**NATURAL RESOURCES CONSERVATION SERVICE**
**MONTANA CONSERVATION PRACTICE SPECIFICATION**

# NUTRIENT MANAGEMENT (ACRE)

## CODE 590

PRODUCER

TRACT. / FIELD NO. / CTU

**DEFINITION:** Nutrient management is managing the amount, source, placement, form, and timing of plant nutrients and soil amendments.

**PURPOSE:** Nutrient management effectively and efficiently uses scarce nutrient resources to adequately supply soils and plants appropriate nutrients to produce food, forage, fiber, and cover while minimizing environmental degradation. Nutrient management is applicable to all lands where plant nutrients and soil amendments are applied.

**CONSERVATION MANAGEMENT SYSTEMS.** Nutrient management may be a component of a conservation management system. It is used in conjunction with crop rotation, residue management, pest management, conservation buffer practices, and/or other practices needed on a site-specific basis to address natural resource concerns and producer objectives. The major role of nutrient management is to minimize nutrient losses from fields, thus helping protect surface and ground water supplies.

**NUTRIENT MANAGEMENT PLANNING.** The nutrient management plan is a dynamic tool and must be monitored and adjusted on an annual basis. As a minimum, a nutrient budget for nitrogen, phosphorus, and potassium will be designed that considers all sources of nutrients including animal manures, organic by-products, waste water, irrigation water, commercial fertilizer, crop residues, legumes, and atmospheric deposition.

Nutrient management components of the conservation plan will include the following information:

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- Nutrient budget, including credits of nutrients available
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of designated sensitive areas
- Guidelines for operation and maintenance.

Nutrient management is most effective when used with other agronomic practices, such as cover or green manure crops, residue management, conservation buffers, water management, pest management, and crop rotation.

Expected Yield.

Method 1. **YIELD GOALS OF CEREALS AND SAFFLOWER** can be calculated using the following procedure:

Refer to Agronomy Technical Note 110.4, Determining Plant Available Moisture for Flex-Crop Systems, to determine (a) plant available soil moisture, and (b) growing season precipitation in inches based on 70 percent probability. Determine consumptive use from FOTG, Section I, Maps, Irrigation Climatic Areas for Montana, 1986. Then, using Tables 1, 2, 3, 4, or 5, estimate potential yield for the specific crop.

Method 2. **AVERAGE YIELD METHOD**

Use the producers yield records (i.e., weight slips from the elevator, documented records, etc.) to average the yields obtained over a period of years. Yield estimates will be more accurate with a greater number of years of data. Years of exceptionally poor or exceptionally good yields should be eliminated from the calculation. Then you simply add up all the yields and divide by the number of years crops were produced.

Example:

1996 = 35 bu/ac
1997 = 38 bu/ac
1998 = 21 bu/ac (drought)
1999 = 40 bu/ac
2000 = 30 bu/ac
2001 = 33 bu/ac

$$\frac{35 + 38 + 40 + 30 + 33}{5 \text{ yrs}} = 35.2 \text{ bu/ac}$$

35.2 plus 5% = **37 BU/AC EXPECTED YIELD**

The expected yield can then be calculated by adding 5 percent onto the average yield. Five percent is added to figure in a little higher yield to cover those years when conditions are favorable and to take into account improved varieties and management techniques.

Soil Tests.

Current soil tests must be used to effectively plan for nutrient application. Current soil tests are those that are no older than five years. When a first time nutrient management plan is designed, especially if animal wastes are to be utilized as a source of nutrients, soil tests should be taken the year the plan is developed for most accurate planning. Due to potential annual variability, Nitrogen should be tested each year a crop is grown. Phosphorus and potassium may be completed once every three years until a baseline or consistent database is established. Application of micro-nutrients should be based on soil tests or plant analysis.

Regular testing of soil nutrient availability is essential for proper nutrient management decision making. Soil tests should be completed as close as possible to the time of seeding. When organic matter mineralizes it releases Nitrogen into the soil for potential plant uptake. The Montana Nitrogen fertilizer guidelines assume an average organic matter level of two percent. This is directly incorporated into the available Nitrogen requirements. For soils that have organic matter levels that exceed two percent, additional Nitrogen will be released to the soil through mineralization at a rate of 15-20 pounds of Nitrogen per acre for each one percent of organic matter. Therefore, for nutrient budgeting purposes, Nitrogen fertilizer rates can be decreased by 15-20 pounds Nitrogen per acre, if the soil has three percent organic matter or more, assuming moisture and heat conditions are adequate (limits: dry land crops maximum 30 pounds; irrigated crops maximum of 60 pounds).

Where annual precipitation is less than 14 inches, zero pounds of nitrate Nitrogen credit for mineralization should be assigned.

$$\frac{\text{Soil sample depth (in.)}}{6 \text{ (in.)}} \times 2 \times \_\_\_ \text{ ppm} = \text{lbs./acre } NO_3$$

Where two soil samples are taken and analyzed at different depths, i.e., at 0”- 12” and at 12”- 24”, calculate pounds of nitrogen using the above formula for each sample depth and add the results.

For example: Soil was sampled at two different depths to get a better representation of nutrient concentrations. Results were:

Sample 1: 0-12" 32 ppm $NO_3$
Sample 2: 12-18" 8 ppm $NO_3$

Calculations – sample 1. $\frac{12"}{6"} \times 2 \times 32$ ppm = 128 lbs./ac $NO_3$

- sample 2. $\frac{6"}{6"} \times 2 \times 8$ ppm = 16 lbs./ac $NO_3$

128 + 16 = 140 lbs./ac $NO_3$

Nutrient Application Timing.

Apply nutrients as close to time of utilization as possible. This will ensure that potential for leaching, runoff, or volatilization will be minimized. Nitrogen application in the fall is not recommended except for fall seeded crops, with the exception of "starter fertilizer".

Field Risk Assessment.

When animal manure or other organic by-products are applied, a site-specific assessment of the potential for Phosphorus and Nitrogen transport from the field must be completed using the Montana Phosphorus Index and the Nitrogen Index. Copies of each completed index will be attached to this specification.

When the Phosphorus Index (PI) assessment rating is **N/A**, **LOW**, or **MEDIUM**, Nitrogen-based Phosphorus application plans will be developed such that manure application rates of Nitrogen do not exceed crop and soil needs based on the nutrient budget (see Table 8).

When the Phosphorus Index (PI) assessment rating is **HIGH**, Phosphorus-based plans will be developed such that manure application rates of Phosphorus do not exceed crop removal rates (see Table 9). When the Phosphorus Index (PI) assessment rating is **VERY HIGH**, Phosphorus-based plans will be developed such that manure application rates of Phosphorus do not exceed crop removal rates or no application of manure will be recommended (see Table 9).

**GENERAL NUTRIENT MANAGEMENT CONSIDERATIONS**

- Test soil, plants, water and organic material for nutrient content.
- Set realistic yield goals.
- Apply nutrients according to soil test analysis recommendations.
- Account for nutrient credits from all sources.
- Consider effects of drought or excess moisture on quantities of available nutrients.
- Use a water budget to guide timing of nutrient applications.
- Use cover and green manure crops where possible to recover or retain residual Nitrogen and other nutrients between cropping periods.
- Use split applications of Nitrogen fertilizer for greater nutrient efficiency.

- Returning crop residue to the soil requires additional Nitrogen due to microbial activity “tying up” some Nitrogen especially when adding high-carbon organic residues. As a rule, approximately ten pounds of Nitrogen for every 1,000 pounds of residue over 3,000 pounds should be added to the soil to offset this tie-up if Nitrogen is in deficit in the nutrient budget.

- If an irrigation water test has been completed, use Table 7 Nitrogen Contribution from Irrigation Water, to determine total pounds of Nitrogen supplied from water.

- Use Table 6, Nitrogen Fixation Estimates for Dryland Conditions, to estimate legume credit of nitrate-Nitrogen when a soil test is not available.

**NUTRIENT MANAGEMENT ASSESSMENT.** Make a site-specific environmental assessment of the potential risk of nutrient management. The boundary of the nutrient management assessment is the Agricultural Management Zone (AMZ), which is defined as the edge of field, bottom of the root zone, and top of crop canopy.

Within an area designated as having impaired or protected natural resources (soil, water, air, plants, and animals), the nutrient management plan should include an assessment of the potential risk for Nitrogen and Phosphorus to contribute to water quality impairment.

The Leaching Index (LI), Nitrogen Index, Phosphorus Index (PI), erosion prediction models, and water quality monitoring, may all be used to assess risk.

Evaluate other areas that might have high levels of nutrients, produced or applied, that may contribute to environmental degradation. For example, areas with high livestock concentrations for large areas of high intensity cropping, such as continuous potatoes, corn, or specialty crops, may be contributing heavy nutrient loads to surface or ground water.

Conservation practices and management techniques will be implemented with nutrient management to mitigate any unacceptable risks.

**GUIDELINES FOR OPERATION AND MAINTENANCE**

- Review the nutrient management component of the conservation plan annually and make adjustments when needed.

- Calibrate application equipment to ensure uniform distribution and accurate application rates.

- Protect nutrient storage areas from weather to minimize runoff and leakage.

- Avoid unnecessary exposure to fertilizer and organic waste, and wear protective clothing when necessary.

- Observe setbacks required for nutrient applications adjacent to water bodies, drainageways, and other sensitive areas.

- Maintain records of nutrient application as required by state, tribal, and local regulations.

- Clean up residual material from equipment and dispose of properly.

**TABLE 1. ESTIMATED SPRING WHEAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]**

| CONSUMPTIVE USE AREA | STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BUSHELS PER ACRE[bc] | | | | | | | | | | | | | | |
| 1. High | 0 | 6 | 10 | 15 | 20 | 24 | 29 | 34 | 39 | 43 | 48 | 53 | 57 | 62 | 67 |
| 2. Moderately High | 0 | 6 | 11 | 16 | 21 | 27 | 32 | 37 | 42 | 47 | 52 | 57 | 62 | 67 | 72 |
| 3. Moderate | 0 | 7 | 13 | 19 | 24 | 30 | 36 | 42 | 48 | 53 | 59 | 65 | 71 | 77 | 82 |
| 4. Moderately Low | 0 | 7 | 13 | 20 | 26 | 32 | 38 | 44 | 50 | 56 | 62 | 68 | 74 | 80 | 87 |

**TABLE 2. ESTIMATED BARLEY YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]**

| CONSUMPTIVE USE AREA | STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BUSHELS PER ACRE[bc] | | | | | | | | | | | | | | |
| 1. High | 6 | 13 | 20 | 27 | 34 | 41 | 48 | 55 | 62 | 69 | 76 | 83 | 90 | 97 | 104 |
| 2. Moderately High | 7 | 14 | 22 | 30 | 37 | 45 | 52 | 60 | 68 | 75 | 83 | 90 | 98 | 106 | 113 |
| 3. Moderate | 8 | 16 | 25 | 33 | 42 | 50 | 59 | 67 | 76 | 84 | 93 | 101 | 110 | 118 | 127 |
| 4. Moderately Low | 8 | 17 | 26 | 35 | 44 | 53 | 62 | 71 | 80 | 89 | 98 | 107 | 116 | 125 | 134 |

a Estimated yields reflect consumptive use data from Huntley, Havre, Sidney, Conrad, Kalispell, Bozeman, and Moccasin.
b Yields may vary from estimates due to climatic conditions, weeds, disease, insects, lodging, or stand density.
c When rooting depths are limited by rocks, gravel, or impermeable layers such as shale, yields may vary.

**TABLE 3. ESTIMATED WINTER WHEAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]**

| CONSUMPTIVE USE AREA | STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BUSHELS PER ACRE[bc] | | | | | | | | | | | | | | |
| 1. High | 0 | 6 | 11 | 17 | 22 | 28 | 33 | 38 | 44 | 49 | 55 | 60 | 65 | 71 | 76 |
| 2. Moderately High | 0 | 6 | 12 | 18 | 24 | 30 | 35 | 41 | 47 | 53 | 59 | 64 | 70 | 76 | 82 |
| 3. Moderate | 0 | 7 | 14 | 20 | 27 | 34 | 40 | 47 | 53 | 60 | 67 | 73 | 80 | 86 | 93 |
| 4. Moderately Low | 0 | 8 | 15 | 22 | 29 | 36 | 43 | 50 | 57 | 64 | 71 | 78 | 85 | 92 | 99 |

**TABLE 4. ESTIMATED OAT YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]**

| CONSUMPTIVE USE AREA | STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BUSHELS PER ACRE[bc] | | | | | | | | | | | | | | |
| 1. High | 0 | 2 | 11 | 21 | 30 | 39 | 49 | 58 | 68 | 77 | 86 | 96 | 105 | 115 | 124 |
| 2. Moderately High | 0 | 2 | 12 | 23 | 33 | 43 | 54 | 64 | 74 | 84 | 95 | 105 | 115 | 126 | 136 |
| 3. Moderate | 0 | 2 | 14 | 26 | 37 | 49 | 61 | 72 | 84 | 96 | 108 | 119 | 131 | 143 | 154 |
| 4. Moderately Low | 0 | 2 | 15 | 28 | 40 | 52 | 65 | 78 | 90 | 102 | 115 | 128 | 140 | 152 | 165 |

**TABLE 5. ESTIMATED SAFFLOWER YIELDS[a] BASED ON STORED SOIL WATER AND GROWING SEASON PRECIPITATION[a]**

| CONSUMPTIVE USE AREA | STORED SOIL WATER + GROWING SEASON PRECIPITATION (IN.) 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 228 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | POUNDS PER ACRE[bc] | | | | | | | | | | | | | | |
| 2. Moderately High | 115 | 279 | 443 | 607 | 771 | 935 | 1,099 | 1,263 | 1,427 | 1,591 | 1,755 | 1,919 | 2,083 | 2,247 | 2,411 |

[a] Estimated yields reflect consumptive use data from Huntley, Havre, Sidney, Conrad, Kalispell, Bozeman, and Moccasin.
[b] Yields may vary from estimates due to climatic conditions, weeds, disease, insects, lodging, or stand density.
[c] When rooting depths are limited by rocks, gravel, or impermeable layers such as shale, yields may vary.

**TABLE 6. NITROGEN FIXATION ESTIMATES FOR DRYLAND CONDITIONS[1]**

| Legume | N FIXATION (Lb./acre) |
|---|---|
| Alfalfa (after harvest) | 40-80 |
| Alfalfa (green manure) | 80-90 |
| Spring Pea | 40-90 |
| Winter Pea | 70-100 |
| Lentil | 30-100 |
| Chickpea | 30-90 |
| Fababean | 50-125 |
| Lupin | 50-55 |
| Hairy Vetch | 90-100 |
| Sweetclover (annual) | 15-20 |
| Sweetclover (biennial) | 80-150 |
| Red Clover | 50-125 |
| Black Medic | 15-25 |

[1] The large variation in estimates is attributed to different years, climate, management, etc.

**TABLE 7. NITROGEN CONTRIBUTION FROM IRRIGATION WATER**

**Water Application Rate** (Acre-feet)

| N IN WATER (PPM) | 0.5 | 1.0 | 1.5 |
|---|---|---|---|
| | (LBS N/ACRE) | | |
| 2 | 3 | 5 | 8 |
| 4 | 5 | 11 | 16 |
| 6 | 8 | 16 | 24 |
| 8 | 11 | 22 | 32 |
| 10 | 13 | 27 | 40 |

**TABLE 8. PHOSPHORUS APPLICATION BASED ON PI**

| PHOSPHORUS RISK RATING | PHOSPHORUS APPLICATION |
|---|---|
| Low Risk | Nitrogen Based |
| Medium Risk | Nitrogen Based |
| High Risk | Phosphorus Based (up to crop removal amounts) |
| Very High Risk | Phosphorus based or no application |

**TABLE 9. PHOSPHORUS APPLICATION FROM SOIL TEST RESULTS**

| SOIL TEST PHOSPHORUS LEVEL | PHOSPHORUS APPLICATION |
|---|---|
| $\leq$8.0 | Nitrogen Based |
| 8.1 – 25.0 | Nitrogen Based |
| 25.1 – 100.0 | Phosphorus Based |
| 100.1 – 150.0 | Phosphorus Based (up to crop removal) |
| >150.0* | No Application |

* Estimate; subject to modification based on the development of new research relevant to Montana

**TABLE 10. GYPSUM REQUIREMENTS FOR SODIUM AFFECTED SOILS**

| SAR* | GYPSUM ($CaSO_4 \bullet 2H_2O$) lbs/10,000 $ft^2$ |
|---|---|
| 0 –12 | 0 |
| 12 – 21 | 50 |
| 21 – 31 | 100 |
| 31 – 40 | 150 |

***SAR** = Sodium adsorption ratio,
0 – 6 inch sample depth

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