of corn. See **(ISU) CROP 3140** for details. *(e.g., if a producer has 200 acres of corn take 7 samples, for 600 acres of corn take 15 samples).*

E. Resource Concern – Water: Nutrients transported to surface waters and groundwater considerations:

- Nitrate offsite losses negatively affect:
  1) municipal and private well drinking water
  2) hypoxia in the Gulf of Mexico
  3) freshwater bodies by contributing to excessive plant and algae growth and reduced biodiversity
- Changes to management practices will often have the biggest impact due to the number of acres affected.
- In CC and CB rotations cover crops reduce nitrate offsite loss by ~30%.
- Benefits from reducing the rate of N applied is dependent on what rate was being applied. As the rate goes above the recommended CNRC rate, the % of N loss increases for each additional lb. applied.
- Small grain added into a CB rotation has the potential to reduce nitrate loss. Overall, the higher percent of time of having living roots, the less risk of nitrate loss. Small grain in the rotation also enhances a cover crop program and may allow for reduced N rates when going to corn if legumes are utilized as the cover crop.
- Other N management practices, edge of field practices, and land use changes can all be part of an overall effective system to reduce N losses.
- Refer to **(ISU) SP 435 A publication,** "Reducing Nutrient Loss: Science Shows What Works Iowa Nutrient Strategy Recommendations" for reducing offsite nitrogen losses.

Nutrient Sensitive Areas *(Section 3 of 5)*

A. **Sensitive Area Requirements**:

- Manure, and/or biosolids applications are required to adhere to the guidelines below concerning sensitive areas to meet the 590 standard.
- Commercial nutrient applications are to be considered but are not required for meeting the Sensitive Areas guidelines for the 590 standard.

B. Sensitive Areas for the 590 Standard are defined on following factors:

- The areas identified below listed in Chapter 65 of the Iowa Administrative Code.
  i. State law requires separation distances from sensitive areas when applying manure from animal feeding operations. See ***DNR 113 08/2023*** *for additional information.*
  ii. Chapter 65 of the Iowa Administrative Code language uses environmentally sensitive "designated areas"

- **Sensitive Areas Include areas within 200' of the following:**
  - Sinkholes (*found in KARST topography)*
  - Wells, *private and public, includes abandoned wells and cisterns.*
  - Drainage wells and associated surface intakes *generally found in north-central IA in the Des Moines Lobe.* *See ARC GIS layer for more specific info.*
  - Water bodies (*IDNR defines in code as "water source"*)
    - Ponds, lakes, reservoirs, public and private.
      - This does not include ponds without outlet to which only one landowner is riparian.
    - Intermittent streams (*creek, stream, ditch*): *where a bed and bank are present and with flowing water part of the year.*
    - Perennial streams and rivers
    - Designated wetlands: land owned by the US Government or IDNR and designed as a protected wetland by the Department of Interior or the IDNR.
      - See Designated Wetland in Iowa List 8-23-2006 for list by county.

- Areas **within 800'** of the following:
  - Water bodies listed as **High-Quality Water Resource**, include High Quality Water (HQ), High Quality Resource Water (HQR) and Protected Water Areas (PWA).
    - *See* ***DNR 117 3/2003*** *– High Quality Water Resources for additional information and a list of the water bodies by county.*

C. Options when inside of the 200' and 800' setbacks are:

- Install / Maintain a minimum of a 50' buffer (permanent vegetated cover including filter strips and riparian forest buffers).
- Inject all nutrients or surface apply and incorporate on same date.
- The above options are stated in ***DNR 113 08/2023.***

Nutrient Sensitive Areas *(Section 3 of 5)*

D. Other potentially sensitive areas, not defined in Chapter 65 of the Administrative Code, that should be considered in the planning process but do not need to be protected to meet the 590 standard include:

- Source water protection areas
- 10-year Flood Plains
- "W" ditches – low grade drainage conduits without grass typically on river bottom with soils with high clay content that tile won't effectively drain.
- Other Wetlands not defined as designated wetlands. *All wetlands can have positive effects on water quality downstream. Many are of high environmental value and should be protected from nutrient loading and other pollutants, especially those with native plant communities.*
- Cropland with greater than 10% slopes
- Shallow to Bedrock
- Classic gullies when the concentrated flow leads to a water.
- Tile line surface intakes *(includes terrace intakes)* which outlet into surface or ground water.

E. Options to consider when these sensitive areas are on the planning land unit:

- If in row crop production recommend spring applied N, split applied N, cover crops and/ or using the low end of Corn Nitrogen Rate Calculator (CNRC).
- Land use change
- Install / Maintain a minimum of a 50' filter strip (NRCS CPS 393) where applicable.
- Inject fertilizers or apply phosphorus fertilizers in the fall when surface loss is less of a risk.
- Implement soil conservation practices to minimize soil loss.
- When completing surface application of nutrients within 200' reduce soil loss to less than 5 tons, have a cover crop established (seeded) and/or use a no-till cropping system.
- For tile surface intakes:
  - Blind inlets *(intakes below the surface, can be used with terrace systems)* are treated the same as surface intakes.
  - *Note: IDNR for manure application does not generally require separation to any surface tile intakes, except some large open lots with NPDES permits that require 100' separation.*

F. Other IDNR rules affecting manure application

- **Liquid manure from confinements** - cannot be applied within **750' of a residence, church, business, school, public use area** unless:
  - it is injected or incorporated within 24 hours of application
  - or there is a written waiver from the owner of said property.
- *Refer to **DNR 113 08/2023** for more specific information on separation distances for land application of manure from open feedlots and confinement feeding operations, including Small Animal Feeding Operations (SAFOs).*

G. (590) Nutrient Management Plans

- All sensitive areas must be located on a map.
- Must state what will be done to protect the sensitive area when manure is being used.
- Recommendations must also be made by the Conservation Planner to protect those areas when commercial fertilizers are used.

Section 4: Manure

This document provides specific information when Manure is utilized as a Nutrient Source.
(See the other 590 Guidance Document Sections for additional information regarding the 590 standard implementation.)

General Information

Manure as an agronomic input brings many positives and some negatives when used as a fertilizer and how it affects resource concerns. Livestock numbers have continued to grow in Iowa. Iowa is the number one manure producer in the country. There is enough manure to meet approximately 40% of Iowa's cropland nutrient needs. The goal of planning with manure application is to maximize its benefits and minimize its negatives.

Positives:

- Benefits to raising livestock where the manure can be utilized.
- Potential to increase carbon in our soils. Exporting grain from the state is also exporting carbon.
- Manure is part of our natural ecosystem. It can be a positive for soil health when applied properly.
- Overall, it is more stable in the soil than commercial fertilizers*. This is especially true for solid manure but less so for liquid swine manure.*
- Livestock industry impacts our Iowa economy more than grain alone.
- Reduces expense of commercial fertilizer brought into the state.

Negatives:

- Potential risks for point pollution (*farmstead*) and nonpoint source pollution (*cropland application*).
    - Offsite nutrient loading. *Higher soil test P levels and greater nitrates are often found in our tributaries where high livestock densities are found.*
    - Pathogens (*fecal coliform*) can contaminate surface water bodies, which may cause them to be unfit for recreational use.
- Variability in nutrient content of manure requires the need for testing.
- Nitrogen availability varies by animal source and handling.
- Potential for degraded air quality (particulate matter, odor, etc.).
- Application concerns:
    - Manure can be difficult to timely apply to the land. Nutrients in manure are less concentrated than in commercial fertilizer. As a result, manure may take more time and expense to apply.
    - Manure applied after crop harvest and before soil temps are 50°F and trending colder are at substantial risk for loss for the nitrogen portion.

A. Manure Testing *(Section 4 of 5)*

- Refer to **(ISU) AE3550 "**How to Sample Manure for Nutrient Analysis".
- Manure testing is critical to determine nutrient supply due to wide variation in nutrient concentrations from operation to operation.
    - The average or "book values" can be used for creating a manure management plan for a new facility or when no manure testing has occurred. But the plan is expected to be updated when actual test results are available.
- Tests are to be completed annually unless test values are stable for 3 consecutive years, then testing can be done every 3 – 5 years. *Note: NPDES permitted operations requires annual testing.*
- Manure sampling history will help determine the degree of variability in the manure from year to year. Testing increases the certainty of the nutrients present.

- The following must be analyzed when testing manure:
    - Total Nitrogen (TN or TKN)
        - *The organic portion of the total N is not all available the first year*.
    - Total phosphorus (P) (*wet basis in lbs. / ton or lbs. / 1,000 gal)* is typically expressed as P_2O_5.
        - If expressed as elemental P convert it to P_2O_5. Multiply P by 2.29.
    - Total potassium (*wet basis in lbs. / ton or lbs. / 1,000 gal)* is typically expressed as K_2O.
        - If expressed as elemental K convert it to K_2O. Multiply K by 1.2.
    - Percent moisture (or dry matter)
        - The concentration of nutrients in manure increases as the percent moisture decreases.
- *Recommend the following be analyzed:*
    - *Ammonium N (wet basis in lbs./ton or lb./1,000 gal), represents the inorganic N fraction is 100% plant available.*
    - *Percent solids classification:*
        - *Solid: > 20% solids*
        - *Semi-solid: 10-20% solids*
        - *Liquid: < 10% solids*

- Conversion factors *(see ISU PM 1588 for more conversions)*
    - Lbs. of nutrient / 1,000 gallons to percent, multiply by .012
    - Percent of nutrient to lbs. / 1,000 gallons, multiply by 83.4
    - Percent of nutrient to lbs. / ton, multiply by 20.0
- Sampling Recommendations:
    - Liquid manure
        - *Recommend taking 3 samples when the pit is fully agitated (4 hours of continuous agitation) and is being pumped out when 2/3 full, 1/2 full and 1/3 full and sending each sample in for analysis.*
        - The samples can be mixed, and one analysis completed to meet the 590 standard, but this will not determine how consistent the product is as its pumped out.
        - Samples can be taken before agitation by pulling a sample toward the top, middle, and near the bottom. When this is done the samples taken are mixed and one sample is analyzed.

A. Manure Testing (continued) *(Section 4 of 5)*

        - Variability in the manure can be greater for liquid manure where the solids can settle if not kept agitated. If solids settle out, higher concentration of nutrients will be present in the last loads. This is especially true with phosphorus.
    - Solid manure
        - *Recommend taking samples from different age and type of manure.*
    - Refer to **(ISU) AE3550** for more detailed information on taking manure samples.

- **Labs**
    - All labs used for manure analysis must be certified by the Manure Testing Laboratory Certification program under the auspices of the Minnesota Department of Agriculture (MDA).
    - Go to their website for a list of certified labs. https://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp
    - Note: IDNR does not require labs be certified for manure testing for their manure management plans.

B. Manure Test Results

- **Analysis – Refer to (ISU) PM 3014 "**How to Interpret Your Manure Analysis"
    - For book values use:
        - **Part 651 Agricultural Waste Management Handbook (AWMFH)**. Chapter 4 - Agricultural Waste Characteristics. *(210-VI-AWMFH, March 2008)*
        - **Midwest Plan Service: MWPS-18 section 1, 2nd edition** "Manure Characteristics"**.**
        - **IDNR Manure Management Plan From - Appendix A**

      **These book values are good starting points, but variability can be up to 50% lower or higher than the book values. Manure testing is critical.*

- **Nutrient Availability** - Refer to **(ISU) PMR 1003 "**Using Manure Nutrients for Crop Production"
    - Manure K is readily crop available.
    - Manure N & P is a mix of organic and inorganic, therefore availability varies in the first year.
        - P availability: ranges from 80 – 100% and is less critical when soil test levels are Optimum to Very High.
        - N availability: ranges from 30 – 100% dependent on source.
        - See **(ISU) PMR 1003**, page 4, Table 1.

- **Volatilization Factor**
    - N loss factor is 10% – 40% when broadcast on surface with no incorporation or irrigation.
    - N loss factor is 0-5% when manure is injected or broadcast and immediately incorporated.
    - See **(ISU) PMR 1003**, page 6, Table 2.

C. Manure Application *(Section 4 of 5)*

- **Rate**
  - Most new liquid manure spreaders have flow meters that allow precision on regulating gallons per acre.
  - Solid manure spreaders need to calibrate the spreader or weigh the spreader loaded and keeping track of loads per field to determine tons per acre. Some have load cells on them that will keep track of the amount in each load.
  - The calculation to determine the amount of N applied or N to take credit for is:
    - Bulk Rate (in tons or 1000 gallons) x lbs. of N/ton or 1,000 gallons (Analysis) x Availability % x Volatilization factor
  - Use Corn Nitrogen Rate Calculator (CNRC) (http://cnrc.agron.iastate.edu/) to determine the recommended rate for nitrogen before corn when following a soybean or corn crop.
    - For the purposes of meeting the 590 standard, the rates determined by the following price ratios can't be exceeded:
      - 0.05 N for manure (e.g., $.20 for lb. N and $4.00 for corn)
      - 0.08 for commercial (e.g., $.32 for lb. N and $4.00 for corn)
      - *Prorate when commercial is used with the manure at greater than 50 lbs.*
    - Total nitrogen cannot be applied over the maximum allowable rate.
    - *Iowa Department of Natural Resources (IDNR) determines maximum nitrogen rate for a Manure Management Plan (MMP) by using the corn yield goal method (corn yield goal multiplied by 0.9 to 1.2lbs based on where you are at in the state), to determine total N.* NRCS cannot use this method.

- **Iowa Phosphorus Index (P Index) -** Refer to **(NRCS) Iowa Technical Note No. 25** "Iowa Phosphorus Index"**.**
  - The purpose of the P Index is to assess the risk of P delivery to surface waters.
  - It's required when manure, municipal and industrial biosolids, and/or organic by-products are being applied as part of an IDNR Manure Management Plan (MMP).
  - NRCS 590 standard requires it be ran for both manure and commercial fertilizers.
  - Developed by Iowa State University.
  - Can be found on the Iowa NRCS website – Iowa Technical Resources – Nutrient Management.
  - **Risk Assessment Ranges:**
    - Very Low (0-1) – Low (1-2):
      - Manure can be applied to meet, but not exceed, the nitrogen needed for the crop.
      - P applied may exceed the crop's nutrient requirements for the rotation, *regardless of soil test value.*
    - Medium (2-5):
      - Manure can be applied
        - to meet, but not exceed, the nitrogen needed for the crop.
        - at rates not to exceed crop P removal rate or the soil test P ISU recommended rate for the planned crops in rotation.
    - High (5-12) or Very High (>15):
      - No manure can be applied without implementing practices that will lower the P Index score to Medium or lower.

C. Manure Application (continued) *(Section 4 of 5)*

P Index requires the following for each field to be evaluated:

1. Sheet and Rill estimated soil loss using RUSLE2 (Water Erosion Prediction Tool).
    - When manure or organic by-products are applied, the erosion component of the P Index must be based on the annual soil loss rate for the year in which the manure is applied not for the crop rotation. Years in the cropping rotation not receiving manure may use a rotational average soil erosion rate.
    - When using the P Index on a field or CMU, use the following guidance for selection of the soil type for calculating soil loss:
        - for NRCS planning purposes - use Iowa NRCS Planning Policy to determine the appropriate soil type for evaluation.
        - for IDNR planning purposes - use Iowa Administrative Code, Chapter 65, to determine the appropriate soil type for evaluation.
2. Ephemeral gully erosion and Classic gully erosion
    - Determine the acres of each and estimated tons of soil loss for the eroded area of each.
3. Structural conservation practices in place (e.g., Grade Stabilization Structures (410), Terraces (600), Water and Sediment Control Basins (638)).
    - *Most of the field being evaluated must be protected by the practice to include in the P Index. If the area is partially protected, split the field into different management areas.*
4. Landform Region
5. Distance from middle of field to stream (*perennial or intermittent*)
6. Filter Strip Width: 0 - 19’ / 20’ – 75’ / > 75’
7. Tillage system: no-till / tilled / perennial cover
8. Rotation, contoured or straight, residue poor or good
9. Soil type
10. Soil test ppm (*use average field P ppm*), type of P test (*e.g., Bray 1, etc.)* and P application rate
11. County
12. Tile present or not *(in Iowa this will mostly be answered yes)*

- **Rate Recommendations:**
    - *Apply manure at a rate that is based on P test level needs when it’s the least limiting nutrient.*
        - *This allows the best economic use of the manure and minimizes offsite nutrient losses.*
        - *This may require supplemental commercial nitrogen to be applied when corn is the next crop depending on manure source and analysis.*
    - *Don’t apply P above the maintenance level for the rotation unless soil test levels are in the Very Low to Low range.*
    - Note: Phytase used in swine feed reduces the P in the manure by 20% – 35%.
        - Phytase increases availability of P in the feed which lowers the amount of supplemental P required in the diet. Because of the improved dietary P utilization, less P is excreted in the manure.

C. Manure Application (continued) *(Section 4 of 5)*

- **Timing**
  - Timing for fall applications is the same as anhydrous. Don't apply until the mid-day soil temperature at 4" soil depth is below 50° F and trending cooler.
  - Fall application of manure can be completed when temperatures are higher than 50°F if:
    - a living crop is present, or a cover crop is planted or will be within 48 hours of the manure application. Cover crop must:
      - contain a minimum of ½ winter hardy grain
      - meet NRCS 340 Cover Crop standard
  - No manure may be applied to frozen, snow covered or saturated soils unless it's on an emergency basis and after a manure disposal plan is developed.
    - *Frozen ground is defined as soil that is impenetrable due to frozen soil moisture but does not include soil that is only frozen to a depth of 2" or less.*
    - *Snow covered ground is defined as soil covered by 1" or more of snow or soil covered by ½" or more of ice.*
    - *For more information see Iowa Senate File 432 Subrule 567 IAC 651(1).*

D. Conservation Plan Considerations

- The nutrient management plan is part of the overall agronomic and conservation plan.
- Inventory all fertilizer application methods *(high disturbance applicator, minimal disturbance applicator, solid surface applied and then incorporated, surface applied and not incorporated, irrigation gun, etc.*) so they are accounted for in determining soil loss and soil condition index (SCI), etc.
- Inventory the cropping systems used including rotations, cover crop use, etc. to determine application timing and to maximize the nutrients in the manure.
- Producer baseline system must be documented for any CNMP or Nutrient Management plans utilizing NRCS programs.

E. Manure Management Plan Resources

- **Iowa Technical Note No. 25** – Iowa Phosphorus Index
- **(ISU) AE3550** "How to Sample Manure for Nutrient Analysis"
- **(ISU) PM 3014** "How to Interpret Your Manure Analysis"
- **(ISU) PMR 1003** "Using Manure Nutrients for Crop Production"
- **(IDNR) Manure Management Plan Form, Appendix A** (DNR Form 542-4000a)
- **Part 651 Agricultural Waste Management Handbook (AWMFH)**. Chapter 4 - Agricultural Waste Characteristics
  - *(210-VI-AWMFH, March 2008)*
- **MWPS-18** Manure Characteristics
- Purdue Manure Management Planner
- Iowa Manure Management Action Group web site Iowa Manure Management Action Group (iastate.edu)

Manure Value References

First Year Availability Estimates

(ISU) PMR 1003 - Table 1. First-year nutrient availability for different animal manure sources.

Manure Source	Nitrogen (N)	Phosphorus (P)	Potassium (K)
	----Percent of Total Nutrient Applied----		
Beef cattle *(solid or liquid)*	30-50	80-100	90-100
Dairy *(solid or liquid)*	30-50	80-100	90-100
Liquid swine *(anaerobic pit)*	90-100	90-100	90-100
Liquid swine *(anaerobic lagoon)*	90-100	90-100	90-100
Poultry *(all species)*	50-60	90-100	90-100

See PMR 1003 for more details.

Volatilization Factors

(ISU) PMR 1003 - Table 2. Correction factors to account for N volatilization losses during and after land application of animal manure.

Application Method	Incorporation	Volatilization Correction Factor
Direct Injection	0	0.98 - 1.00
Broadcast (liquid/solid)	Immediate incorporation	0.95 - .99
Broadcast (liquid)	No incorporation	0.75 - .90
Broadcast (solid)	No incorporation	0.75- .90
Irrigation	No incorporation	0.60 - .75

DNR Form 542-4000a

Manure Management Plan Form
Appendix A4: Nutrients in Animal Manure
Page 4

Management System	N	P_2O_5	K_2O	Management System	N	P_2O_5	K_2O
	Lbs./1,000 gallon				Lbs./ton		
Liquid, Pit				**Solid Manure (Bedded)**			
Swine				**Swine-confined**			
Nursery, 25 lb.	35	20	20	Nursery, 25 lb.	14	9	11
Grow-finish, 150 lb. (wet /dry)	58	40	45	Grow-finish, 150 lb.	14	9	11
Grow-finish, 150 lb. (dry feed)	50	42	30	Gestation, 400 lb.	14	9	11
Grow-finish, 150 lb. (earthen)	32	22	20	Sow and litter, 450 lb.	14	9	11
Gestation, 400 lb.	25	25	25	Farrow-nursery	14	9	11

Sow and litter[1], 450 lb.	25	20	15	Farrow finish	14	9	11
Farrow-nursery[2]	27	23	22				
Farrow-finish[3]	44	32	24				
Wean-finish (dry feed0	49	40					
Wean-finish (wet/dry)	56	38					
Dairy-confined				**Dairy-confined**			
Cows, 1,200 lb. or more	25	12	11	Cows, 1,200 lb. or more	12	6	12
Heifers, 900 lb.	25	12	11	Heifers, 900 lb.	12	6	12
Calves, 500 lb.	25	12	11	Calves, 500 lb.	12	6	12
Veal calves, 250 lb.	25	12	11	Veal calves, 250 lb.	12	6	12
Dairy herd[4]	25	12	11	Dairy herd[4]	12	6	12
Beef-confined				**Beef-confined**			
Mature cows, 1,000 lb.	40	25	35	Mature cows, 1,000 lb.	12	6	12
Finishing, 900 lb.	40	25	35	Finishing, 900 lb.	12	6	12
Feeder calves, 500 lb.	40	25	35	Feeder calves, 500 lb.	12	6	12
Lagoon[5]				**Poultry**			
(all animals)	4	3	4	Layer, caged, 4 lb.[6]	35	80	50
				Broiler, litter, 2 lb.	65	65	45
				Turkey, litter, 10 lb.	40	40	25
Open Lot Runoff							
Earthen lots (liquids)				**Open lot (solids, scraped)**			
Beef, 400 sq ft/hd	3	1	6	Beef, 400 sq ft/hd	22	16	14
Dairy, 1,000 sq ft/hd	3	1	6	Dairy, 1,000 sq ft/hd	11	6	11
Swine, 50 sq ft/hd	3	1	6	Swine, 50 sq ft/hd	15	14	9
Concrete lots (liquids)							
Beef, 400 sq ft/hd	6	2	7				
Dairy, 1,000 sq ft/hd	6	2	7				
Swine, 50 sq ft/hd	15	5	10				

[1]Sow and litter figures are per farrowing crate

[2]Farrow-nursery figures are per sow in the breeding herd and include one farrowing sow, five gestation sows, and nine nursery pig spaces.

[3] Farrow-finish figures are per sow in the breeding herd and include one farrowing sow, five gestation sows, nine nursery pigs, and 36 finishing pig spaces.

[4] Per productive cow in the herd; includes lactating cow, 330 days; dry cow, 35 days; heifer, 222 days; and calf, 165 days.

[5] Weights assumed: beef, 1,000 pounds; dairy, 1,200 pounds; swine, 150 pounds.

[6] Wet basis at 41 percent moisture.

Section 5: 512 and 528

*The 590 nutrient and lime recommendations to be followed when giving technical assistance for the following conservation practice standards:
- Pasture and Hay Planting (512)
- Prescribed Grazing (528)

*The recommended rates of N, P, K and Lime need to be followed to meet CPS 512 and put in the CPS 512 Implementation Requirement (IR).

*See 590 Guidance Documents Sections 1 – 4 for additional information regarding 590 implementation.

*Financial assistance programs may have additional requirements.

Phosphorus (P), Potassium (K), and pH

A. Soil Sampling - Refer to (ISU) PM 869 "Fertilizing Pasture" and **(ISU) CROP 3108** "Take a Good Soil Sample to Help Make Good Fertilization Decisions".

- P & K sampling depth is 6" for both pasture and cropland.
  - pH sampling depth can be reduced to 2" – 3" for pasture and no-till. *This is because surface applied limestone seldom changes pH below approximately 3". <u>This is seldom done and requires a second sample taken at 6" for P & K.</u>*
  - For pasture renovations where tillage will occur after lime application, the sampling depth should be at 6".
- Average soil sample size will be no more than 10 acres.
  - Judgement will need to be made on the planner to determine if this criteria is met. Odd areas, streams, ditches, etc. can be excluded from the total acres.

- **<u>Recommendations / Considerations:</u>**
  - Where pastures are being hayed, greater amounts of P & K are being removed. Soil sampling is critical to ensure proper fertility for production.
  - In pasture, sample different plant communities separately when more than one is present.
  - Don't take cores from odd areas or cattle concentration areas. If you want to know the fertility levels in those areas, then collect as a separate sample.
  - Soil test levels will vary with time of year. Sampling at the same time of year is recommended for consistency to determine if fertility levels are increasing or decreasing.
    - Dry soils may not provide accurate results. Fall and spring are the best times to soil sample. Also, that is the time of year the soil tests were calibrated for.

B. P & K Analysis and Rate - Refer to (ISU) PM 869 "Fertilizing Pasture" and **(ISU) CROP PM 1688** "General Guide for Crop Nutrient and Limestone Recommendations in Iowa".

- Soil test ppm categories for P & K (from PM 1688, Table 1).

Soil test category	P (Bray-1 or Mehlich-3 colorimetric)	K (Ammonium Acetate & Mehlich-3; dried samples)
Very Low (VL)	0 - 9	0 - 125
Low (L)	10 - 17	126 - 170
Optimum	18 - 25	171 - 220
High (H)	26 - 34	221 - 270
Very High (VH)	35+	271+

Note: When the soil test method was Mehlich-3 ICP, Olsen, or Field-Moist or Slurry Samples were used for K, go to PM-1688, Table 1, page 3. Note: Alfalfa soil test categories are different, refer to PM-1688, Table 1.

- Use **(ISU) PM869, "**Fertilizing Pasture" for determining rates for pastures.
  - Table 1 and 2 combined (from PM869). Annual phosphorus and potassium application rate for pastures.

Soil test category	Bluegrass		Tall grass & Annual Forages		Alfalfa-Grass		Clover/Trefoil-Grass	
	P2O5	K2O	P2O5	K2O	P2O5	K2O	P2O5	K2O
	lb. / acre							
Very Low (VL)	45	55	63	88	80	145	57	93
Low (L)	35	40	43	68	60	125	43	73
Optimum	20	25	27	50	48	118	27	50
High (H)	0	0	0	0	0	0	0	0
Very High (VH)	0	0	0	0	0	0	0	0

- Use **(ISU) PM1688,** "General Guide for Crop Nutrient and Limestone Recommendations in Iowa" for determining rates of P & K for for hay ground.
  - Table 10, page 8 – alfalfa and alfalfa-grass hay
  - Table 11, page 9 – clover/ trefoil-grass hay
  - Table 12, page 9 – tall cool-season grasses, warm-season grasses, sorghum-sudan hay
- A 2-year rate of P & K may be applied every other year.

Phosphorus (P), Potassium (K), and pH (continued) *(Section 5 of 5)*

C. Soil pH: Analysis and Rate refer to (ISU) PM1688, "A General Guide for Crop Nutrient and Limestone Recommendations in Iowa" (Table 16, page 11) to determine rate of lime needed.

- Determine the type of forage present/ forage desired (e.g., grass, alfalfa, other legumes).
- Soil pH is used to determine the need for lime. The buffer pH is used to determine how much Effective Calcium Carbonate Equivalent (ECCE) lime material to apply to move the pH to the desired level.
- Trigger and Target pH:
  - Alfalfa: if the soil pH is 6.5 or lower, lime to a target pH of 6.9.
  - Other legumes, grasses, mixes, pastures: if the soil pH is 5.5 or lower, lime to a target pH of 6.0.
  - If alfalfa is included in the seed plan, lime to a target pH of 6.9. *Consider using alternative legumes if producer does not want to lime to pH of 6.9.*
- Where no-tillage will occur (existing pasture and long term no-till) samples taken at 6" can be used for pH but lime application rates should be adjusted to ½ of the amounts recommended for a 6" depth.
- When recommendations call for 3 tons or more of ECCE lime, consider split applying over multiple years (*not to exceed 3 years*).
- For small areas consider using Pell Lime but the amount must be based on the recommended rate of ECCE lime.

Nitrogen (N)

Refer to (ISU) PM869, "Fertilizing Pasture"

A. Rate

One-time Annual Rate, *for established stands* (N lbs./ac)

- Kentucky Bluegrass dominated pasture: April: 60 – 100 lbs.
- Tall cool-season grass pasture: April: 80 – 120 lbs.
- Warm Season grass pasture: May: 80 – 150 lbs.
  - For annual warm season grass forages: mid to late May or close to planting.
- Legume-Grass mixes:
  - When 30% dry weight (50% visual) or more of the stand is legumes: 0 lbs.
    - *For red clover and alfalfa which have a higher dry weight, 30% dry weight = 30% visual.*
  - When less than 30% of the stand is legumes, follow recommended rates for the dominant grass type present.

For new cool-season grasses or grass-legume mix seedings, consider 30lbs of nitrogen (*optional*). N is not recommended when the previous crop contained a legume.

Split Applications (N lbs./ac)

- Kentucky Bluegrass dominated pasture: April: 60 – 80lbs / late spring: 40 - 50lbs / early to mid-August: 40 - 60lbs.
- Tall cool-season grass pasture: April: 80 – 120lbs / late spring: 40 – 50lbs / early to mid-August: 60 – 80lbs
  - Recommend the early to mid-August application when adequate stand exists and when producer is stockpiling for late fall and winter grazing.

Nitrogen (N) (continued) *(Section 5 of 5)*

B. Forms of nitrogen:

- Urea (46-0-0)
- Ammonium sulfate (21-0-0)
- Ammonium nitrate (34-0-0), *Limited availability in Iowa. N does not volatize when surface applied.*
- UAN, 28% and 32% N, *may leaf burn growing forages*
- Manure

C. **Nitrogen volatilization losses**

- Issue when surface applying N on pastures, especially in the summer months. Conditions where losses are increased are: 1) soil is wet and drying out, 2) warm temps, 3) high residue, and 4) soils with pH above 7.0.
- Urea N loss can be as high as 20-30%. Receiving at least 0.25" of rainfall within two days after application can greatly diminish the potential for loss.
- Products to reduce nitrogen loss include: Encapsulated Nitrogen (ESN), Polymer coated urea, and Urease Inhibitor.
    - Consider when applying during warm temperatures.
    - *For additional information look at 590 Guidance Document Section 2 on Nitrogen.*
    - NRCS only recognizes, *able to use in NRCS programs or provide Technical Assistance,* products that Iowa State University recommends.

D. Recommendations:

- Interseed legumes into grass pastures when less than 30% dry weight (50% visual). This will provide the needed nitrogen and improve forage quantity and quality throughout the summer.
    - *For red clover and alfalfa which have a higher dry weight, 30% dry weight = 30% visual.*
- When legumes are not present, split applications of nitrogen are recommended.

Sensitive Areas

- Refer to 590 Guidance Document Section 3 for more details.
- Perennial vegetation providing 80% ground cover may have fertilizer applied within 50 ft of the sensitive area.

References

- (ISU) CROP 3108 "Take a Good Soil Sample to Help Make Good Fertilization Decisions"
- (ISU) PM869, "Fertilizing Pasture"
- (ISU) PM1688**,** A General Guide for Crop Nutrient and Limestone Recommendations in Iowa

References

- (ISU) CROP 3108 Take a Good Soil Sample to Help Make Good Fertilization Decisions, December 2016
- (ISU) PM 869, Fertilizing Pasture, Revised March 2023
- (ISU) PM 1688**,** A General Guide for Crop Nutrient and Limestone Recommendations in Iowa, Revised February 2023
- (ISU) SP 435 A, Reducing Nutrient Loss: Science Shows What Works, Revised October 2019
- (ISU) CROP 3073, Nitrogen Use in Iowa Corn Production, Revised March 2018
- (ISU) PM 2015, Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn, April 2006
- (ISU) CROP 3140, Use of the Late-Spring Soil Nitrate Test in Iowa Corn Production, May 2017
- (ISU) PM 2026, Sensing Nitrogen Stress in Corn, April 2011
- (ISU) AG 202, Spring Wheat in Iowa, March 2008
- (ISU) CROP 3154 Use of the End-of-Season Corn Stalk Nitrate Test in Iowa Corn Production, July 2018
- Iowa Department of Natural Resources, DNR 113 Separation Distances for Land Application of Manure from Open Feedlots & Confinement Feeding Operations, including SAFOs and truck wash effluent, Revised August 2023
- Iowa Department of Natural Resources, DNR 117 High Quality Water Resources, March 2003
- (ISU) AE 3550, How to Sample Manure for Nutrient Analysis, January 2021
- (ISU) PM 3014, How to Interpret Your Manure Analysis, September 2011
- MidWest Plan Service, MWPS-18, Section 1, Second Edition Manure Characteristics – Manure Management Systems Services, January 2004
- Iowa Department of Natural Resources, DNR Form 542-4000 Manure Management Plan Form, January 2022
- (ISU) PMR 1003 Using Manure Nutrients for Crop Production, April 2023