NRCS Water Quality Job Sheet — November 1998

Nitrogen Management Matrix and Recommended Water Quality BMP’s

Table 1 - Potential leaching hazard as predicted by soil type [1], aquifer depth [2], and irrigation method.

Irrigation Method	Aquifer Depth and Condition		
	Shallow or Contaminated	**Deep or uncontaminated**	**Aquifer Properties Unknown**
Flood or Conventional furrow with efficiency < 60%	Coarse soil: *Severe* Fine soil: *Moderate*	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Severe* Fine soil: *Moderate*
Spinkler or surge furrow with efficiency > 60%	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Moderate* Fine soil: *Slight*
Drip or low-energy precision application irrigation	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Slight* Fine soil: *Slight*	Coarse soil: *Moderate* Fine soil: *Slight*
Dryland < 35 inch rainfall	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Slight* Fine soil: *Slight*	Coarse soil: *Moderate* Fine soil: *Slight*
Dryland 35 inch rainfall or greater	Coarse soil: *Severe* Fine soil: *Moderate*	Coarse soil: *Moderate* Fine soil: *Slight*	Coarse soil: *Severe* Fine soil: *Moderate*

[1] Soil texture breakdown: Coarse soil is soil with > 35% sand and < 30% clay including, loamy sand, sandy loam, sandy clay loam, or loam soil. If the predominant soil or soils in a field are coarse textured, the entire field should be considered coarse in this rating scale. Fine textured soils include those textures not mentioned above.

[2] Shallow groundwater is defined here as < 25 feet below the soil surface. Contaminated refers to aquifers with > 10 ppm NO_3 –N.

Severe leaching hazard: Operators should implement all feasible BMP’s.
Moderate leaching hazard: Operators should evaluate fertilizer use and apply feasible BMP’s.
Slight leaching hazard: Operators should continue to use fertilizers according to recommendations and good management procedures.

Table 2 - Best Management Practices Explained

Account for nitrogen from sources other than commercial fertilizer.	Examples: 20 – 30 pounds of N for every percent soil organic matter, Nitrates in irrigation water (see Table 4), 15 – 30 pounds N from rainfall depending on location, N credit from legume cover crop = 5% of annual biomass produced, animal waste application, etc.
Fertilizer placement and timing (dryland or irrigated when appropriate)	N fertilizer application should be timed to coincide as closely as possible to the period of maximum crop uptake. Fall application of N for spring crops should be avoided in situations with severe leaching potential. Subsurface or incorporated fertilizers are much less prone to surface loss. Band applications of fertilizer can reduce total amount applied and increase plant use efficiency. Partial application of N in the spring followed by sidedress application improves crop N uptake efficiency and reduces N available for leaching (see Figure 1). Waiting for crop to be well established before applying large amounts of N reduces early season losses and enables the producer to better forecast yield potential. Normal sidedress applications should be reduced in situations of poor stand, lower than normal rainfall, or poor weed control. Conversely, exceptional growing conditions justify increased fertility at sidedress time.

Table 2 - **Best Management Practices Explained**

Fertilizer placement and timing (irrigated when appropriate)	In furrow irrigated cropland, alternate furrow irrigation used with ridge bands can greatly reduce downward movement of N. Application of N through high efficiency irrigation systems such as center pivot or surge systems at periods of maximum uptake may increase N efficiency. Tail water recovery should also be employed in these situations. It is not recommended that N be applied through low efficiency furrow and flood irrigation systems due to the runoff and deep percolation loss potential.
Nitrogen forms	Nitrate forms are readily available for plant growth, but are subject to leaching losses. Nitrate forms should not be applied in large quantities when leaching hazard is severe or moderate. Ammonium N forms, such as urea or anhydrous ammonia, are preferred because they are not immediately subject to leaching. However, under warm moist conditions, transformation of NH_4 to NO_3 occurs rapidly. Other more slowly available N sources are available and should be used when economically feasible. Nitrification inhibitors can be used to delay the conversion of NH_4 to NO_3 under certain conditions. Producers should consider use of nitrification inhibitors when it is not feasible to split applications or other management techniques in situations of severe leaching potential. Nitrification inhibitors should not be used as a substitute for other BMP's.
Plant Analysis	Plant analysis during the growing season is another practice to help assess nutrient sufficiency in the growing plant. This technology allows the producer to apply less preplant N, and monitor and adjust plant nutrient status throughout the growing season. Plant analysis, properly used, offers producers insurance that careful N management will not negatively affect the bottom line.
Irrigation Management.	Increasing irrigation efficiency and uniformity reduces the amount of water drained through the soil, and decreases the amount of NO_3 and other contaminants leached. Examples of application systems that can increase efficiency are center pivot, surge, low-energy precision application, and drip. Delivery systems such as lined ditches and pipelines, as well as, tailwater recovery ponds, can greatly increase overall efficiency. Shortening irrigation run length on coarse textured soils can decrease deep percolation and leaching. Laser leveling of fields, irrigation scheduling due to soil depletion and plant needs, and conservation tillage can also significantly decrease irrigation requirements.
Crop Rotation.	Crop rotation can be beneficial minimizing fertilizer and pesticide needs. Often, yield improvement and economic benefits are achieved through a good rotation plan. Combined with conservation tillage, organic matter may be increased improving water holding and reducing leaching. The rotation of deep-rooted crops with shallow rooted crops can help scavenge N, which escaped the root zone of the shallow rooted crop.
Proper calibration and maintenance of application equipment.	Proper calibration and maintenance of application equipment is essential for all nutrient management programs to ensure proper amount and uniform application of the desired nutrients.
Soil Testing.	Soil testing (at least at the frequency noted in Table 3) is essential to all nutrient management programs. Periodic deep testing within the root zone is recommended for loamy to clayey soils to account for accumulation that may occur. In situations of severe leaching, periodic testing below the root zone should be initiated to determine if nitrates are leaching below the root zone.
Realistic yields goals.	Realistic yield goals are essential to all nutrient management programs. It is generally suggested that realistic yield goals be established for each field by averaging the past 5 years yield and then adding 5% to account for variability in climate, improvement in plant genetics, etc.

Figure 1 – General Estimations of potential soil nitrogen losses occurring when fertilizer is applied in a single (A) or in split applications (B).

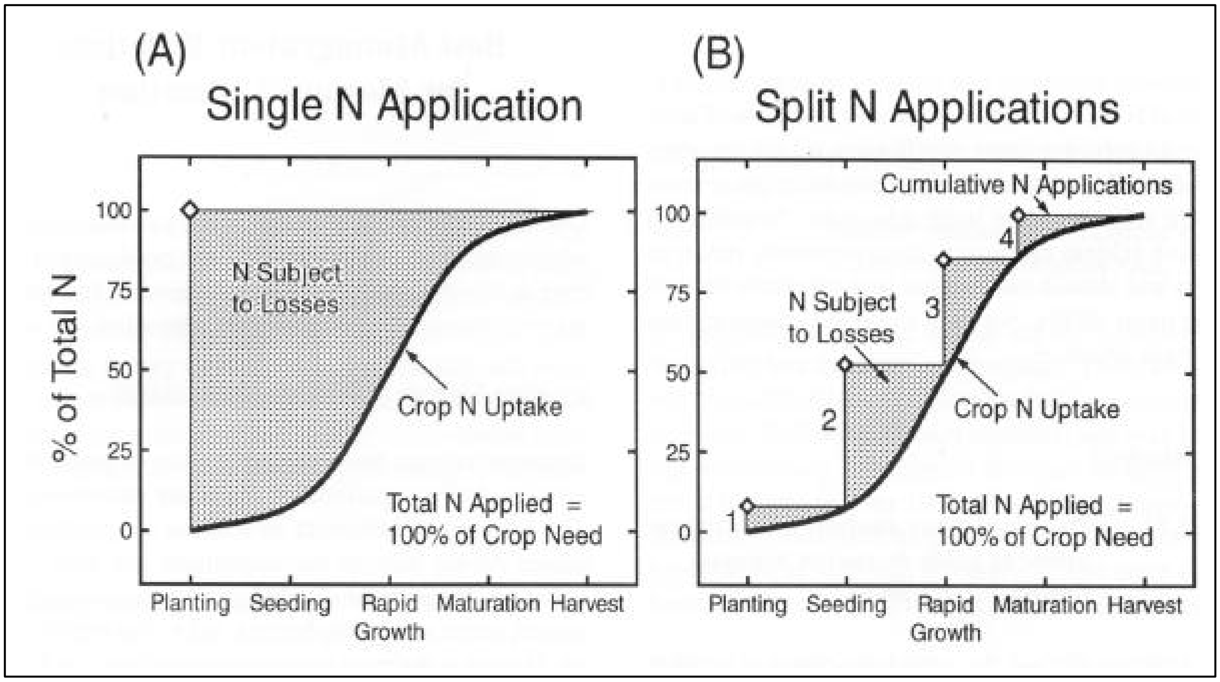

Table 3 – Approximate rooting depths for selected crops under furrow irrigation.

Crop	Root Depth at Maturity (ft)
Corn	2 - 3
Small grains	3 - 5
Onions	1 – 2
Sugarbeet	5 – 8
Alfalfa	8 – 15
Dry beans	2 - 3
Cotton	2 - 5

Table 4 – N credit from irrigation water.

NO3-N conc. In water (ppm or mg/L)	Effective Irrigation (acre inches) 6	12	18	24	30	36
	Lb N/ac					
2	3	5	8	11	14	16
4	5	11	16	22	27	33
6	8	16	24	32	41	49
8	11	22	32	43	54	65
10	13	27	40	54	67	81
12	15	32	48	65	81	97
14	18	37	56	76	95	113
16	21	42	64	87	109	129
18	24	47	72	98	123	145

Matrix, text, Figure 1, and Table 3 adapted from, *Best Management Practices for Nitrogen Fertilization,* Colorado State University Cooperative Extension Bulletin #xcm-172, Irrigation N credit table from, CSU Extension publication, *BMP's for Irrigated Agriculture*. Other sources include, USDA – NRCS nutrient management standard, Texas Ag. Extension Service, *Soil fertility and Fertilizer Management,* and Texas Ag. Experiment Station information.