UC Manure Technical Guide Series
for Crop Management Professionals

Crop Nutrient Harvest Removal

Crop nutrient harvest removal – the yield multiplied by nutrient concentration in the harvested portion of the crop – is not the same as plant nutrient uptake, and it may be only distantly related to nutrient requirement. But for crops in which the harvested portion represents a large fraction of the total plant biomass (mainly forages and some grain and vegetable crops), nutrient harvest removal can be a useful indicator of crop nutrient use efficiency. Harvest removal of nitrogen averaged over several years can be compared to total inputs of N to evaluate nitrogen use efficiency or NUE. A high ratio of total N input to N removed in harvest averaged over three or more years is an indication of low crop NUE. Together with other evidence, low NUE is an indication of excess losses of N and potential negative environmental effects. There is no consensus on the value of NUE that can be considered as agronomically efficient, but some sources suggest that multi-year NUE values <1.4 (mathematically equivalent to crop harvest of ~70% of N inputs from all sources) are feasible on farm and can be considered as agronomically efficient.

Harvest removal quantities of P and K are less clearly related to inputs of those nutrients and nutrient use efficiency. Over a period of years, trends in soil test and plant analysis values are most useful for assessing agronomic adequacy of these nutrients; but harvest nutrient removals compared to inputs over time may provide some additional helpful information.

Dairy producers in the Central Valley of California are required by waste discharge regulations to report annual crop NPK harvest removals for each field (Order No. R5-2007-0035, Waste Discharge Requirements General Order for Existing Milk Cow Dairies, California Regional Water Quality Control Board, Central Valley Region). The reporting must be based on measurements of yield and analysis of samples of the harvested plant material, not on published values.

However for other farms and in planning situations where farm data are sparse or completely lacking, literature values will be useful. The table in this publication is a compilation of typical nutrient (NPK) concentrations for several agronomic crops grown in California. Nutrient concentrations are expressed as pounds per unit harvest weight at typical harvest moisture contents. The values shown are the same as those published by the Central Valley Regional Water Quality Control Board for use during the preliminary stages of planning (Preliminary Dairy Facility Assessment) under the above-mentioned regulation. These values may differ somewhat from those published by Cooperative Extension in other states, by the USDA-NRCS, and by various industry organizations.

Furthermore, actual nutrient concentrations may differ from the table values by as much as 30% due to variations in soil nutrient supply, weather, and plant genetics as well as presence of non-nutrient yield-limiting factors. Table values are expressed on a field-moist basis and should be adjusted where yields are expressed at a different moisture content. For example, according to the table, a 3-ton yield of wheat grain would remove 174 lb N/acre (3 tons/acre x 58 lb/ton). This is based on a grain moisture content of 10%. However, if the yield of the wheat was 3 tons/acre at 13% moisture, the yield adjusted to a moisture content of 10% would be 2.9 tons/acre; and therefore the estimated N removal would be 168 lb N/acre (2.9 tons/acre x 58 lb/ton). The adjustment of yield in this example is calculated as follows:

Yield at 10% moisture = Yield at 13% x (1-.13)/(1-.10) = 3.0 x (0.87/0.90) = 2.9 tons/acre

where 0.13 and 0.10 are the moisture content values expressed as decimal fractions.

However, in many situations, the difference in moisture content (between table and actual values) will be much smaller than the discrepancy in N concentration.

Crop	Typical Yield in tons	Typical Moisture %	Typical Protein %	lbs of nutrient/ton of yield		
				N	P[b]	K[b]
Barley, grain	2.5	10%	9-12%(10.5%)[d]	37[d]	7.0[e]	10[e]
Barley silage, boot stage	8	70%	15-19% (17%)	16	2.6	11.6
Barley silage, soft dough	16	70%	8-12% (10%)	10	1.6	8.3
Corn, grain	5	10%		29[e]	5.5[e]	6[e]
Corn, silage	30	70%	8-11% (9%)	8	1.5	6.6
Cotton	3 (bales)			35[f]	5.7[f]	11.6[f]
Oats, grain	1.6	10%	10-15%(12.5%)[d]	44[d]	6.5[e]	7.5[e]
Oats,silage-soft dough	16	70%	8-15% (10%)	10	1.6	8.3
Oats, hay	4	10%	8-15% (12%)	40	6.5	33
Safflower	2			100	11	62
Sorghum	4	10%		50	8.7	40
Sugar beets	30			8.5	0.9	15
Triticale, boot stage	12	70%	15-19%(17%)[d]	16[d]	2.7	11.6
Triticale, soft dough	22	70%	9-13%(11%)[d]	11[d]	1.7	7.5
Wheat, grain	3	10%	10-15%(12.5%)[d]	58[d]	10.9[e]	50[e]
Wheat, silage, boot stage	10	70%	15-19% (17%)	16	2.8	12
Wheat, silage, soft dough	18	70%	9-13% (11%)	11	1.7	8.3
Alfalfa, hay	8	10%	18-24% (21%)	60	5.4	42
Bermudagrass, hay	8	10%	9-13% (11%)	35	4.6	42
Clover-grass, hay	6	10%	10-14 (12%)	38	5.0	42
Orchardgrass, hay	6	10%	9-14% (11%)	35	4.6	42
Ryegrass, hay	6	10%	8-12 (10%)	32	4.6	42
Sudangrass silage	8/cutting	70%	8-12 (10%)	11	1.7	12
Sudangrass hay	8	10%	8-12 (10%)	32	4.4	33
Tall Fescue, hay	6	10%	8-12 (10%)	32	4.6	42
Timothy, hay	6	10%	9-14% (11%)	35	4.6	42

[a] Values are approximations, actual values may vary by 30% or more.

[b] P x 2.29 = P_2O_5, P_2O_5 x 0.437 = P, K x 1.20 = K_20, K_2O x 0.83 = K.

[c] Central Valley Regional Water Quality Board Website table prepared by R. Meyer, UC Davis, www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/0612/dairy/dairy-pdfa.pdf

[d] Personal communication with Lee Jackson, UC Davis cereal agronomist.

[e] National NRCS website table, www.nrcs.usda.gov/technical/ECS/nutrient/tbb2.html

[f] UCANR Publication 3352, Cotton Production Manual. Values in lb nutrient/bale

Crop Nutrient Harvest Removal. 2009. University of California Cooperative Extension Manure Technical Bulletin Series. http://manuremanagement.ucdavis.edu

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December 2009

University of California Manure Technical Guide Series
for Crop Management Professionals

Series Sponsors
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Financial support for this publication was provided by the California Department of Food & Agriculture and the California Dairy Research Foundation. Contents of this publication and others in this series do not necessarily reflect the views or policies of the sponsors or the University of California.