

December 18, 2015

Ms. Pamela Creedon, Executive Officer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

SUBJECT: Nitrogen Management Plan Technical Advisory Work Group - Crop Nitrogen Knowledge Gap Study Plan and Guidance Documents

Dear Ms. Creedon:

The Coalitions listed as signatory to this letter are submitting the Nitrogen Management Plan Technical Advisory Work Group Crop Nitrogen Knowledge Gap Study Plan (NMP TAWG Study Plan) as required by your letter dated February 19, 2015. To develop the NMP TAWG Study Plan and Guidance Documents, the Coalitions invited several experts from academia, state and federal agencies, and industry to discuss the available knowledge about nitrogen removed from fields at harvest. The Coalitions submitted on March 13, 2015 a detailed description of the TAWG including the purpose and composition of the TAWG as well as a list of questions to be answered by the TAWG. In the letter, the Coalitions identified 13 questions to be answered by the NMP TAWG. The NMP TAWG Study Plan and Guidance Documents reflects the information provided by the experts to answer these questions.

The NMP TAWG Study Plan identifies a) the current state of knowledge regarding crop nitrogen uptake/removal for Central Valley crops; b) the methodology(ies) that are currently available to estimate crop nitrogen removal; c) how study plan results (assessment of current understanding and knowledge gaps) will be disseminated to growers; d) a proposed workplan and milestone schedule for addressing any identified knowledge gaps and the rationale for any proposed prioritization; e) the relationship and associated timelines between the study plan, the Management Practices Evaluation Program, and the California Department of Food and Agriculture's Fertilizer Research and Education Program.

Regards,

Central Valley Water Quality Coalitions listed on the following page

Buena Vista Water Quality Coalition
Tim Ashlock

Cawelo Water District
Dave Hampton

East San Joaquin Water Quality Coalition
Parry Klassen

Kaweah Water Quality Coalition
Donald Ikemiya

Kern River Water Quality Coalition
Nicole Bell

Kings River Water Quality Coalition
Casey Creamer

Sacramento Valley Water Quality Coalition
Bruce Houdesheldt

San Joaquin County and Delta Water Quality Coalition
Michael Wackman

Tule Basin Water Quality Coalition
David DeGroot

Westlands Water Quality Coalition
Charlotte Gallock

Westside San Joaquin River Water Quality Coalition
Joseph McGahan

Westside Water Quality Coalition
Greg Hammett



DECEMBER 18, 2015

**CROP NITROGEN KNOWLEDGE GAP
STUDY PLAN AND GUIDANCE
DOCUMENTS**

PREPARED BY THE NITROGEN MANAGEMENT PLAN TECHNICAL ADVISORY
WORK GROUP FOR THE CENTRAL VALLEY REGIONAL WATER QUALITY
CONTROL BOARD

SUBMITTED BY THE CENTRAL VALLEY WATER QUALITY COALITIONS



Table of Contents

Executive Summary.....	1
Crop Nitrogen Knowledge Gap Study Plan	2
Background	2
NMP TAWG Activities.....	2
Nitrogen Management Plan Summary Report	4
1. Identify the current state of knowledge regarding crop uptake/removal for Central Valley crops.....	5
Knowledge Gaps – Evaluation Process	5
N Removed Knowledge.....	6
2. What methodologies are currently available to estimate crop nitrogen removal?	9
3. Recommended methods for calculating nitrogen removal (used by Coalition to convert A/Y data submitted by growers).....	10
4. How are study plan results (current understanding of N removed and knowledge gaps) to be disseminated to growers?.....	10
5. Work Plan and milestone schedule for addressing any identified knowledge gaps and the rationale for prioritization	10
Milestone Schedule (Q12).....	10
Phased Schedule for Summary Reporting Requirements (Q9, Q10)	11
6. The relationship and associated timelines between the study plan, the Management Practices Evaluation Program and the California Department of Food and Agriculture’s Fertilizer Research and Education Program.	11
N Research by Commodity Groups	11
Coordination with Management Practices Evaluation Program (MPEP).....	11
Guidance Documents.....	12
Purpose	12
Amount of Available N in Dry/Liquid Fertilizers (Q5)	12
Amount of Available N in Soil Amendments (Q6).....	12
Amount of Residual N in the Soil (Q7)	13
Soil Nitrate Testing References:.....	13
Amount of Available N in Irrigation Water (Q8)	13
Nitrogen Management.....	14
Crop Specific References for Nitrogen Management	14

Almonds	14
Grapes – Wine, Raisin and Table	14
Walnuts	14
Citrus	14
Pistachios	15
Stone Fruits	15

List of Tables

Table 1. Crop acreage within the Central Valley Grouped by 1) Annuals or Short Term Perennials and 2) Perennials.....	8
Table 2. N removed calculators from FREP, which can be incorporated into Coalition’s standard Y-to-R conversion methodology.	9
Table 3. Milestones and Deliverables.	10

List of Figures

Figure 1. Process For Developing Y-to-R Conversion Tools.	7
--	---

Appendix A: Available Crop Nitrogen Calculators

Executive Summary

The third party agricultural coalitions representing growers enrolled in the Irrigated Lands Regulatory Program (ILRP) were required to submit a study plan outlining the state of knowledge about the amount of nitrogen removed from agricultural fields with harvested material, and which is sequestered in permanent tissue. The Coalitions developed questions to guide the identification of the knowledge gaps and held a series of meetings with the Nitrogen Management Plan Technical Advisory Work Group (NMP TAWG). The NMP TAWG experts from the University of California, state and federal agencies, and private industry met with the stakeholders to develop the answers to those questions. The information obtained during the NMP TAWG stakeholder meetings informed the Crop Nitrogen Knowledge Gap Study Plan (Study Plan) as well as the Guidance Documents for growers. Guidance documents were developed for growers to assist them with completing their Nitrate Management Plans. Each Coalition will disseminate the information according to their outreach strategy.

Concurrent with the identification of knowledge gaps, the Coalitions submitted to the Regional Water Board the Nitrogen Management Plan Summary Report Template. On that template, growers will report the ratio of applied nitrogen (A) to yield (Y) as the indicator of N removed from the field at harvest. After receiving the A/Y information from growers, the Coalitions will convert A/Y to A/R where R is the amount of N removed or sequestered. The focus of the NMP TAWG process became the identification of reliable values of N removed for crops in the Central Valley to allow for the Y-to-R conversion.

During the NMP TAWG meetings, experts agreed that there is still much to understand regarding the details of nitrogen utilization by Central Valley crops. Nevertheless, the Coalitions identified existing N removed calculators that can be used for a majority of the Central Valley crops. Nitrogen removed calculators are currently available from USDA-Natural Resources Conservation Service (NRCS), the International Plant Nutrition Institute (IPNI), and CDFA-Fertilizer Research and Education Program (FREP). The Coalitions were cautioned by the experts about utilizing calculators without further review of their appropriateness to calculate and report N removed within the regulatory framework of the ILRP. As a result, the Coalitions devoted considerable resources to developing the process by which the existing N removed calculators could be evaluated for use in the NMP reporting process.

FREP's evaluation of N removed and N uptake includes an assessment of relevant studies. Therefore, FREP's N removed numbers and compiled literature were the focus of the initial evaluations. FREP N removed calculators were identified for 6 crops covering approximately 40% of the acreage in the Central Valley (not including rice acreage). The Coalitions developed a schedule to develop Y-to-R conversions for the remaining crops in the Central Valley.

Crop Nitrogen Knowledge Gap Study Plan

Background

In a letter dated February 19, 2015, the Executive Officer of the Central Valley Regional Water Quality Control Board (Regional Water Board) required all agricultural coalitions to 1) submit by March 16, 2015 a detailed description of the Technical Advisory Work Group the agricultural coalitions planned to convene including the purpose of the Work Group, the questions or issues to be addressed by the Work Group, and the composition of the Work Group, 2) by December 18, 2015 submit or provide references that growers and their certifiers are being directed to use in the preparation of the nitrogen management plan, and 3) by December 18, 2015 provide a Crop Nitrogen Knowledge Gap Study Plan describing the current understanding of crop nitrogen uptake and removal, recommended methods for calculating nitrogen removal that will be provided to member growers, and how identified knowledge gaps associated with nitrogen uptake and removal will be addressed.

The agricultural coalitions submitted the required descriptions associated with the formation of the Technical Advisory Work Group. This submission addresses the requirements of the Crop Nitrogen Knowledge Gap Study Plan which include:

1. Identify the current state of knowledge regarding crop uptake/removal for Central Valley crops,
2. The methodologies that are currently available to estimate crop nitrogen removal,
3. Recommended methods for calculating nitrogen removal (used by Coalition to convert A/Y data submitted by growers),
4. How study plan results (assessment of current understanding and knowledge gaps) will be disseminated to growers,
5. A proposed work plan and milestone schedule for addressing any identified knowledge gaps and the rationale for prioritization, and
6. The relationship and associated timelines between the study plan, the Management Practices Evaluation Program, and the California Department of Food and Agriculture's Fertilizer Research and Education Program.

The guidance documents that will be available for growers to assist them with the preparation of their nitrogen management plans are included at the end of this document. A brief description of the Nitrogen Management Plan Technical Advisory Work Group (NMP TAWG) process is provided along with the questions that the Central Valley Agricultural Coalitions used to focus NMP TAWG expertise.

NMP TAWG Activities

As outlined in the March 16, 2015 submission to the Regional Water Board, a Nitrogen Management Plan Technical Advisory Work Group (NMP TAWG) was formed to assist Central Valley Agricultural Coalitions with understanding the state of knowledge about N removed from crops in the Central Valley, and defining methods to calculate N applied in various soil amendments such as compost and manure. The NMP TAWG met several times between April and September 2015 to discuss all four topics. The discussions and information developed through the NMP TAWG process guided the Coalitions' proposed N reporting metric.

To assist with the development of the Study Plan and associated guidance documents for growers, the Coalitions developed the following questions:

1. Determine the currently available scientific knowledge of nitrogen removal or consumption for the crops planted on the majority of acreage in the Central Valley.
2. Determine if there are different metrics that should be used for annual and perennial crops.
3. Determine what crops have established crop removal or consumption formulas (NMP Item 13).
4. Determine if available methodologies can be used to estimate unestablished nitrogen removal or consumption of other crops with similar characteristics (NMP Item 13).
5. Determine the methods to estimate the amount of available nitrogen from dry or liquid fertilizer applications or foliar nitrogen sources (NMP Items 16 & 17).
6. Provide the appropriate estimation methods for the amount of available organic nitrogen in manure, compost, cover crops, or other organic amendments (NMP Item 19).
7. Recommended method(s) to estimate the amount of residual nitrogen in the soil after the previous harvest (NMP Item 22).
8. Recommended method(s) to estimate the nitrogen available in irrigation water (NMP Item 23).
9. Determine what elements of the Nitrogen Management Plan template should be included in the NMP Summary Report.
10. Provide an appropriate phased schedule for the reporting of crop removal or similar metric.
11. Establish how the Study Plan results will be disseminated to the growers.
12. Provide a work plan and milestone schedule for addressing any identified knowledge gaps and the rationale for any proposed prioritization.
13. Identify the relationship and associated timelines between the Study Plan, the Management Practices Evaluation Program, and the California Department of Food and Agriculture's Fertilizer Research and Education Program.

The responses to these 13 questions were used to address each of the 5 requirements as well as develop the guidance that will be provided to growers to assist their completion of the nitrogen management plan.

The NMP TAWG reviewed the current knowledge of N removal (**Question 1**) for both annual and perennial crops (**Question 2**) and identification of known crop removal formulae (**Question 3**). During that review, it was established that several sources of data (e.g., CDFA, IPNI, NRCS) are available that provide specific information on the amount of N removed at harvest (see **Appendix A** for a list of 806 available N removal calculators, representing at least 260 distinct crops). These sources include information on a substantial proportion of the crops that cover nearly all the acreage in the Central Valley (Table 1). However, those sources do not cover all crops grown in the Central Valley (e.g. olives with approximately 50,000 – 70,000 acres in the Central Valley), and some of the information may need to be refined. For example, for some crops different N removal calculators provide similar estimates of the amount of N removed but for other crops, there are substantial differences in the estimates of N removed generated by different calculators. It will therefore be necessary to investigate the basis of the

calculators, and select and/or adjust them so that they function well for the crop in question, as it is grown in the Central Valley.

In the initial work, the search for N removed data was focused on websites and literature centered on fertilizer management and soil fertility since those studies gave the most valuable information to growers regarding nutrient management and crop yield. Most of these studies are conducted to better understand when nitrogen is utilized by the plant and where the nitrogen is utilized within the plant (e.g. plant growth or yield). These studies can be both time and money intensive but provide valuable information for nutrient management.

Although not explicitly developed to serve as a basis for N removed calculations, plant tissue N concentrations can be used for estimating N removed by employing the mathematical formula provided in Section 2 (**Questions 3, 4**).

Questions 5 through 8 are addressed in the Guidance Document section of this Study Plan to assist member growers, Certified Crop Advisors and other nitrogen management specialists in accurately and consistently reporting nitrogen management in the Nitrogen Management Plan template.

Nitrogen Management Plan Summary Report

The NMP TAWG reviewed options for reporting nitrogen removed on the Nitrogen Management Plan Summary Report (NMP Summary Report). A request to report N applied and the ratio of N Applied/Yield (A/Y) for the NMP Summary Report template reporting metric was submitted to the Regional Water Board on November 19, 2015. The submission includes the recommended elements of the NMP Template that should be included in the NMP Summary Report, and the rationale for reporting A/Y as the crop consumption metric (**Question 9**). In addition to information on each nitrogen management unit (e.g. acres, crop grown), the members will report to their Coalition the amount of N applied (pounds per acre) and the ratio A/Y for each management unit. Growers will know the amount of N applied on each management unit from the information recorded on their NMP for that specific crop year, as well as the yield.

1. Identify the current state of knowledge regarding crop uptake/removal for Central Valley crops

The following terminology is used throughout this document and is defined below.

- **Applied nitrogen** – the sum of nitrogen applied from all sources including nitrate in irrigation water, commercial fertilizers, compost, manure, and cover crops.
- **Nitrogen (N) uptake** – the amount of nitrogen taken up by the plant and incorporated into plant tissue.
- **Nitrogen (N) consumed** – same as nitrogen uptake.
- **Nitrogen (N) removed** – the amount of N that is removed from the field in harvested crops and incorporated in the tissues of permanent crops.

Knowledge Gaps – Evaluation Process

During the NMP TAWG meetings, experts discussed generally what is known about how and when plants need and use nitrogen. It was agreed during these meetings that there is still much to understand regarding the details of nitrogen utilization in Central Valley crops, especially due to the amount of variability in nitrogen use efficiency resulting from variability in the environment and crop management. Nevertheless, coalitions identified existing N removed calculators that can be used to estimate nitrogen removed for a majority of the Central Valley crops (provided in **Appendix A**).

N removed calculators are currently available from USDA-Natural Resources Conservation Service (NRCS), the International Plant Nutrition Institute (IPNI), and CDFA-Fertilizer Research and Education Program (FREP). In presentations at the NMP TAWG meetings, representatives from each of those entities stressed that their values were not developed for use in a regulatory program. The Coalitions were cautioned about adopting the values without further review about their appropriateness to calculate and report N removed in the Irrigated Lands Regulatory Program. As a result, the Coalitions devoted considerable resources to developing the process by which the existing N removed calculators could be evaluated for use in the NMP reporting process.

FREP's evaluation of N removed and N uptake includes an assessment of relevant studies focused on N removed evaluations. Therefore, FREP's N removed numbers and compiled literature were the focus of the initial evaluations using the process described below

(http://apps.cdfa.ca.gov/frep/docs/N_Uptake.html).

The Coalitions developed a process flow chart illustrating the steps the Coalitions will follow to develop usable Y-to-R conversion tools (Figure 1). Schedules can be attached to the steps shown as needed. The process entails development of an initial version of Y-to-R conversion tools (1.0) for use by the coalitions, focusing on a prioritized list of cropping systems. This list is driven by factors such as total cropping system acreage, so that most of the irrigated acreage is addressed. Along with the initial toolset (version 1.0), a prioritized list of refinements to the initial version would be developed, and employed to develop a version (2.0) incorporating those refinements. This refined version will replace the initial version.

There are calculators to convert Yield to N removed for most irrigated agricultural acreage in the Central Valley. However, the suitability of some of the calculators for Central Valley crops needs to be assessed using current production and management practice information. The process shown in Figure 1 describes how the calculators can be evaluated and refined for use with Central Valley crops. The Coalitions have already evaluated the FREP N removed values for the top crops in the Central Valley and the results are explained later in this report.

N Removed Knowledge

Based on a review of the available information and the presentations of the experts during the NMP TAWG meetings, the Coalitions evaluated the suitability of the N removed data for the crops on the CDFA-FREP webpage. The information on these crops was developed recently and represents the most reliable information available for immediate use. The Coalitions reviewed N removed information from CDFA-FREP for the crops grown in 80% of the Central Valley based on 2012 USDA crop information (Table 1). It was determined that for some crops, the information is sufficiently reliable to develop an N removed calculator to estimate the amount of N removed at harvest (Table 2). The Coalitions can use these N removed calculators to convert A/Y to A/R beginning in 2016.

N removed calculators exist for the majority of remaining crops grown in the Central Valley. For a few crops, N removed calculators are not readily available (see **Appendix A** for the list of crops for which calculators are available). For crops with no calculators, an N removed value could be developed using information about N in plant tissue from existing technical literature.

Once N removed calculators are identified, refinement of N removed calculations will be possible over time (**Questions 10 and 12**).

FIGURE 1. PROCESS FOR DEVELOPING Y-TO-R CONVERSION TOOLS.

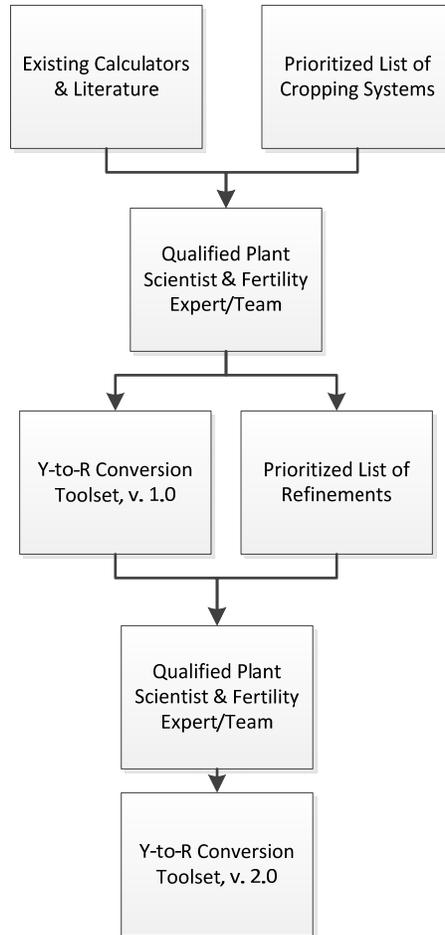


TABLE 1. CROP ACREAGE WITHIN THE CENTRAL VALLEY GROUPED BY 1) ANNUALS OR SHORT TERM PERENNIALS AND 2) PERENNIALS.

Crop #	Crop / Crop Type	Acreage¹	Acreage Percentage
<i>Annuals or Short Term Perennials</i>			
1	Rice	599,092	9.7%
2	Alfalfa Hay	498,767	8.1%
3	Corn Silage	471,111	7.6%
4	Wheat, Irrigated	257,852	4.2%
5	Tomatoes, Processing	252,506	4.1%
6	Cotton, Pima	235,572	3.8%
7	Hay, Small Grains	226,858	3.7%
8	Corn, Grain	182,854	3.0%
9	Haylage, Excluding Alfalfa	169,010	2.7%
10	Cotton, Upland	123,483	2.0%
11	Haylage, Alfalfa	72,795	1.2%
12	Beans, Dry	54,000	0.9%
13	Hay, Other	52,435	0.8%
14	Sunflower	46,914	0.8%
<i>Perennials</i>			
15	Almonds	887,792	14.4%
16	Grapes Wine, Raisin and Table	643,053	10.4%
17	Walnuts	295,895	4.8%
18	Citrus, All	226,596	3.7%
19	Pistachios	221,629	3.6%
20	Stone Fruits ²	141,328	2.3%
	Totals	5,659,542	91.80%
	Totals excluding rice	5,060,450	82.10%

¹ Central Valley Crop Acreage retrieved from the USDA/NASS "Quick Stats 2.0" on 2/17/2015 by M. Cady; reflects 2012 crop year.

² Prunes, Peaches, Nectarines, Plums, Apricots and Pluots.

TABLE 2. N REMOVED CALCULATORS FROM FREP, WHICH CAN BE INCORPORATED INTO COALITION’S STANDARD Y-TO-R CONVERSION METHODOLOGY.

Crop	N removed per unit of yield	Percent of Central Valley acreage (not including rice)
Almonds	0.068	15.9%
Corn, Silage	0.0269	8.4%
Tomatoes, Processing	0.039	4.5%
Pistachios	0.056	4.0%
Walnuts	0.048	5.3%
Plums/Prunes	0.012	<2.5%
Total Percentage Acreage		~40%

2. What methodologies are currently available to estimate crop nitrogen removal?

The response to this question has been provided in preceding sections.

The conceptual framework for estimating N removed is consistent across crops. It is estimated by multiplying the weight of harvested material by its N concentration. N removed can be estimated by the following calculation:

$$Y_e * C_e + Y_o * C_o = R,$$

where Y_e is the mass of economic yield, C_e is the N concentration in the economic yield, Y_o is the mass of other removed material, and C_o is the N concentration in other removed material.

The main focus of the N removed effort to date has been on the C factors (nitrogen concentrations), yet all elements of the calculation have their advantages and drawbacks. The focus here is on defining a standard methodology for converting Y to R by the coalitions. Specific factors can be refined over time, as updated information becomes available.

Y_e : This is the element for which the best, most accurate measurements exist because production of economic yield is the main point of farming, and because it is upon this measurement that payments to farmers are based. This is one reason that the A/Y ratio was proposed for grower reporting to coalitions.

C_e : Economic yield characteristics like moisture and protein (N) content are principal determinants of C_e . Standard values for them can be estimated and used to estimate N concentrations for use in Y-to-R conversions.

Y_o: When other off grade fruit or plant parts are mixed with the main economic plant material, standard values for those components may be estimated and added to the total yield to account for N in this material.

C_o: There is seldom a good justification for growers to measure and record this parameter (the N content of other material removed from the field) on a routine basis, since this material is by definition of lesser economic value. Standard values for this parameter may be developed to convert Y_o to the mass of N in this material.

The last three parameters can often be developed from values in the literature if reliable estimates are not otherwise available.

3. Recommended methods for calculating nitrogen removal (used by Coalition to convert A/Y data submitted by growers)

This was addressed in Sections 1 and 2.

4. How are study plan results (current understanding of N removed and knowledge gaps) to be disseminated to growers?

This document and the associated attachments will be posted on the NMP TAWG website (www.esjcoalition.org/TAWG/ESJLoginTAWG.asp) as well as websites operated by Central Valley Water Quality Coalitions and other farm organizations. Each Coalition has an outreach program that is tailored to their needs and will disseminate the information to their members as appropriate. These outreach mechanisms may include any or all of the following: member meetings, mailings, website postings, and newsletters/reports (**Question 11**).

5. Work Plan and milestone schedule for addressing any identified knowledge gaps and the rationale for prioritization

Milestone Schedule (Q12)

TABLE 3. MILESTONES AND DELIVERABLES.

Date	Deliverable
December 18, 2015	Y-to- R conversions for initial list of crops (version 1.0 from Figure 1) for use by coalitions in 2016 (Table 2)
July 2016	Work Plan for expanding/revising Y-to-R conversions for use by coalitions in subsequent years
March 2017	Revision/expansion of Y-to-R conversions for use by coalitions in subsequent years

Phased Schedule for Summary Reporting Requirements (Q9, Q10)

The Coalitions are utilizing the A/Y ratio as the grower-reported nitrogen consumption ratio. This information can be obtained from members immediately. This information can be consistently recorded by growers over time and converted to N removed by the Coalitions. With the inclusion of information about N applied, the Coalitions can report the estimated ratio of A/R immediately for the crops listed in Table 2. Coalitions will expand this crop list by the analysis completed pursuant to the work plan to be delivered in July 2016.

6. The relationship and associated timelines between the study plan, the Management Practices Evaluation Program and the California Department of Food and Agriculture's Fertilizer Research and Education Program.

N Research by Commodity Groups

Some major commodity groups are conducting research to improve knowledge of the amount of N removed at harvest, particularly as it relates to nitrogen application rates. For example, the Almond Board of California and the California Walnut Commission are funding such studies. If there are opportunities to work with commodity groups to study N removed in priority crops, the Coalitions will coordinate with these efforts to optimize the use of these resources.

Coordination with Management Practices Evaluation Program (MPEP)

The deliverables and timelines in the MPEP work plans will be another avenue to communicate technical work performed by the coalitions. To meet the MPEP obligations, coalitions will coordinate closely with CDFA, UCCE, commodity groups, etc. to optimize the use of resources to deliver results that respond to ILRP needs for technical tools.

Grant opportunities will be pursued as they become available (**Question 13**).

Guidance Documents

Purpose

This reference to guidance documents has been prepared to assist growers when filling out a Nitrogen Management Plan. This document includes a brief summary of the references. Links to the references are listed under each section. Coalitions may also include additional references for their members. The guidance documents will be updated as additional resources become available.

Amount of Available N in Dry/Liquid Fertilizers (Q5)

The available nitrogen (N) in commercial fertilizer products (dry, liquid or foliar) is printed on fertilizer labels by the manufacturer/supplier as part of the Guaranteed Analysis or Grade, as required by State Law.

The amount of N in a product is expressed as a percentage by weight of the product for all dry and liquid fertilizer products. For liquid fertilizers, the product density must be known and is listed as pounds per gallon (lbs/gal) of the fertilizer product. The first three numbers of the Guaranteed Analysis describe the nitrogen, phosphorus and potash content of the product. Examples:

- The granular fertilizer product 21-7-14 has 21% nitrogen by weight or 21 lbs of N per 100 pounds of product. It also contains 7% P₂O₅, and 14% K₂O.
- The liquid product CAN 17 has 17% nitrogen by weight and a product density of 12.64 lbs/gal. Thus, each gallon of this product contains 2.15 lbs of nitrogen.

A fertilizer supplier or Certified Crop Advisor (CCA) can provide assistance in determining the amount of N in commercial fertilizer.

Amount of Available N in Soil Amendments (Q6)

Nitrogen (N) content of manure/compost/cover crops and other organic amendments varies according to the source, moisture content, as well as storage and handling methods. The proportion of N available for plant uptake after the application of an organic amendment or incorporation of a cover crop can also vary. If necessary, a CCA can help a grower to determine the amount of N available in soil amendments.

Additional information is available from several university extension programs, including the calculations of the amount of plant available N in **manure**:

- University of Missouri (<http://extension.missouri.edu/p/G9186>),
- Purdue University (<https://www.extension.purdue.edu/extmedia/AY/AY-277.html>), and
- Oregon State University (<http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20528/em8954-e.pdf>).

Guidelines for the **use of compost** are available at:

- University of Massachusetts, Amherst (<https://soiltest.umass.edu/fact-sheets/interpreting-your-compost-test-results>).

Calculating the amount of **N in compost** is explained in several sources, including the following:

- Pennsylvania State University Extension (<http://extension.psu.edu/business/start-farming/soils-and-soil-management/determining-nutrient-applications-for-organic-vegetables-basic-calculations-introduction-to-soils-fact-3>), and
- Louisiana State University Extension (<http://seafood.oregonstate.edu/.pdf%20Links/Basic-Principles-of-Composting-LSU.pdf>).

Amount of Residual N in the Soil (Q7)

A rule of thumb for soil sampling is that the results obtained are only as good as the sample taken. A laboratory report on a sample can be misinterpreted if the nature and intensity of the analyzed sample are not known and taken into account. To evaluate the fate of applied N, it may be helpful to estimate or measure total N and organic carbon, components of the C:N ratio. *A CCA familiar with your crop and local conditions can help plan sampling, analysis, and interpretation of results to develop nitrogen application recommendations.* Additional information is available from:

- University of Maine Cooperative Extension (<http://umaine.edu/gardening/master-gardeners/manual/soils/interpreting-soil-tests/>),
- Purdue University (<https://www.agry.purdue.edu/ext/corn/news/timeless/assessavailablen.html>), and
- Montana State University (<http://store.msuextension.org/publications/agandnaturalresources/mt200703AG.pdf>).

Soil Nitrate Testing References:

<http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=4406>

<http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=13140>

http://vric.ucdavis.edu/pdf/FERTILIZATION/fertilization&soil_Using%20the%20pre-sidedressing%20soil%20nitrate%20%E2%80%98Quick%20Test%E2%80%99%20to%20guide%20N%20ofertilizer%20management.pdf

<http://www.growershipper.com/images/nitrate/Nitrate-Quick-Test-SOP-FINAL-ENGLISH.pdf>

Amount of Available N in Irrigation Water (Q8)

Step 1: If the nitrate concentration of the water supply is not otherwise known (e.g., from previous analytical results, or from the water supplier), collect a water sample and have it analyzed by a qualified lab.

Water sampling and analysis methodology can be obtained from a commercial analytical laboratory. If a grower collects their own water sample for nitrate it needs to be kept on ice en route to the testing laboratory.

Step 2: Calculate amount of N in irrigation water

Commercial analytical laboratories may provide results of water analysis either as NO₃ alone or as NO₃-N. Sometimes NO₂ is also included but the contribution of N as NO₂ is typically negligible. Once the

concentration of NO₃ in the irrigation supply water is known, the steps used for calculating the pounds of NO₃ applied can be found at the following websites:

- University of California Agriculture and Natural Resources website, <http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=9361>.
- University of Florida IFAS Extension site (<http://edis.ifas.ufl.edu/ae479>) or the University of Missouri Extension site (<http://extension.missouri.edu/p/WQ278>).

Growers can also consult a Certified Crop Advisor (CCA) or commercial laboratory for guidance in calculating N in irrigation water.

Nitrogen Management

<http://ciwr.ucanr.edu/nitrogenmanagement/>

http://ciwr.ucanr.edu/Tools/Nitrogen_Hazard_Index/

Crop Specific References for Nitrogen Management

Almonds

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

CDFA/FREP Almond Fertilization Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Almonds.html>

UC Davis; Almond Fertilization Model:

http://ucce.ucdavis.edu/rics/fnric2/almondNKmodel/almond_model.html

Grapes – Wine, Raisin and Table

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

CDFA/FREP Grapevine Fertilization Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Grapevines.html>

CDFA/FREP Grapevines Nitrogen Uptake and Partitioning:

http://apps.cdfa.ca.gov/frep/docs/N_Grapevines.html

Walnuts

CDFA/FREP Walnut Fertilization Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Walnut.html>

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

UC Davis; Walnut Fertilization Model:

http://ucce.ucdavis.edu/rics/fnric2/walnutnmodel/html/walnut_n_model.html

Citrus

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

CDFA/FREP Citrus Fertilization Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Citrus.html>

Arpaia, M.L., Lund, L.J., 2003. <http://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/completedprojects/96-0280Arpaia.pdf>

CDFA; Citrus Uptake and Partitioning: http://apps.cdfa.ca.gov/frep/docs/N_Citrus.html

Pistachios

CDFA/FREP Pistachio Fertilization Guidelines:

<http://apps.cdfa.ca.gov/frep/docs/Pistachio.html#Nitrogen>

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

CDFA/FREP Pistachio Uptake and Partitioning: http://apps.cdfa.ca.gov/frep/docs/N_Pistachio.html

Stone Fruits

CDFA/FREP Fertilizer Guidelines: <http://apps.cdfa.ca.gov/frep/docs/Guidelines.html>

CDFA/FREP Prune and Plum Fertilization Guidelines:

http://apps.cdfa.ca.gov/frep/docs/N_PrunePlum.html

CDFA/FREP Plum and Prune Nitrogen Uptake and Partitioning:

http://apps.cdfa.ca.gov/frep/docs/N_PrunePlum.html

APPENDIX A: AVAILABLE CROP NITROGEN CALCULATORS

Following is a listing of currently available crop N removal calculators available from CDFA, IPNI, and NRCS.

Source	Crop
NRCS¹	Acorn
IPNI	alfalfa
NRCS	Alfalfa + Orchardgrass, for hay
NRCS	Alfalfa + Orchardgrass, for hay (cut 1)
NRCS	Alfalfa + Smooth Brome, for green chop
NRCS	Alfalfa + Smooth Brome, for hay
NRCS	Alfalfa + Smooth Brome, for hay (cut 1)
NRCS	Alfalfa + Smooth Brome, for hay (cut 2)
NRCS	Alfalfa + Timothy, for green chop (50% alfalfa)
NRCS	Alfalfa + Timothy, for hay
NRCS	Alfalfa + Timothy, for hay (cut 1)
NRCS	Alfalfa + Timothy, for hay (cut 2)
NRCS	Alfalfa, for green chop
NRCS	Alfalfa, for green chop (early bloom)
NRCS	Alfalfa, for green chop (early bloom, cut 1)
NRCS	Alfalfa, for green chop (early bloom, cut 2)
NRCS	Alfalfa, for green chop (early bloom, cut 3)
NRCS	Alfalfa, for green chop (full bloom)
NRCS	Alfalfa, for green chop (full bloom, cut 1)
NRCS	Alfalfa, for green chop (full bloom, cut 2)
NRCS	Alfalfa, for green chop (full bloom, cut 3)
NRCS	Alfalfa, for green chop (mid bloom)
NRCS	Alfalfa, for green chop (mid bloom, cut 1)
NRCS	Alfalfa, for green chop (mid bloom, cut 2)
NRCS	Alfalfa, for green chop (pre bloom)
NRCS	Alfalfa, for green chop (pre bloom, cut 1)
NRCS	Alfalfa, for green chop (pre bloom, cut 2)
NRCS	Alfalfa, for green chop (pre bloom, cut 3)
NRCS	Alfalfa, for hay
NRCS	Alfalfa, for hay (cut 1)
NRCS	Alfalfa, for hay (cut 2)
NRCS	Alfalfa, for hay (cut 3)
NRCS	Alfalfa, for hay (early bloom)
NRCS	Alfalfa, for hay (early bloom, cut 1)
NRCS	Alfalfa, for hay (early bloom, cut 2)
NRCS	Alfalfa, for hay (early bloom, cut 3)

¹ The entire NRCS database may be downloaded to facilitate its use by coalitions.

Source	Crop
NRCS	Alfalfa, for hay (full bloom)
NRCS	Alfalfa, for hay (full bloom, cut 1)
NRCS	Alfalfa, for hay (full bloom, cut 2)
NRCS	Alfalfa, for hay (full bloom, cut 3)
NRCS	Alfalfa, for hay (late vegetative, cut 1)
NRCS	Alfalfa, for hay (late vegetative, cut 2)
NRCS	Alfalfa, for hay (late vegetative, cut 3)
NRCS	Alfalfa, for hay (mid bloom)
NRCS	Alfalfa, for hay (mid bloom, cut 1)
NRCS	Alfalfa, for hay (mid bloom, cut 2)
NRCS	Alfalfa, for hay (mid bloom, cut 3)
NRCS	Alfalfa, for hay (pre bloom)
NRCS	Alfalfa, for hay (pre bloom, cut 1)
NRCS	Alfalfa, for hay (pre bloom, cut 2)
NRCS	Alfalfa, for hay (pre bloom, cut 3)
NRCS	Alfalfa, for seed
NRCS	Alfalfa, for silage (tenth bloom, cut 2)
IPNI	almond
CDFA	Almonds
NRCS	Almonds (without shell)
NRCS	Almond (with shell)
IPNI	Alsike clover
NRCS	Apple
IPNI	apple
NRCS	Apricot
NRCS	Artichoke-Globe, for bud
NRCS	Artichoke-Jerusalum, for tuber
NRCS	Asparagus-Green, for shoot or spear (immature)
NRCS	Asparagus-White, for shoot or spear (immature)
NRCS	Avocado (all varieties)
NRCS	Avocado (Florida)
NRCS	Avocado (California)
IPNI	bahaigrass
NRCS	Bahiagrass, for green chop
NRCS	Bahiagrass, for hay
NRCS	Bahiagrass, for hay (mature)
NRCS	Banana
NRCS	Barbados Cherry
CDFA	Barley

Source	Crop
IPNI	barley (grain & straw)
NRCS	Barley-2 row, for grain
NRCS	Barley-2 row, for straw
NRCS	Barley-6 row, for grain (excluding Pacific Coast)
NRCS	Barley-6 row, for grain (Pacific coast only)
NRCS	Barley-6 row, for green chop (boot)
NRCS	Barley-6 row, for hay
NRCS	Barley-6 row, for straw
NRCS	Bean, for seed (dry)
NRCS	Bean-Faba, for pod with seeds (immature)
NRCS	Bean-Kidney, for seed
NRCS	Bean-Kidney, for straw
NRCS	Bean-Lima(baby), for pod with seeds
NRCS	Bean-Lima, for pod with seeds
NRCS	Bean-Lima, for seed
NRCS	Bean-Lima, for straw
NRCS	Bean-Navy, for seed
NRCS	Bean-Navy, for straw
IPNI	beans
NRCS	Bean-Snap for seed (dry)
NRCS	Bean-Snap, for pod with seeds (immature)
NRCS	Beechnut (dry)
NRCS	Beet-Red Table, for root
NRCS	Beet-Red Table, for top
NRCS	Bentgrass-Colonial, for hay
IPNI	bermudagrass
NRCS	Bermudagrass, for green chop
NRCS	Bermudagrass, for green chop (early to mid bloom)
NRCS	Bermudagrass, for green chop (full bloom to mature)
NRCS	Bermudagrass, for green chop (pre bloom)
NRCS	Bermudagrass, for hay
NRCS	Bermudagrass, for hay (early to mid bloom)
NRCS	Bermudagrass, for hay (full bloom to mature)
NRCS	Bermudagrass, for hay (pre bloom)
IPNI	birdsfoot trefoil
NRCS	Blackberry
NRCS	Blackeye pea or Cowpea or Southern Pea
NRCS	Blueberry

Source	Crop
IPNI	bluegrass
NRCS	Bluegrass, for green chop
NRCS	Bluegrass, for green chop (early bloom)
NRCS	Bluegrass, for green chop (full bloom)
NRCS	Bluegrass, for green chop (mid bloom)
NRCS	Bluegrass, for hay
NRCS	Bluegrass, for hay (full bloom)
NRCS	Bluegrass-Kentucky, for green chop
NRCS	Bluegrass-Kentucky, for green chop (early bloom)
NRCS	Bluegrass-Kentucky, for green chop (full bloom)
NRCS	Bluegrass-Kentucky, for green chop (mature)
NRCS	Bluegrass-Kentucky, for green chop (mid bloom)
NRCS	Bluegrass-Kentucky, for hay
NRCS	Bluegrass-Kentucky, for hay (early bloom)
NRCS	Bluegrass-Kentucky, for hay (full bloom)
NRCS	Bluegrass-Kentucky, for hay (mature)
NRCS	Bluegrass-Kentucky, for hay (mid bloom)
NRCS	Bluestem, for green chop
NRCS	Bluestem, for green chop (early bloom)
NRCS	Bluestem, for green chop (full bloom)
NRCS	Bluestem, for green chop (mature)
NRCS	Bluestem, for hay
NRCS	Bluestem, for hay (early bloom)
NRCS	Bluestem, for hay (full bloom)
NRCS	Bluestem, for hay (mature)
NRCS	Brazilnut (dry, unblanched)
NRCS	Breadfruit
CDFA	Broccoli
IPNI	broccoli
NRCS	Broccoli, for stem
NRCS	Broccoli, for stem and immature floral parts
IPNI	bromegrass
NRCS	Bromegrass, for green chop
NRCS	Bromegrass, for green chop (late bloom)
NRCS	Bromegrass, for green chop (mature)
NRCS	Bromegrass, for hay
NRCS	Bromegrass, for hay (early bloom)
NRCS	Bromegrass, for hay (mature)
NRCS	Bromegrass, for seed

Source	Crop
NRCS	Bromegrass-Smooth, for green chop
NRCS	Bromegrass-Smooth, for green chop (full bloom)
NRCS	Bromegrass-Smooth, for green chop (mature)
NRCS	Bromegrass-Smooth, for green chop (mid bloom)
NRCS	Bromegrass-Smooth, for green chop (pre bloom)
NRCS	Bromegrass-Smooth, for hay
NRCS	Bromegrass-Smooth, for hay (full bloom)
NRCS	Bromegrass-Smooth, for hay (late vegetative)
NRCS	Bromegrass-Smooth, for hay (mature)
NRCS	Bromegrass-Smooth, for hay (mid bloom)
NRCS	Bromegrass-Smooth, for hay (pre bloom)
NRCS	Bromegrass, for hay (late bloom)
NRCS	Brussel Sprouts, for bud
IPNI	buckwheat
NRCS	Buckwheat (ordinary cultivars), for grain
NRCS	Buckwheat (ordinary cultivars), for straw
NRCS	Butternut (dry)
IPNI	Cabbage
NRCS	Cabbage, for head (with outer leaves)
NRCS	Cabbage, for head (without outer leaves)
NRCS	Cabbage, for waste (outer leaves)
NRCS	Cabbage-Chinese
NRCS	Cabbage-Red
NRCS	Cabbage-White
NRCS	Canarygrass-Reed, for green chop
NRCS	Canarygrass-Reed, for green chop (early bloom)
NRCS	Canarygrass-Reed, for green chop (mature)
NRCS	Canarygrass-Reed, for green chop (mid bloom)
NRCS	Canarygrass-Reed, for green chop (vegetative)
NRCS	Canarygrass-Reed, for hay
NRCS	Canarygrass-Reed, for hay (early bloom)
NRCS	Canarygrass-Reed, for hay (mature)
NRCS	Canarygrass-Reed, for hay (mid bloom)
NRCS	Canarygrass-Reed, for hay (vegetative)
IPNI	canola
NRCS	Canola, for seed
NRCS	Canola, for straw
IPNI	cantelope
NRCS	Carambola

Source	Crop
NRCS	Carissa
NRCS	Carrot, for root
NRCS	Carrot, for top
CDFA	Cauliflower
NRCS	Cauliflower, for immature inflorescence
IPNI	Celery
NRCS	Celery-Green
NRCS	Celery-Self-blanching
NRCS	Chard-Swiss, for immature leaf
NRCS	Cherimoya
NRCS	Cherry (sour, red)
NRCS	Cherry (sweet)
NRCS	Chestnut-Chinese
NRCS	Chestnut-European
NRCS	Chestnut-Japanese
NRCS	Chicory, for green chop
NRCS	Chive
CDFA	Citrus
NRCS	Clover + Timothy, for hay
NRCS	Clover-Alsike, for green chop
NRCS	Clover-Alsike, for green chop (full bloom)
NRCS	Clover-Alsike, for green chop (mid bloom)
NRCS	Clover-Alsike, for hay
NRCS	Clover-Alsike, for hay (early bloom)
NRCS	Clover-Alsike, for hay (full bloom)
NRCS	Clover-Alsike, for hay (mid bloom)
NRCS	Clover-Crimson, for green chop
NRCS	Clover-Crimson, for green chop (late bloom)
NRCS	Clover-Crimson, for hay
NRCS	Clover-Crimson, for hay (early bloom)
NRCS	Clover-Crimson, for hay (late bloom)
NRCS	Clover-Red + Grass, for hay
NRCS	Clover-Red + Grass, for hay (full bloom)
NRCS	Clover-Red + Grass, for hay (mature)
NRCS	Clover-Red + Grass, for hay (mid bloom)
NRCS	Clover-Red + Timothy, for hay
NRCS	Clover-Red, for green chop
NRCS	Clover-Red, for green chop (early bloom)
NRCS	Clover-Red, for green chop (full bloom)

Source	Crop
NRCS	Clover-Red, for green chop (late vegetative)
NRCS	Clover-Red, for green chop (mid bloom)
NRCS	Clover-Red, for hay
NRCS	Clover-Red, for hay (early bloom)
NRCS	Clover-Red, for hay (full bloom)
NRCS	Clover-Red, for hay (late vegetative)
NRCS	Clover-Red, for hay (mature)
NRCS	Clover-Red, for hay (mid bloom)
NRCS	Clover-Red, for seed
NRCS	Clover-White, for green chop
NRCS	Clover-White, for green chop (full bloom)
NRCS	Clover-White, for hay
NRCS	Clover-White, for hay (full bloom)
NRCS	Clover-White, for hay (late bloom)
NRCS	Clover-White, for hay (mature)
NRCS	Clover-White-Ladino type + Grass, for green chop
NRCS	Clover-White-Ladino type + Grass, for green chop (early bloom)
NRCS	Clover-White-Ladino type + Grass, for hay
NRCS	Clover-White-Ladino type + Grass, for hay (mature)
NRCS	Clover-White-Ladino type + Timonth, for silage
NRCS	Clover-White-Ladino type, for green chop
NRCS	Clover-White-Ladino type, for green chop (early bloom)
NRCS	Clover-White-Ladino type, for hay
NRCS	Clover-White-Ladino type, for hay (early bloom)
NRCS	Clover-White-Ladino type, for hay (mature)
NRCS	Coconut, for meat
NRCS	Coconut, for milk
IPNI	corn (grain stover silage)
CDFA	Corn for Grain
CDFA	Corn for Silage
NRCS	Corn-Field, for grain (shelled, yellow dent, grade #1)
NRCS	Corn-Field, for silage (dough stage)
NRCS	Corn-Field, for silage (mature)
NRCS	Corn-Field, for silage (milk stage)
NRCS	Corn-Field, for stover (yield less than 95 bu/acre, mature, without ear, dry)

Source	Crop
NRCS	Corn-Field, for stover (yield more than 95 bu/acre, mature, without ear, dry)
NRCS	Corn-Popcorn, for grain
NRCS	Corn-Popcorn, for stover (mature, without ear, dry)
NRCS	Corn-Sweet, for ears with husk (immature)
NRCS	Corn-Sweet, for grain (dry)
NRCS	Corn-Sweet, for stover (without ear and husk, immature)
NRCS	Corn-Sweet, for stover (without ear and husk, mature, very dry)
CDFA	Cotton
IPNI	cotton (lint seed stover)
NRCS	Cotton, for lint without seed or cotton lint
NRCS	Cotton, for seed with lint or seed cotton
NRCS	Cotton, for seed without lint
NRCS	Cotton, for stalks (dry)
NRCS	Cowpea, for hay
NRCS	Cowpea, for seed
NRCS	Cowpea, for straw
NRCS	Crabapple
NRCS	Cranberry
NRCS	Cucumber, for fruit
NRCS	Cup plant
NRCS	Currant-European black
NRCS	Currants-Red & White
NRCS	Custard-Apple
NRCS	Date palm, for fruit
NRCS	Eggplant, for fruit
NRCS	Elderberry
NRCS	Elephantgrass, for silage
NRCS	Elephantgrass, for silage (mature)
NRCS	Elephantgrass, for silage (vegetative)
NRCS	Endive (Chicory), for immature leaf
NRCS	Escarole, for leaf
IPNI	fescue grass
NRCS	Fescue, for green chop
NRCS	Fescue, for green chop (early bloom)
NRCS	Fescue, for green chop (early vegetative)
NRCS	Fescue, for green chop (late bloom)

Source	Crop
NRCS	Fescue, for green chop (mature)
NRCS	Fescue, for green chop (over ripe)
NRCS	Fescue, for hay
NRCS	Fescue, for hay (early bloom)
NRCS	Fescue, for hay (early vegetative)
NRCS	Fescue, for hay (late vegetative)
NRCS	Fescue-Meadow, for hay
NRCS	Fescue-Tall, for green chop
NRCS	Fescue-Tall, for green chop (early bloom)
NRCS	Fescue-Tall, for green chop (early bloom) (Pacific coast)
NRCS	Fescue-Tall, for green chop (early vegetative)
NRCS	Fescue-Tall, for green chop (full bloom) (Pacific coast)
NRCS	Fescue-Tall, for green chop (late vegetative)
NRCS	Fescue-Tall, for green chop (late vegetative) (Pacific coast)
NRCS	Fescue-Tall, for green chop (mature)
NRCS	Fescue-Tall, for green chop (mature) (Pacific coast)
NRCS	Fescue-Tall, for green chop (mid bloom)
NRCS	Fescue-Tall, for green chop (mid bloom) (Pacific coast)
NRCS	Fescue-Tall, for green chop (Pacific coast)
NRCS	Fescue-Tall, for hay (early bloom)
NRCS	Fescue-Tall, for hay (early vegetative)
NRCS	Fescue-Tall, for hay (full bloom)
NRCS	Fescue-Tall, for hay (full bloom) (Pacific coast)
NRCS	Fescue-Tall, for hay (late vegetative)
NRCS	Fescue-Tall, for hay (late vegetative) (Pacific coast)
NRCS	Fescue-Tall, for hay (mature)
NRCS	Fescue-Tall, for hay (mid bloom)
NRCS	Fescue-Tall, for hay (over ripe)
NRCS	Fescue-Tall, for hay (Pacific coast)
NRCS	Fig
NRCS	Filbert or Hazelnut, dry
IPNI	flax (grain & straw)
NRCS	Flax, for seed
NRCS	Flax, for straw
NRCS	Gamagrass-Eastern, for hay (boot, cut 1)

Source	Crop
NRCS	Gamagrass-Eastern, for hay (inflorescence to anthesis, cut 1)
NRCS	Gamagrass-Eastern, for hay (maturity, cut 1)
NRCS	Gamagrass-Eastern, for hay (seed ripening, cut 1)
NRCS	Gamagrass-Eastern, for hay (vegetative, cut>1)
NRCS	Garlic
NRCS	Ginkgo Nut or Maidenhair Tree Nut
NRCS	Gooseberry
NRCS	Grape-American type
NRCS	Grape-European type
NRCS	Grapefruit-Pink & Red (all areas)
NRCS	Grapefruit-Pink & Red (California & Arizona)
NRCS	Grapefruit-Pink & Red (Florida)
NRCS	Grapefruit-Pink, Red, & White (all areas)
NRCS	Grapefruit-White (all areas)
NRCS	Grapefruit-white (California)
NRCS	Grapefruit-white (Florida)
IPNI	grapes
CDFA	Grapevines
NRCS	Grass + Clover-Red, for hay
NRCS	Grass + Clover-Red, for hay (full bloom)
NRCS	Grass + Clover-Red, for hay (mature)
NRCS	Grass + Clover-Red, for hay (mid bloom)
NRCS	Grass + Clover-White-Ladino type, for green chop
NRCS	Grass + Clover-White-Ladino type, for green chop (early bloom)
NRCS	Grass + Clover-White-Ladino type, for hay
NRCS	Grass + Clover-White-Ladino type, for hay (mature)
NRCS	Grass, for green chop
NRCS	Grass, for green chop (early bloom)
NRCS	Grass, for green chop (mature)
NRCS	Grass, for hay
NRCS	Grass, for hay (early bloom)
NRCS	Grass, for hay (full bloom)
NRCS	Grass, for hay (mature)
NRCS	Grass, for silage, (early bloom)
NRCS	Groundcherry
NRCS	Guar, for green chop (mature)
NRCS	Guar, for green chop (pre bloom)

Source	Crop
NRCS	Guar, for green chop (vegetative)
NRCS	Guar, for hay
NRCS	Guava-Common
NRCS	Guava-Strawberry
NRCS	Hickory Nut (dry)
NRCS	Jackfruit
NRCS	Java-plum
NRCS	Jojoba, for seed
NRCS	Jujube-Common
NRCS	Kale, for green chop
NRCS	Kale, for leaf
NRCS	Kiwi
NRCS	Kohlrabi
NRCS	Kumquat
NRCS	Leek
NRCS	Lemon
NRCS	Lentil-Common, for seed
NRCS	Lespedeza-Korean, for hay (early bloom)
NRCS	Lespedeza-Korean, for hay (full bloom)
NRCS	Lespedeza-Korean, for hay (pre bloom)
NRCS	Lespedeza-Korean, for hay (vegetative)
NRCS	Lespedeza-Sericea, for hay
NRCS	Lespedeza-Sericea, for hay (cut 2)
NRCS	Lespedeza-Sericea, for hay (cut 3)
NRCS	Lespedeza-Sericea, for hay (early bloom)
NRCS	Lespedeza-Sericea, for hay (full boom)
NRCS	Lespedeza-Sericea, for hay (mid bloom)
NRCS	Lespedeza-Sericea, for hay (vegetative)
NRCS	Lespedeza-Sericea, for seed
NRCS	Lespedeza-Striate, for hay
NRCS	Lespedeza-Striate, for hay (early bloom)
NRCS	Lespedeza-Striate, for hay (full bloom)
NRCS	Lespedeza-Striate, for hay (mid bloom)
NRCS	Lespedeza-Striate, for hay (pre bloom)
CDFA	Lettuce
IPNI	lettuce
NRCS	Lettuce-Butterhead or Curled, for leaf
NRCS	Lettuce-Chrisphead or Iceberg or Great Lakes, for leaf

Source	Crop
NRCS	Lettuce-Head, for head
NRCS	Lettuce-Romaing or Cos, for leaf
NRCS	Lime
NRCS	Longan
NRCS	Loquat
NRCS	Lychee Nut
NRCS	Macadamia Nut (dry)
NRCS	Mammee apple
NRCS	Mango
NRCS	Melon-Canteloupe
NRCS	Melon-Casaba
NRCS	Melon-Honeydew
NRCS	Melon-Waternelon
IPNI	millet (grain & straw)
NRCS	Millet-Foxtail, for grain
NRCS	Millet-Foxtail, for green chop and silage (late bloom)
NRCS	Millet-Foxtail, for hay
NRCS	Millet-Foxtail, for straw
NRCS	Millet-Pearl, for grain
NRCS	Millet-Pearl, for green chop and silage (milk to soft dough stage)
NRCS	Millet-Pearl, for hay
NRCS	Millet-Pearl, for straw
NRCS	Millet-Proso, for grain
NRCS	Millet-Proso, for straw
IPNI	mint (for oil)
NRCS	Mint, for hay (mature)
NRCS	Mulberry
NRCS	Mungbean
NRCS	Mushroom
NRCS	Mustard, for greens (immature leaf)
NRCS	Mustard, for hay
NRCS	Mustard, for seed
NRCS	Natalgrass for hay
NRCS	Nectarine
IPNI	oat (grain & straw)
NRCS	Oat, for grain (not including Pacific Coast)
NRCS	Oat, for grain (Pacific coast)
NRCS	Oat, for green chop

Source	Crop
NRCS	Oat, for green chop (boot to early bloom)
NRCS	Oat, for green chop (dough stage)
NRCS	Oat, for green chop (full bloom)
NRCS	Oat, for green chop (mature)
NRCS	Oat, for green chop (vegetative)
NRCS	Oat, for hay
NRCS	Oat, for hay (dough stage)
NRCS	Oat, for hay (early bloom)
NRCS	Oat, for hay (full bloom)
NRCS	Oat, for hay (mature)
NRCS	Oat, for hay (milk stage)
NRCS	Oat, for hay (vegetative)
NRCS	Oat, green chop (milk stage)
NRCS	Oat, straw (not including Pacific coast)
NRCS	Oat, straw (Pacific Coast)
NRCS	Oatgrass-Tall, for hay
NRCS	Ohelogerrie
NRCS	Okra
NRCS	Okra-Chinese
NRCS	Onion-Dry (bulb)
NRCS	Onion-Dry (bulb) cultivar 'Southport White Globe'
NRCS	Onion-Dry (bulb) cultivar 'Sweet Spanish'
NRCS	Onion-Green (bulb)
NRCS	Onion-Green (leaf)
NRCS	Orange (all commercial varieties)
NRCS	Orange (Florida)
NRCS	Orange (with peel)
NRCS	Orange-Navel (California)
IPNI	oranges
NRCS	Orange-Valencia (California)
IPNI	orchardgrass
NRCS	Orchardgrass + Alfalfa, for hay
NRCS	Orchardgrass + Alfalfa, for hay (cut 1)
NRCS	Orchardgrass, for green chop
NRCS	Orchardgrass, for green chop (mature)
NRCS	Orchardgrass, for green chop (mid bloom)
NRCS	Orchardgrass, for green chop (pre bloom)
NRCS	Orchardgrass, for hay
NRCS	Orchardgrass, for hay (mature)

Source	Crop
NRCS	Orchardgrass, for hay (mid bloom)
NRCS	Orchardgrass, for hay (pre bloom)
NRCS	Orchardgrass, for hay (vegetative)
NRCS	Papaya
NRCS	Parsley
NRCS	Parsnip
NRCS	Passion-Fruit, (purple)
NRCS	Pea, for straw
NRCS	Pea, for vine (without pods)
IPNI	peach
NRCS	Peach (without skin)
NRCS	Pea-Chinese, for immature pod with seeds
NRCS	Pea-English, for seed (immature seed)
NRCS	Pea-Field, for hay
NRCS	Pea-Field, for seed (dry)
NRCS	Pea-Field, for silage
NRCS	Pea-Field, for straw
NRCS	Pea-Flat, for silage (early bloom)
NRCS	Pea-Garden, for pod
NRCS	Pea-Garden, for seed (dry)
NRCS	Pea-Garden, for seed (immature seed)
NRCS	Pea-Garden, for straw
IPNI	peanut
NRCS	Peanut, for fruit (pod with seeds)
NRCS	Peanut, for hay (dug and with nuts)
NRCS	Peanut, for hay (dug and without nuts)
NRCS	Peanut, for hay (mowed)
NRCS	Peanut, for seed only
NRCS	Peanut, for vine only
NRCS	Pear
IPNI	pear
IPNI	peas
NRCS	Pea-Shelling, for seed (immature seed)
NRCS	Pea-Sugar, for immature pod with seeds
NRCS	Pecan (dry)
NRCS	Pepper-Bell (green)
NRCS	Pepper-Bell (red)
NRCS	Pepper-Chili (green)
NRCS	Pepper-Chili (red)

Source	Crop
NRCS	Pepper-Pimiento
NRCS	Persimmon-Japanese
NRCS	Persimmons-Native
NRCS	Pineapple
CDFA	Pistachio
NRCS	Pistachio, for nuts (dry)
NRCS	Pitanga
NRCS	Plantain
NRCS	Plum
NRCS	Pomegranate (without skin)
IPNI	potato (tuber, stems, and leaves)
NRCS	Potato-Irish for tuber
NRCS	Potato-Irish, for vine
NRCS	Prairie (Marsh), for hay
NRCS	Prairie (Meadow), for hay (intermountain area)
NRCS	Prairie, for hay (Colorado, Wyoming)
NRCS	Prairie, for hay (Kansas, Oklahoma)
NRCS	Prairie, for hay (Midwest, Minnesota, South Dakota)
NRCS	Prairie, for hay (western, early cut)
NRCS	Prairie, for hay (western, mature and weathered)
NRCS	Prairie, for hay (western, mature)
NRCS	Prairie, for hay (western, mid-season cut)
NRCS	Pricklypear (without skin)
IPNI	prunes
NRCS	Pummelo (without skin)
NRCS	Pumpkin
NRCS	Quince
NRCS	Radish, for root, cultivar 'Icicle'
NRCS	Radish, for root, cultivar 'Scarlet Globe'
NRCS	Radish-Chinese Winter, for root
NRCS	Raspberry
IPNI	red clover
NRCS	Redtop, for green chop
NRCS	Redtop, for hay
NRCS	Redtop, for hay (full bloom)
NRCS	Redtop, for hay (late vegetative)
NRCS	Redtop, for hay (mature)
NRCS	Redtop, for hay (mid bloom)
IPNI	reed canary grass

Source	Crop
NRCS	Rhubarb, for fruit
NRCS	Rhubarb, for leaf petiole
CDFA	Rice
IPNI	rice (grain & straw)
NRCS	Rice, for straw
NRCS	Rice-Rough, for grain
NRCS	Rose-apple
NRCS	Roselle
NRCS	Rutabaga
IPNI	rye (grain & straw)
NRCS	Rye, for grain
NRCS	Rye, for green chop
NRCS	Rye, for green chop (dough stage)
NRCS	Rye, for green chop (mature)
NRCS	Rye, for hay
NRCS	Rye, for hay (dough stage)
NRCS	Rye, for hay (mature)
NRCS	Rye, for straw
IPNI	ryegrass
NRCS	Ryegrass-Perennial, for green chop
NRCS	Ryegrass-Perennial, for green chop (early vegetative)
NRCS	Ryegrass-Perennial, for green chop (late vegetative)
NRCS	Ryegrass-Perennial, for green chop (mid bloom)
NRCS	Ryegrass-Perennial, for hay
NRCS	Ryegrass-Perennial, for hay (early vegetative)
NRCS	Ryegrass-Perennial, for hay (late vegetative)
NRCS	Ryegrass-Perennial, for hay (mature)
NRCS	Ryegrass-Perennial, for hay (mid bloom)
IPNI	safflower
NRCS	Safflower, for seed
NRCS	Saltgrass, for hay
NRCS	Sapodilla
NRCS	Sapote
NRCS	Sesame, for seed
NRCS	Smooth Brome + Alfalfa, for green chop
NRCS	Smooth Brome + Alfalfa, for hay
NRCS	Smooth Brome + Alfalfa, for hay (cut 1)
NRCS	Smooth Brome + Alfalfa, for hay (cut 2)

Source	Crop
IPNI	sorghum (grain & stover)
NRCS	Sorghum, for grain
NRCS	Sorghum, for green chop
NRCS	Sorghum, for green chop (dough stage)
NRCS	Sorghum, for green chop (mid bloom)
NRCS	Sorghum, for green chop (milk stage)
NRCS	Sorghum, for silage
NRCS	Sorghum, for silage (dough stage)
NRCS	Sorghum, for silage (early bloom)
NRCS	Sorghum, for silage (mature)
NRCS	Sorghum, for silage (milk state)
NRCS	Sorghum, for stover
NRCS	Sorghum/Sudangrass, for grain
NRCS	Sorghum/Sudangrass, for green chop
NRCS	Sorghum/Sudangrass, for green chop (early bloom)
NRCS	Sorghum/Sudangrass, for green chop (full bloom)
NRCS	Sorghum/Sudangrass, for green chop (mature)
NRCS	Sorghum/Sudangrass, for green chop (vegetative)
NRCS	Sorghum/Sudangrass, for hay
NRCS	Sorghum/Sudangrass, for silage
NRCS	Sorghum/Sudangrass, for straw
NRCS	Soursop
IPNI	soybean (grain & stover)
NRCS	Soybean, for grain
NRCS	Soybean, for green chop
NRCS	Soybean, for green chop (early bloom)
NRCS	Soybean, for green chop (full bloom)
NRCS	Soybean, for green chop (mature)
NRCS	Soybean, for green chop (mid bloom)
NRCS	Soybean, for hay
NRCS	Soybean, for hay (early bloom)
NRCS	Soybean, for hay (full bloom)
NRCS	Soybean, for hay (mature)
NRCS	Soybean, for hay (mid-bloom)
NRCS	Soybean, for immature seed
NRCS	Soybean, for straw
NRCS	Spinach
NRCS	Spinach-New Zealand
IPNI	squash

Source	Crop
NRCS	Squash Straight neck, for immature fruit (summer)
NRCS	Squash-Acorn, for mature fruit (winter)
NRCS	Squash-Balsampear, for immature fruit (summer)
NRCS	Squash-Butternut, for mature fruit (winter)
NRCS	Squash-Chinese wintermelon, for mature fruit (winter)
NRCS	Squash-Chinese, for immature fruit (summer)
NRCS	Squash-Crockneck, for immature fruit (summer)
NRCS	Squash-Hubbard, for mature fruit (winter)
NRCS	Squash-Pink Banana, for mature fruit (winter)
NRCS	Squash-Scallop, for immature fruit (summer)
NRCS	Squash-Zucchini, for immature fruit (summer)
C DFA	Strawberries
NRCS	Strawberry
NRCS	Sugar apple
IPNI	sugarbeet (roots & tops)
NRCS	Sugarbeet, root with crown
NRCS	Sugarbeet, root without crown
NRCS	Sugarbeet, top with crown
NRCS	Sugarbeet, top without crown
IPNI	sugarcane
NRCS	Sugarcane, cane top + trash
NRCS	Sugarcane, millable cane (less than 12 month crop)
NRCS	Sugarcane, millable cane and trash (less than 12 month crop)
IPNI	sunflower (grain & stover)
NRCS	Sunflower, for seed (with hull, confection type)
NRCS	Sunflower, for seed (with hull, oil type)
NRCS	Sunflower, for stover (yield less than 500 lb/acre)
NRCS	Sunflower, for stover (yield more than 500 lb/acre)
IPNI	sweet potato
NRCS	Sweet Potato, for root
NRCS	Sweet Potato, for vine
NRCS	Sweetclover, for green chop
NRCS	Sweetclover, for green chop (full bloom)
NRCS	Sweetclover, for green chop (mid bloom)
NRCS	Sweetclover, for green chop (pre bloom)
NRCS	Sweetclover, for green chop (vegetative)
NRCS	Sweetclover, for hay

Source	Crop
NRCS	Sweetclover, for hay (early bloom)
NRCS	Sweetclover, for hay (full bloom)
NRCS	Sweetclover, for hay (mature)
NRCS	Sweetclover, for hay (vegetative)
NRCS	Sweetclover, for seed
NRCS	Sweetclover, for silage
NRCS	Sweetclover, for silage (early bloom)
NRCS	Sweetclover, for silage (full bloom)
NRCS	Sweetclover, for silage (pre bloom)
IPNI	switchgrass
NRCS	Switchgrass, for green chop
NRCS	Switchgrass, for green chop (mature)
NRCS	Switchgrass, for green chop (full bloom)
NRCS	Switchgrass, for green chop (over ripe)
NRCS	Switchgrass, for green chop (vegetative)
NRCS	Tamarind
NRCS	Tangerine
NRCS	Taro, for corm
NRCS	Taro-Pink, for corm
NRCS	Taro-White, for corm
NRCS	Timothy + Alfalfa, for green chop (50% alfalfa)
NRCS	Timothy + Alfalfa, for hay
NRCS	Timothy + Alfalfa, for hay (cut 1)
NRCS	Timothy + Alfalfa, for hay (cut 2)
NRCS	Timothy + Clover, for hay
NRCS	Timothy + Clover-Red, for hay
NRCS	Timothy + Clover-White-Ladino type, for silage
IPNI	timothy grass
NRCS	Timothy, for green chop
NRCS	Timothy, for green chop (early to mid bloom)
NRCS	Timothy, for green chop (late bloom)
NRCS	Timothy, for green chop (mature)
NRCS	Timothy, for green chop (vegetative)
NRCS	Timothy, for hay
NRCS	Timothy, for hay (full bloom)
NRCS	Timothy, for hay (mature)
NRCS	Timothy, for hay (mid bloom)
NRCS	Timothy, for hay (pre bloom)
NRCS	Timothy, for hay (vegetative)

Source	Crop
NRCS	Timothy, for silage
NRCS	Timothy, for silage (boot)
NRCS	Timothy, for silage (early bloom)
NRCS	Timothy, for silage (full bloom)
NRCS	Timothy, for silage (milk stage)
NRCS	Timothy, for silage (pre bloom)
NRCS	Timothy, for silage (vegetative)
IPNI	tobacco
NRCS	Tobacco-Air cured, Burley type
NRCS	Tobacco-Air cured, Havana Seed type
NRCS	Tobacco-Air cured, Maryland Broadleaf type
NRCS	Tobacco-Flue-cured
NRCS	Tomato
IPNI	tomato
CDFA	Tomatoes
NRCS	Trefoil-Birdsfoot, for green chop
NRCS	Trefoil-Birdsfoot, for green chop (early bloom)
NRCS	Trefoil-Birdsfoot, for green chop (mid bloom to full bloom)
NRCS	Trefoil-Birdsfoot, for hay
NRCS	Trefoil-Birdsfoot, for hay (early bloom)
NRCS	Trefoil-Birdsfoot, for hay (mid bloom to full bloom)
NRCS	Triticale, for grain
NRCS	Turnip, for green chop
NRCS	Turnip, for green chop
NRCS	Turnip, for root
IPNI	vetch
NRCS	Vetch, for seed
NRCS	Vetch-Common, for green chop
NRCS	Vetch-Common, for green chop (early bloom)
NRCS	Vetch-Common, for green chop (full bloom)
NRCS	Vetch-Common, for hay
NRCS	Vetch-Common, for hay (early bloom)
NRCS	Vetch-Common, for hay (full bloom)
NRCS	Vetch-Hairy, for green chop (mid bloom)
NRCS	Vetch-Hairy, for hay
NRCS	Vetch-Hairy, for hay (vegetative)
CDFA	Walnut
NRCS	Walnut-Black, for seed extracted from nut

Source	Crop
NRCS	Walnut-English or Persian
CDFA	Wheat
IPNI	wheat (spring/winter grain & straw)
NRCS	Wheat, for green chop
NRCS	Wheat, for green chop (milk stage)
NRCS	Wheat, for hay
NRCS	Wheat, for hay (dough stage)
NRCS	Wheat, for hay (mature)
NRCS	Wheat, for hay (milk stage)
NRCS	Wheat-Bread-Hard Red Spring, for grain
NRCS	Wheat-Bread-Hard Red Winter, for grain
NRCS	Wheat-Bread-Soft Red Winter, for grain
NRCS	Wheat-Bread-Soft White Winter, for grain
NRCS	Wheat-Durum, for grain
NRCS	Wheatgrass, for green chop
NRCS	Wheatgrass, for green chop (mature)
NRCS	Wheatgrass, for green chop part (early bloom)
NRCS	Wheatgrass, for hay
NRCS	Wheatgrass, for hay (early bloom)
NRCS	Wheatgrass, for hay (late bloom)
NRCS	Wheatgrass, for hay (mature)
NRCS	Wheatgrass-Bluebunch, for hay (over ripe)
NRCS	Wheatgrass-Crested, for green chop
NRCS	Wheatgrass-Crested, for green chop (early bloom)
NRCS	Wheatgrass-Crested, for green chop (full bloom)
NRCS	Wheatgrass-Crested, for green chop (mature)
NRCS	Wheatgrass-Crested, for hay
NRCS	Wheatgrass-Crested, for hay (early bloom)
NRCS	Wheatgrass-Crested, for hay (full bloom)
NRCS	Wheatgrass-Crested, for hay (mature)
NRCS	Wheatgrass-Crested, for hay (mid bloom)
NRCS	Wheatgrass-Intermediate, for hay
NRCS	Wheatgrass-Slender, for hay
NRCS	Wheatgrass-Slender, for hay (early bloom)
NRCS	Wheatgrass-Slender, for hay (full bloom)
NRCS	Wheatgrass-Slender, for hay (vegetative)
NRCS	Wheatgrass-Tall, for hay
NRCS	Wheatgrass-Thickspike, for hay
NRCS	Wheatgrass-Western, for hay

Source	Crop
NRCS	Wheatgrass-Western, for hay (full bloom)
NRCS	Wheatgrass-Western, for hay (mature)
NRCS	Wheatgrass-Western, for hay (vegetative)
NRCS	Wheat-Spelt, for grain
NRCS	Wheat-Spelt, for straw
NRCS	Wheat-Spring including Durum, for straw
NRCS	Wheat-Winter, for straw
NRCS	Wildrice, for grain
NRCS	Wildrice, for straw
NRCS	Yam