Appendix F

Agronomic Rate Determination by Crop

Crop species and yield goal are important considerations when formulating agronomic rates. Multiplying the crop yields by the crops' nutrient uptake allows you to determine the amount of nutrients the plants can remove from the soil. When determining agronomic rates for manure application, it is important to choose achievable yield goals. Setting goals to high results in unused nutrients. The following pages provide some of the information you may need to determine agronomic rates for crops. An example illustrating the steps involved in determining the rate is also included.

Step 1: Set Crop Yield Goals

A) Your records will provide the data needed to generate realistic goals. To set your goals, average yields for the past three to five years for each field.

Example:		Date	Orchardgrass Yield Average Yield
	1991 7.0 tons DM/ac	7.0 + 6.5 + 6.5 + 7.0 = 27	
1992	6.5 tons DM/ac	27) 4 = 6.75	
1993	6.5 tons DM/ac		
1994	7.0 tons DM/ac	**Yield Goal = 6.75 tons DM/ac**	

Your Farm: Crop to be grown
Yield Goal, tons/ac

B) If you do not have data for past yields, contact your local Soil Conservation Service office for help in determining expected yields for your soil type. The following table provides a range of yields for crops grown in Western Washington.

Typical Yield Ranges for Western Washington Crops

Crop	Yield Range (100% DM)
Orchardgrass/Clover Mix, Prebloom	3 to 8 tons/ac
Alfalfa, Early Bloom	6 to 8 tons/ac
Orchardgrass	3 to 8 tons/ac
Rye Grass, Perennial	3 to 7 tons/ac
Corn Silage	4 to 9 tons/ac
Annual Winter Cover (Cereal Grains)	0.5 to 3 tons/ac
Native Forage (ie, Blue Grass, Bent Grass)	1.5 to 3.5 tons/ac
	1 to 2.5 tons/ac

Source: Chaney; Fransen; Grusenmeyer

Expected pasture yields under very intensive management systems could be as high as yields listed above for hay or silage. Under less intensive systems, multiply the above yields by a factor of .8 for pastures that are well managed, .6 for moderately managed, or .4 for poorly managed.

Step 2: Determine Crop Nutrient Content

C) The percent nutrients removed varies considerably depending on such factors as crop mix and time of harvest. Laboratory analysis is the only accurate means of knowing the nutrient content of your forages. If a lab analysis is not available, check with your local Natural Resources Conservation Service or Cooperative Extension office for local data. If local data do not exist, the following table can be used to estimate nutrient needs for Western Washington crops.

Plant Nutrient Content by Crop

Crop	Percent of Nutrients by Weight (DM Basis) N	P	K
Orchardgrass/Clover Mix, Prebloom	3.0	0.3	2.5*
Alfalfa, Early Bloom	3.2	0.2	2.5
Orchardgrass	2.9	0.4	3.0*
Rye Grass, Perennial	2.9	0.3	1.5
Corn Silage	1.2	0.3	1.1
Annual Winter Cover (Cereal Grain)	1.8	0.3	2.0*
Native Forage (ie, Blue Grass, Bent Grass)	2.2	0.35	2.0
Annual Rye Grass, Fall Planted	2.4	0.40	1.8

*The percent nutrients removed varies depending on the crop mix. The asterisk indicates crops where potassium uptake can vary considerably. This difference may be of significance if potassium concentrations in your soil or forage are already a concern.

Source: Adapted from SCS, Agricultural Handbook (Grusenmeyer)

D) Calculate Nutrient Uptake by Crop

Example: Crop *Orchardgrass* Yield Goal *6.75 tons DM/ac* (from Step 1, A)

Percent of Nutrients by Weight (from Step 2, C)

N *2.9%* P *0.4%* K *3.0%*

Calculate nutrients for yield goals:

convert yield goal to lbs *6.75* tons DM/ac H 2000 lbs/ton = *13,500* lbs DM/ac

calculate nitrogen for yield goal *0.029* H *13,500* = *391* lbs N/ac
calculate phosphorus for yield goal *0.004* H *13,500* = *54* lbs P/ac
calculate potassium for yield goal *0.030* H *13,500* = *405* lbs K/ac

Your Farm: Crop ____ Yield Goal _____ ton DM/ac

Percent of Nutrients by Weight
N ___ P ___ K ___

Calculate nutrients for yield goals:

convert yield goal to lbs ___ tons/ac H 2000 lbs/ton = ____ lbs/ac

calculate nitrogen for yield goal ___ H ____ = ___ lbs N/ac
calculate phosphorus for yield goal ___ x ____ = ___ lbs P/ac
calculate potassium for yield goal ___ H ____ = ___ lbs K/ac

The following table provides an estimate of nutrient uptake for Western Washington crops. The yield goal is an average taken from the yield ranges listed in the previous table titled "Typical Yield Ranges for Western Washington Crops".

Crop Nutrient Requirements

Crop	**Yield Goal** (100% DM)	**N** (lbs/ac)	**P** (lbs/ac)	**K** (lbs/ac)
Orchardgrass/Clover Mix, Prebloom	5.5 tons/ac	330	33	275*
Alfalfa, Early Bloom	7 tons/ac	448	28	350
Orchardgrass	5.5 tons/ac	319	44	330*
Rye Grass, Perennial	5 tons/ac	290	30	150
Corn Silage	6.5 tons/ac	156	39	143
Annual Winter Cover (Cereal Grains)	1.75 tons/ac	63	10.5	70*
Native Forage (ie, Blue Grass, Bent Grass)	2.5 tons/ac	110	17.5	100
Annual Rye Grass, Fall Planted	1.75 tons/ac	84	140	63
*Crop nutrient needs vary depending on crop mix.				

Step 3: Adjust for Nutrients Met From Other Sources

E) Determine the amount of N being applied through irrigation water.

ppm NO_3-N (from water test results) H 2.7 H ___ inches water applied) 12 = lbs N per acre added in irrigation water

Example: *10* ppm NO_3-N H 2.7 H *18* inches) 12 = *40* lbs N/acre

Your Farm: __ ppm NO_3-N x 2.7 H __ inches) 12 = __ lbs N/acre

F) Adjust crop N requirements to account for N being added through irrigation water.

Example: *391* lbs N/ac (from Step D) - *40* lbs N/acre (from Step E) = *351* lbs N/acre

Your Farm: ___ lbs N/acre - ___ lbs N/acre = ___ lbs N/acre

G) Adjust crop N requirements to account for residual soil NO_3 concentrations.

Example: *351* lbs N/acre (from Step F) - *20* lbs N/acre (from soil nitrate tests) = *331* lbs N/acre

Your Farm: ___lbs N/acre - ___lbs N/acre = ___lbs N/acre

H) If other nutrients are a concern in your area, you should repeat the above steps to make adjustments for them as well. This is particularly true for potassium due to herd health problems that can result if forage is fed that is too high in this nutrient.

Result:

In this example, the orchardgrass needs an additional 331 lbs of N per acre in order to reach the yield goal of 6.75 tons of DM per acre. Based on a number of management factors, this 331 lbs of N may also need to be increased to account for volitilazation and denitrification. The following table identifies ranges for nitrogen loss for different application methods.

Method of Application	Type of	Percent Nitrogen Loss*
Broadcast *without* incorporation	Solid Liquid	15-30 10-25
Broadcast *with* incorporation**	Solid Liquid	1-5 1-5
Injection (knifing)	Liquid	0-2
Irrigation	Liquid	30-40

Source: Follett, et al

*Percent of total nitrogen in manure applied which was lost within three days of application; wind and temperature effects may increase losses. About 1/3 of the ammonium N is lost by ammonia volatilization for surface application.

**Incorporation within a few hours of application.