A. Project Information Final Report Contract 20-0250-SA July 1, 2020 – June 30, 2024 (NCE Granted)

Nitrogen Content of the Harvested Portion of Specialty Crops to Estimate Crop Nitrogen Removal and Improve Nitrogen Management in Crops

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B. ABSTRACT

The Central Coast Regional Water Quality Control Board (CCRWQCB) approved Ag Order 4.0 in April of 2021. This regulatory action requires growers to calculate the quantity of nitrogen (N) that leaves the field in the harvested product. This value is needed to complete the "applied (A) N minus removed (R) N" (A-R) metric which determines the amount of N that remains in the field following crop production. Nitrogen removal crop coefficients provide an easy-to-use method to estimate N removed in the harvested portion of the crop. This project is establishing N removal crop coefficients for crops lacking this information, that represent 95% of the acreage in Region 3. This project originally proposed to evaluate 35 crops of interest to the coastal production district. However, we received input from growers and the Regional Water Board Staff and increased the number of crops and crop products evaluated to 75. In addition to the large-acreage field crops grown in Region 3 such as leafy greens and cole crops, crops such as berries, representative flowers species, small acreage vegetables and a variety of Asian vegetables were also evaluated. This report provides the N removal coefficients evaluated by this project.

C. INTRODUCTION

The Agricultural Discharge Order 4.0 approved by the CCRWQCB in April 2021 requires that growers calculate the load of N that is left in the field following crop production. Ag Order 4.0

uses the following metric to measure the load of N that remains in a production field after the crop is harvested: A minus R equation in which A is the quantity of nitrogen applied to the field (fertilizer, soil amendments and irrigation water) and R is the quantity of nitrogen that is removed from the field (in the harvested product or sequestered with cover crops and high carbon amendments). Applied N minus removed N targets and limits were scheduled to begin at the end of 2023 but have been stayed by an order from the State Water Board until some technical issues can be resolved by an Expert Pannel process. However, growers are still required to report A minus R values for their operations until the State Water Board issues are resolved, so there is no change in the need to calculate N removal data by growers. Crop coefficients are an essential tool for growers to utilize to determine N removal by their crops. This project was undertaken to establish crop coefficients for crops that represent 95% of the acreage in Region 3, the area under the jurisdiction of the CCRWQCB.

D. OBJECTIVES

- 1. Assess N removed in harvested product for 35 commodities identified in the special request for proposals over three growing seasons.
- 2. Develop N removal coefficients that can be multiplied by grower yield data to provide an estimate of N removed in the harvested crop.
- 3. Expand knowledge and promote appropriate use of N-removal coefficients (as part of routine N-management planning, and evaluation) by growers, advisors and consultants.

E. METHODS

Assess N removed in harvested product for 35 commodities identified in the special request for proposals over three growing seasons: Contacts were made with cooperating growers and arrangements were made for sampling commercial production field of the commodities. Based on feedback received from growers and CCRWQCB staff, we increased the number of commodities and commodity products to 75. From 2020 to 2024 the selected commodities were evaluated. Samples were collected from four to six locations in each field. The fields were chosen from a broad range of geographic locations and across soil types, as well as production and irrigation practices. The commodities evaluated included the principle cool season vegetables grown on the Central Coast as well as selected berries, specialty vegetables important to smaller growers and Asian vegetables. Due to the large variety of flowers grown in this region, two flower types were selected to serve as representative types: gerberas (single flower stems with no foliage) and snap dragons (single flower stems with foliage). Harvested crop samples were collected on commercial farms directly from harvest crews and immediately weighed in the field to get the fresh weight biomass of the commodity. Samples were then dried at the UCCE facilities at 60 C for 48-72 hours and reweighed to obtain dry biomass weight. Dried samples were sent to the UC Davis Analytical laboratory and analyzed for total nitrogen content.

Develop N removal coefficients that can be multiplied by grower yield data to provide an estimate of N removed (R) in the harvested crop: The percent solids of the commodity was calculated from the fresh and dry weight evaluations. The percent solids was multiplied by the percent N in the sample to develop the N removal coefficient. Table 1 shows the mean N removal coefficient for each commodity. The range of the coefficients observed in these

evaluations is also shown. The variability in the N removal coefficients is due to variability in the percent N and percent solids in the crop tissue (also shown in Table 1). The ranges in the data in Table 1 are on a per field basis. The N removal coefficient is multiplied by the pounds of harvested product from the field to determine the pounds of N that is removed in the product. This information supplies the N reporting data required in Ag Order 4.0 by the CCRWQCB. The N removal coefficient data has been entered into the MS Access Database and is available to growers.

Expand knowledge and promote appropriate use of N-removal coefficients (as part of routine N-management planning, and evaluation) by growers, advisors and consultants: The results of this project have been discussed at grower meetings and published in the Monterey County Blog.

F. DATA/RESULTS

Assess N removed in harvested product for 35 commodities identified in the special request for proposals over three growing seasons: This project was originally written to develop N removal coefficients for 35 commodities. However, smaller growers requested that we develop N removal coefficients for vegetable commodities that comprise smaller acreages, Asian vegetables, berries and representative flower varieties. As a result, N removal coefficients for the 75 commodities and commodity products were developed and are shown in Table 1. The mean, minimum and maximum percent dry matter and percent nitrogen are also shown in Table 1. The variability of the N removal coefficients are the result of variability in the percent solids and nitrogen of the commodities. These factors vary due to growing conditions in each field such as irrigation and fertility practices and differences in varieties.

The N removal coefficients are multiplied by the pounds of the harvested product to calculate pounds of N in the harvested product that is leaving the field. As an example: 1,000 cartons/A of fresh market romaine lettuce with an average net weight of lettuce per carton of 40 lbs = 40,000 pounds lettuce. To calculate N removed in this product: 40,000 pounds x 0.00184 = 73.6 pounds of N/A in the harvested product. This is a mean removal estimate. As can be seen from the data in Table 1, there is a range in the removal coefficients and growers may justify the use of a higher coefficient based on their specific conditions on their ranch.

Develop N removal coefficients that can be multiplied by grower yield data to provide an estimate of N removed in the harvested crop: Nitrogen removal coefficients vary within a commodity and commodity products due to growing conditions mentioned above. The coefficients ranged from 0.00078 for blue berries to 0.00727 for pea tips. Higher concentrations of N as well as higher solids in the tissue resulted in higher removal coefficients. As a result, it is not surprising to see that a field with higher N fertility or less available water in the soil at harvest would tend to have a higher N removal coefficient. Nitrogen removal coefficients between crops tended to segregate by crop type. For instance, as a group, leafy and flowering vegetables with higher N content tended to have higher removal coefficients (e.g. 0.00465 and 0.00434, respectively) than bulb or heading vegetables which tend to have lower N content (e.g. 0.00186 and 0.00205, respectively); these vegetables

have lower N in their tissue than leafy vegetables that contain greater quantities of chlorophyl which is rich in N. As a result, the N removal coefficients tend to fall in recognizable ranges depending on the type of commodity.

Expand knowledge and promote appropriate use of N-removal coefficients (as part of routine N-management planning, and evaluation) by growers, advisors and consultants: The results from this project have been widely distributed at grower meetings. The results of this project were first used by growers in the March 2024 Irrigation and Nutrient Management Plan (INMP) report. The coefficients were made available to growers through the drop down menu in the reporting form used by Preservation Inc., by the CCRWQCB, by agencies and consultants assisting growers in filling out their N reporting forms.

Table 1. Mean and range of crop coefficients (coeff) developed by this FREP funded project and additional crops evaluated. Factors used to develop the coefficients are also included: percent dry matter (%DM) and percent nitrogen (%N)

			mean	min	max	mean	min	max	mean	min	max	# fields
Commodity	Product	Pack type	coeff	coeff	coeff	%DM	%DM	%DM	%N	%N	%N	sampled
A choy	Fresh Market	Carton	0.00269	0.00200	0.00422	5.72	4.23	9.85	4.76	3.43	5.52	15
Amaranth	Fresh Market	Carton	0.00613	0.00435	0.01483	10.97	7.69	26.97	5.62	4.4	6.1	15
Annual Artichoke	Fresh Market	Carton	0.00382	0.00344	0.00448	16.26	12.71	20.25	2.40	1.86	3.17	19
Arugula	Bulk	Bulk	0.00580	0.00507	0.00685	9.43	7.30	11.86	6.22	4.83	6.96	15
Beans, Green (Snap)	Fresh Market	Carton	0.00328	0.00285	0.00394	10.33	7.56	13.68	3.24	2.55	3.77	10
Beet (with tops)	Fresh Market	Carton	0.00305	0.00269	0.00344	11.06	8.51	12.48	2.79	2.28	3.91	15
Berries, black	Fresh Market	Carton	0.00223	0.00140	0.00294	15.16	12.57	17.55	1.48	0.98	2.05	30
Berries, blue	Fresh Market	Carton	0.00078	0.00020	0.00119	15.32	13.08	17.09	0.51	0.14	0.81	15
Berries, raspberry	Fresh Market	Carton	0.00180	0.00160	0.00208	13.64	11.60	16.21	1.33	1.02	1.55	29
Bok Choy, baby	Fresh Market	Carton	0.00209	0.00085	0.00344	3.57	1.88	5.33	5.73	4.24	6.58	15
Bok Choy, Full size	Fresh Market	Carton	0.00178	0.00148	0.00188	4.75	3.90	5.39	3.78	2.76	4.36	12
Broccoli	Fresh Market	Carton	0.00463	0.00390	0.00579	9.11	8.05	11.04	5.09	4.22	6.01	19
Broccolini	Fresh Market	Carton	0.00520	0.00433	0.00690	11.16	9.44	13.49	4.67	3.44	5.51	15
Brussels Sprout	Fresh Market	Carton	0.00628	0.00540	0.00790	14.08	13.11	15.75	4.47	3.71	5.44	21
Cabbage, Green	Bulk Cored	Bulk	0.00183	0.00125	0.00229	7.26	6.38	8.04	2.51	1.80	3.02	15
Cabbage, Green	Bulk Whole	Bulk	0.00173	0.00107	0.00225	7.34	6.48	8.36	2.37	1.38	3.01	16
Cabbage, Green	Fresh Market	Carton	0.00221	0.00161	0.00357	7.86	5.74	10.95	2.82	2.06	3.26	25
Cabbage, Red	Bulk Cored	Bulk	0.00205	0.00138	0.00257	8.92	8.25	9.62	2.30	1.47	2.70	15
Cabbage, Red	Fresh Market	Carton	0.00201	0.00155	0.00239	8.10	7.16	9.46	2.50	1.73	3.05	18
Cauliflower	Fresh Market	Carton	0.00283	0.00234	0.00339	7.06	6.07	8.01	4.02	3.49	4.93	28
Celery	Fresh Market	Carton	0.00106	0.00052	0.00144	4.99	3.57	6.64	2.19	0.99	3.03	16
Celery	Processing	Bulk	0.00100	0.00064	0.00128	4.51	3.49	6.74	2.34	0.95	3.13	7
Chinese Celery	Fresh Market	Carton	0.00301	0.00161	0.00418	7.12	6.16	8.59	4.24	2.48	5.65	15
Chayote tips	Fresh Market	Carton	0.00542	0.00311	0.00714	7.37	5.36	9.11	7.40	3.87	8.58	15
Cilantro	Clip	Bulk	0.00595	0.00449	0.00810	11.13	8.22	14.06	5.35	4.83	6.24	19
Cilantro	Bunch	Carton	0.00413	0.00250	0.00488	8.44	7.37	9.91	4.94	2.81	6.05	17
Cucumber	Fresh Market	Carton	0.00114	0.00088	0.00144	4.86	4.40	5.66	2.33	1.88	2.57	18
Endive	Fresh Market	Carton	0.00274	0.00216	0.00346	7.63	6.34	9.20	3.60	2.85	4.59	15
Escarole	Fresh Market	Carton	0.00242	0.00191	0.00292	6.67	5.65	7.61	3.64	3.15	4.41	15
Fennel	Fresh Market	Carton	0.00202	0.00132	0.00238	7.43	6.75	8.25	2.72	1.96	3.16	15
Flower, Gerbera	Fresh Market	Bunches	0.00325	0.00276	0.00478	13.24	11.05	14.80	2.46	2.05	3.62	22
Flower, Snapdragon	Fresh Market	Bunches	0.00239	0.00183	0.00314	10.76	8.61	15.45	2.27	1.52	2.97	15
Flower, Status	Fresh Market	Bunches	0.00327	0.00315	0.00341	27.64	25.48	29.75	1.20	1.10	1.26	3
Gai Choy	Fresh Market	Carton	0.00360	0.00294	0.00523	6.34	5.15	8.37	5.66	4.81	6.25	15
Gailan	Fresh Market	Carton	0.00425	0.00281	0.00575	8.52	5.43	12.96	5.14	4.34	6.04	15
Kale, Baby Lacinato	Bulk	Bulk	0.00705	0.00588	0.00878	11.30	9.40	14.06	6.24	5.57	6.68	15
Kale, Baby Curled Leaf	Bulk	Bulk	0.00631	0.00631	0.00631	10.82	10.82	10.82	5.84	5.84	5.84	1
Kale, Multi Pick	Fresh Market	Carton	0.00548	0.00405	0.00700	13.27	11.87	15.36	4.16	2.64	4.98	42
Leek	Bulk	Bulk	0.00235	0.00157	0.00357	10.82	9.53	11.94	2.17	1.47	3.21	12
Leek	Fresh Market	Carton	0.00213	0.00164	0.00245	12.91	11.63	15.20	1.71	1.08	2.10	3
Leek	Mean	Mean	0.00231	0.00157	0.00357	11.24	9.53	15.20	2.08	1.08	3.21	15

Table 1 continued. Mean and range of crop coefficients (coeff) developed by this FREP funded project and additional crops evaluated. Factors used to develop the coefficients are also included: percent dry matter (%DM) and percent nitrogen (%N)

		,	mean	min	max	mean	min	max	mean	min	max	# fields
Commodity	Product	Pack type	coeff	coeff	coeff	%DM	%DM	%DM	%N	%N	%N	sampled
Lettuce, Baby Green	Bulk	Bulk	0.00338	0.00236	0.00469	6.80	4.98	9.17	4.98	3.60	5.87	21
Lettuce, Baby Red	Bulk	Bulk	0.00356	0.00260	0.00546	6.97	5.20	9.13	5.11	4.36	6.12	23
Lettuce, Butter	Fresh Market	Carton	0.00199	0.00155	0.00266	5.70	4.53	6.72	3.50	2.87	4.05	20
Lettuce, Green Leaf	Fresh Market	Carton	0.00207	0.00148	0.00283	6.80	5.73	7.96	3.06	2.25	3.71	20
Lettuce, Iceberg	Bulk Cored	Bulk	0.00120	0.00099	0.00160	4.02	3.58	4.89	2.99	2.62	3.55	20
Lettuce, Iceberg	Fresh Market	Film Wrap	0.00127	0.00108	0.00168	4.31	3.73	5.13	2.95	2.52	3.80	19
Lettuce, Iceberg	Fresh Market	Naked	0.00129	0.00102	0.00161	4.32	3.77	5.02	2.98	2.46	3.38	21
Lettuce, Iceberg	Mean		0.00125	0.00103	0.00163	4.22	3.69	5.01	2.97	2.53	3.58	60
Lettuce, Red Leaf	Fresh Market	Carton	0.00224	0.00191	0.00307	5.81	5.03	6.99	3.85	3.32	4.41	20
Lettuce, Romaine	Bulk Tops & Tails	Bulk	0.00152	0.00135	0.00189	4.97	4.53	5.52	3.06	2.78	3.43	5
Lettuce, Romaine	Bulk Whole	Bulk	0.00149	0.00136	0.00166	4.91	4.21	5.84	3.06	2.70	3.50	15
Lettuce, Romaine	Mean bulk	Bulk	0.00150	0.00135	0.00189	4.93	4.21	5.84	3.06	2.70	3.50	20
Lettuce, Romaine	Fresh Market	Carton	0.00184	0.00137	0.00247	5.92	5.02	7.59	3.11	2.39	3.71	20
Lettuce, Romaine	Hearts	Carton	0.00188	0.00114	0.00239	5.71	4.29	7.50	3.33	1.64	3.87	21
Lettuce, Romaine	Mean F. Market	Carton	0.00186	0.00125	0.00243	5.81	4.66	7.54	3.22	2.02	3.79	41
Malabar spinach	Fresh Market	Carton	0.00240	0.00147	0.00309	6.71	5.13	9.04	3.69	1.72	5.19	15
Mizuna	Bulk	Bulk	0.00548	0.00454	0.00646	8.97	6.83	10.25	6.19	4.57	7.24	5
Napa Cabbage	Fresh Market	Carton	0.00181	0.00148	0.00212	5.00	4.49	5.90	3.67	2.51	4.73	12
Onion, Dry Red	Bulk	Bulk	0.00126	0.00090	0.00222	11.61	10.62	12.67	1.07	0.80	1.75	16
Onion, Dry Yellow	Bulk	Bulk	0.00164	0.00125	0.00207	11.10	9.81	13.26	1.47	1.21	1.65	15
Parsley, Curly	Fresh Market	Carton	0.00440	0.00325	0.00529	13.88	10.35	16.97	3.28	1.92	4.22	8
Parsley, Italian	Fresh Market	Carton	0.00436	0.00382	0.00499	13.23	9.24	16.26	3.39	2.63	4.38	8
Parsley, All	Mean F. Market	Mean	0.00438	0.00325	0.00529	13.56	9.24	16.97	3.33	1.92	4.38	16
Pea, Edible Pod	Fresh Market	Carton	0.00472	0.00415	0.00526	12.74	11.57	13.76	3.70	3.52	3.88	15
Pea tips	Fresh Market	Carton	0.00727	0.00332	0.00902	11.75	5.43	16.60	6.28	5.27	8.02	15
Pepper, Red Bell	Fresh Market	Carton	0.00194	0.00181	0.00203	8.99	8.87	9.14	2.15	2.04	2.21	3
Radicchio	Bulk	Bulk	0.00216	0.00214	0.00219	6.55	6.52	6.58	3.31	3.28	3.33	2
Radicchio	Fresh Market	Carton	0.00235	0.00211	0.00295	6.96	6.41	7.68	3.40	2.81	4.47	13
Radicchio	Mean	Mean	0.00233	0.00211	0.00295	6.91	6.41	7.68	3.39	2.81	4.47	15
Radish, Red (no tops)	Bulk	Bulk	0.00167	0.00126	0.00213	5.83	5.01	7.17	2.86	2.29	3.23	15
Radish, Red (with tops)	Fresh Market	Carton	0.00248	0.00215	0.00262	6.34	5.73	7.46	3.93	3.30	4.41	15
Rapini	Fresh Market	Carton	0.00605	0.00544	0.00695	9.97	8.86	10.85	6.08	5.45	6.81	15
Shallot	Bulk	Bulk	0.00241	0.00159	0.00339	19.99	19.17	21.20	1.20	0.76	1.66	16
Spinach, Clip	Bulk	Bulk	0.00484	0.00388	0.00702	8.12	6.63	11.18	5.97	5.30	6.40	21
Squash Crookneck	Fresh Market	Carton	0.00182	0.00182	0.00182	7.01	7.01	7.01	2.59	2.59	2.59	1
Squash Zucchini	Fresh Market	Carton	0.00191	0.00163	0.00251	5.80	5.09	6.57	3.31	2.70	4.02	18
Tong Ho	Fresh Market	Carton	0.00344	0.00194	0.00553	6.94	5.50	9.26	4.97	3.53	6.46	15
Water Spinach (Ong Choy)	Fresh Market	Carton	0.00350	0.00241	0.00502	7.25	5.29	9.58	4.91	2.97	6.38	15
Yam Leaves	Fresh Market	Carton	0.00510	0.00353	0.00607	10.35	8.75	13.37	4.98	3.15	5.79	15
Yu choy	Fresh Market	Carton	0.00352	0.00192	0.00535	6.71	4.08	9.47	5.21	4.47	5.82	15

G. DISCUSSION AND CONCLUSIONS

Nitrogen removal coefficients were developed for 75 commodities and commodity products grown on the Central Coast of California. These coefficients provide growers with a tool that they can use to determine the amount of N in the harvested portion of their crops that leaves the field at the end of the production cycle. This is the information that the growers are required to supply to the CCRWQCB in their annual INMP reports. The INMP relies on the A (applied N) minus R (removed N) as a measure of the amount of N that remains in the field (the load) after crop production. This load of N that remains in the field is considered at risk for N leaching to groundwater resources. Growers could calculate on their own the N removed from a field, but the process would be expensive and time consuming. The N removal

coefficients developed by this project provide a reasonably accurate means of estimating N in the harvested product. As is seen in Table 1, there is a fair bit of variability around the mean N removal coefficient. Coefficients tend to be higher for commodities with higher N and higher percent solids. The CCRWQCB does allow for growers to use different coefficients if they can justify its use or if they develop their own coefficient. However, N removal coefficients for a given crop will tend to fall in certain ranges. For instance, high N content leafy vegetables will have higher coefficients that will tend to vary in the 0.00500 to 0.00600 range. Head vegetables tended to range from 0.00200 to 0.00300. This project has demonstrated that coefficients may vary, but there are limits as to how far they will vary.

H. CHALLENGES

This project can be a never-ending process. The extended amount of time it took to complete this project was due to more commodities being added to the to-do list from both growers and the CCRWQCB staff. Once a commodity was added to the to-do list, then it took time to finalize sampling the representative fields and getting the results back from the lab. We think we now have a good number of crops completed that can provide the CCRWQCB with the tools it needs to provide the growers with a way to estimate N removed from fields. In addition, for the remaining crops without a coefficient, they can use representative commodities to estimate N removed and get an estimate that is reasonably close.

I. PROJECT IMPACTS

The coefficients were made available to the CCRWQCB, to Preservation Inc. for use in their dropdown menu for filling in the INMP reports as well as to growers and consultants for their use in reporting. As a result, N removal coefficients provided by this project were first used in the March 2024 INMP reporting to the CCRWQCB.

J. OUTREACH ACTIVITIES SUMMARY *Meetings:*

Event Name (1)	2021 Irrigation and Nutrient Management Meeting				
Presentation title	Development of N removal coefficients for vegetables on the central coast				
Location and date	Virtual meeting, 2/23/2021				
Attendee demographics (CCAs, PCAs, growers, consultants, researchers, etc.)	CCAs, PCAs, growers, consultants, researchers, and NGO reps.				
CCA/Grower Continuing Education Units (CEUs) offered	3.0 CCA & 1.0 CDPR continuing education credits	Number of participants	85		

Events Name (2)	California Leafy Greens Research Board Meetings				
Presentation title	Nitrogen removal coefficients for leafy greens				
Location and date	March 30 and October 12, 2021				
Attendee demographics (CCAs, PCAs, growers, consultants, researchers, etc.)	Leafy green growers and PCA's				
CCA/Grower Continuing Education Units (CEUs) offered	na	Number of participants	120		

Event Name (3)	2022 Irrigation and Nutrient Management Meeting				
Presentation title	Factors Affecting the R Side of the A-R Metric Equation in Ag Order 4.0				
Location and date	UCCE Meeting Room, Salinas, CA February 23, 2022				
Attendee demographics (CCAs, PCAs, growers, consultants, researchers, etc.)	CCAs, PCAs, growers, consultants, researchers, and NGO reps.				
CCA/Grower Continuing Education Units (CEUs) offered	3.0 CCA & 1.0 CDPR continuing education credits	Number of participants	90		

Event Name (4)	September 2022 Santa Clara County Farm Bureau Meeting				
Presentation title	A-R Research Updates and Ongoing Research Work				
Location and date	Farm Bureau Meeting Room, Morgan Hill, CA September 14, 2022				
Attendee demographics (CCAs, PCAs, growers, consultants, researchers, etc.)	growers				
CCA/Grower Continuing Education Units (CEUs) offered	None	Number of participants	15		

Event Name (5)	2023 Irrigation and Nutrient Management Meeting				
Presentation title	Getting organized for Ag Order 4.0				
Location and date	UCCE Meeting Room, Salinas, CA				
Attendee demographics (CCAs, PCAs, growers, consultants, researchers, etc.)	CCAs, PCAs, growers, consultants, researchers, and NGO reps.				
CCA/Grower Continuing Education Units (CEUs) offered	3.0 CCA & 1.0 CDPR continuing education credits	Number of participants	85		

The results from this project have been shared with regional growers and stakeholders including Central Coast Water Quality Preservation, Inc. (CCWQP), a regional grower cooperative monitoring program. The results from this project have been incorporated by CCWQP into different INMP reporting forms/nitrogen removal calculators they have developed for growers:

https://docs.google.com/forms/d/e/1FAIpQLSdvCWYESc8KdXIvPDt8FbKnpIGLm_ SUldaQUAhmqwqwOEDDYg/viewform https://ccwqp.org/wp-content/uploads/INMP_Template_v1.02.xlsx https://ccwqp.org/wpcontent/uploads/N_Removal_ConversionCoeffsMarch2024Update.pdf

The results from this project were used when assisting 40 Asian growers complete their annual ILRP reporting requirements in February, 2024.

Publications:

Smith, R.F. and M. Cahn. 2021. Ag Order 4.0 Finalized: Implications for Nitrogen management on the Central Coast. UCCE Monterey County Blog: <u>https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=46578</u>. May 1

Smith, R. and M. Cahn. 2022. New water quality regulations will change how vegetables are grown on the Central Coast. Progressive Crop Consultant Magazine. 7(4): 10-15 July/August.

K. REFERENCES

L. APPENDIX:

n/a

M. FACT SHEET/DATA BASE TEMPLATE

- 1. Nitrogen Content of the Harvested Portion of Specialty Crops to Estimate Crop Nitrogen Removal and Improve Nitrogen Management in Crops
- 2. Contract 20-0250-SA

- 3. Project Leaders:
 - Richard Smith and Michael Cahn, UCCE Farm Advisors, Monterey, San Benito and Santa Cruz Counties
 - Aparna Gazula, UCCE Small Farms Advisor, Santa Clara, San Benito and Santa Cruz Counties
 - Andre Biscaro, UCCE Irrigation and Water Resources Farm Advisor, Ventura County
 - Cooperator:
 - i. Daniel Geisseler, Associate CE Specialist, Dept of Land, Air and Water Resources
- 4. July 1, 2020 June 30, 2024
- 5. Research conducted commercial production fields
- 6. Production fields in Monterey, San Benito, Santa Clara and Ventura Counties
- 7. Highlights:
- Crop removal coefficients are calculated from the percent nitrogen (N) and solids of the harvested portion of a crop. The coefficients can be multiplied by the net pounds of harvested product that leaves a field to determine the pounds of N that it contains. The amount of N removed by the crop is used in the Irrigation and Nutrient Management Plan (INMP) report to the Central Coast Regional Water Quality Control Board (CCRWQCB). The purpose of the report is assess compliance with targets and limits of N loading allowed in vegetable production fields following crop production.
- This project evaluated crop removal coefficients for 75 crops and crop products grown on the Central Coast of California. These coefficients provide a simple and reasonably accurate measure of N removed by commodities and helps facilitate growers completing INMP reporting.
- Crop removal coefficients vary due to variability in the percent N and solids in the harvested product. Growers may decide to use a higher coefficient for their commodity based on their production practices. However, coefficients tend to fall in certain ranges based on the type of commodity. For instance, leafy green vegetables that have high amounts of N-rich chlorophyl will have higher coefficients than head or bulb vegetables that are lower in chlorophyll content.
- 8. Introduction

The Agricultural Discharge Order 4.0 approved by the CCRWQCB in April 2021 requires that growers calculate the load of N that is left in the field following crop production. Ag Order 4.0 uses the following metric to measure the load of N that remains in a production field after the crop is harvested: A minus R equation in which A is the quantity of nitrogen applied to the field (fertilizer, soil amendments and irrigation water) and R is the quantity of nitrogen that is removed from the field (in the harvested product or sequestered with cover crops and high carbon amendments). Applied N minus removed N targets and limits were scheduled to begin at the end of 2023 but have been stayed by an order from the State Water Board until some technical issues can be resolved by an Expert Pannel process. However, growers are still required to report A minus R values for their operations until the State Water Board issues are resolved, so there is no change in the need to calculate N removal data by growers. Crop coefficients are an essential tool to determine N removal by their crops. This project was undertaken to establish crop coefficients for crops that represent 95% of the acreage in Region 3, the area under the jurisdiction of the CCRWQCB.

9. Methods/Management

Samples were collected from four to six locations in commercial fields that covered a broad range of geographic locations, soil types and production practices. The commodities evaluated included the principle cool season vegetables and smaller acreage specialty commodities that represented 95% of the crops grown on the Central Coast. Samples were collected on commercial farms directly from harvest crews and immediately weighed in the field to get the fresh weight biomass of the commodity. Samples were then dried at the UCCE facilities at 60 C for 48-72 hours and reweighed to obtain dry biomass weight. Dried samples were sent to the UC Davis Analytical laboratory and analyzed for total nitrogen content. Percent solids of the commodity were calculated from the fresh and dry weight evaluations. The percent solids were multiplied by the percent N in the sample to develop the N removal coefficient. 10. Findings

N removal coefficients for the 75 commodities and commodity products were developed. Nitrogen removal coefficients vary within a commodity and commodity products due to growing conditions mentioned above. The coefficients ranged from 0.00078 for blue berries to 0.00727 for pea tips. Higher concentrations of N as well as higher solids in the tissue resulted in higher removal coefficients. Nitrogen removal coefficients between crops tended to segregate by crop type. For instance, as a group, leafy and flowering vegetables with higher N content tended to have higher removal coefficients (e.g. 0.00465 and 0.00434, respectively) than bulb or heading vegetables which tend to have lower N content (e.g. 0.00186 and 0.00205, respectively); these vegetables have lower N in their tissue than leafy vegetables with higher N-rich chlorophyl content. As a result, the N removal coefficients tend to fall in recognizable ranges depending on the type of commodity. The data and final coefficients have been entered into the MS Access Data Base and is publicly available.

N. COPY OF THE PRODUCT/RESULT

Crop removal coefficients have been supplied to the CCRWQCB, Preservation Inc., to consultants and to growers for their use in filling out INMP reports.