



# Agricultural Marketing Service

U.S. DEPARTMENT OF AGRICULTURE

## AWARD YEARS 2021 AND PRIOR

This annual Performance Progress Report (PPR) must illustrate the progress made toward the completion of your project. If this project is completed at the time of the annual PPR submission, the project report should be marked as final. Please note character limits (abbreviated "char.") throughout.

### PROJECT INFORMATION

|                                      |                                                                                                                   |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>Project Title</b> (250 char.)     | <i>Measuring the impact of a climate smart product, PlantCatalyst, on reduction of fertilizer and soil health</i> |
| <b>Organization Name</b> (250 char.) | <i>CAW Industries Inc.</i>                                                                                        |
| <b>Project Start Date</b>            | <i>5/21/2021</i>                                                                                                  |
| <b>Project End Date</b>              | <i>12/31/2025</i>                                                                                                 |

### ORGANIZATION POINT OF CONTACT

|                      |                               |
|----------------------|-------------------------------|
| <b>Full Name</b>     | <i>John Willard III</i>       |
| <b>Phone Number</b>  | <i>605-343-8100</i>           |
| <b>Email Address</b> | <i>john@plantcatalyst.com</i> |

### BACKGROUND INFORMATION

#### PROJECT PROGRESS

|                                                                                    |                                  |
|------------------------------------------------------------------------------------|----------------------------------|
| Please provide the total percentage of work completed on the project.              | <input type="text" value="100"/> |
| Is this a final report? Please select the box to the right if the answer is "yes". | <input type="checkbox"/>         |

#### PROJECT BACKGROUND (REQUIRED FOR FINAL REPORTS)

Provide enough information for the reader to understand the importance or context of the project and any key findings. This section may draw from the background and justification contained in the accepted project plan. As the project has been completed, write this section in past tense. If this is an annual report, please skip this section. (1200 char.)

*Corn varieties such as sweet corn required the most nitrogen per acre of any specialty crop and therefore had a disproportionate impact on groundwater contamination and greenhouse gas emissions. This project aimed to show that using South Dakota–manufactured PlantCatalyst allowed growers to reduce nitrogen fertilizer while maintaining yield and improving soil health over time.*

*A public–private partnership between CAW Industries, Inc. and South Dakota State University (SDSU) built on earlier research to evaluate how PlantCatalyst influenced soil biological activity and nitrogen use. SDSU conducted multi-year field trials at the West River Research Farm using 0%, 50%, and 100% of recommended nitrogen rates, measuring crop growth, yield, and soil health responses with and without PlantCatalyst®. Soil indicators were collected annually to assess whether reduced fertilizer combined with PlantCatalyst® improved soil function and whether those*

*effects persisted across years. In the final project year, additional growth chamber experiments were added to test PlantCatalyst effects on spinach performance and nutrient response.*

## OBJECTIVE(S) (REQUIRED)

Please provide the approved project's objectives from the accepted project plan. Use the boxes to indicate if the objective is in progress, has been completed, or is not (and will not be) completed. At the final report, if "no" is selected for any of the listed objectives, you must expand upon this in the Challenges and Developments Section. Additional objectives may be added as needed.

| + | # | Objective (2,000 char.)                                                                  | Objective Completed? |
|---|---|------------------------------------------------------------------------------------------|----------------------|
| - | 1 | <i>Investigate if Plant Catalyst can reduce fertilizer use</i>                           | Yes                  |
| - | 2 | <i>Investigate if Plant Catalyst can improve soil health</i>                             | Yes                  |
| - | 3 | <i>Investigate if Plant Catalyst can increase economic returns</i>                       | Yes                  |
| - | 4 | <i>Investigate if Plant Catalyst can conserve soil resources and/or reduce emissions</i> | Yes                  |

## OUTCOMES

Please only report on the outcomes and indicators that are selected and approved for this project. Use the check boxes to indicate which outcomes and indicators are selected. Select the "N/A" box for any indicators that are not applicable.

1. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH INCREASED SALES

☐

2. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH INCREASED CONSUMPTION

☐

3. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH INCREASED ACCESS AND AWARENESS

☐

4. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH GREATER CAPACITY OF SUSTAINABLE PRACTICES OF SPECIALTY CROP PRODUCTION RESULTING IN INCREASED YIELD, REDUCED INPUTS, INCREASED EFFICIENCY, INCREASED ECONOMIC RETURN, AND/OR CONSERVATION OF RESOURCES

☒

*Please provide the numbers of plant/seed releases (e.g., cultivars, drought-tolerant plants, organic, enhanced nutritional composition, etc.) for this reporting period.*

| Indicators                       | Value | N/A                      |
|----------------------------------|-------|--------------------------|
| 1. Number of plant/seed releases |       | <input type="checkbox"/> |

*Please select the applicable indicators and provide data for the adoption of best practices and technologies resulting in increased yields, reduced inputs, increased efficiency, increased economic return, and conservation of resources for this reporting period.*

| Indicators                                                                    | Value | N/A                      |
|-------------------------------------------------------------------------------|-------|--------------------------|
| 2.a. Number of growers/producers indicating adoption of recommended practices | 0     | <input type="checkbox"/> |

| Indicators                                                                                        | Value | N/A                                 |
|---------------------------------------------------------------------------------------------------|-------|-------------------------------------|
| 2.b. Number of growers/producers reporting reduction in pesticides, fertilizers, water used/acres | 0     | <input type="checkbox"/>            |
| 2.c. Number of producers reporting increased dollar returns per acre or reduced costs per acre    | 0     | <input type="checkbox"/>            |
| 2.d. Number of acres in conservation tillage or acres in other best management practices          |       | <input checked="" type="checkbox"/> |

Please provide the total number of adults reached and select the applicable indicators for this reporting period.

| Indicators                                                                                                      | Value | N/A                      |
|-----------------------------------------------------------------------------------------------------------------|-------|--------------------------|
| 3. Number of habitat acres established and maintained for the mutual benefit of pollinators and specialty crops |       | <input type="checkbox"/> |

5. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH MORE SUSTAINABLE, DIVERSE, AND RESILIENT SPECIALTY CROP SYSTEMS ☒

Please provide data for the applicable indicators for this reporting period.

| Indicators                                                                                                                                                                                                                                     | Value | N/A                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------|
| 1. Number of new or improved innovation models (biological, economic, business, management, etc.), technologies, networks, products, processes, etc. developed for specialty crop entities including producers, processors, distributors, etc. |       | <input checked="" type="checkbox"/> |
| 2. Number of innovations adopted                                                                                                                                                                                                               |       | <input checked="" type="checkbox"/> |
| 3. Number of specialty crop growers/producers (and other members of the specialty crop supply chain) that have increased revenue expressed in dollars                                                                                          |       | <input checked="" type="checkbox"/> |
| 4. Number of new diagnostic systems analyzing specialty crop pests and diseases                                                                                                                                                                |       | <input checked="" type="checkbox"/> |
| 5. Number of new diagnostic technologies available for detecting plant pests and diseases                                                                                                                                                      |       | <input checked="" type="checkbox"/> |
| 6. Number of first responders trained in early detection and rapid response to combat plant pests and diseases                                                                                                                                 |       | <input checked="" type="checkbox"/> |
| 7. Number of viable technologies/processes developed or modified that will increase specialty crop distribution and/or production                                                                                                              | 1     | <input type="checkbox"/>            |
| 8. Number of growers/producers that gained knowledge about science-based tools through outreach and education programs                                                                                                                         |       | <input checked="" type="checkbox"/> |

6. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH INCREASING THE NUMBER OF VIABLE TECHNOLOGIES TO IMPROVE FOOD SAFETY ☐

7. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH INCREASED UNDERSTANDING OF THREATS TO FOOD SAFETY FROM MICROBIAL AND CHEMICAL SOURCES ☐

8. ENHANCE THE COMPETITIVENESS OF SPECIALTY CROPS THROUGH ENHANCING OR IMPROVING THE ECONOMY AS A RESULT OF SPECIALTY CROP DEVELOPMENT ☐

ADDITIONAL APPROVED OUTCOME (IF APPLICABLE) ☐

## OUTCOME REMARKS (REQUIRED)

Please explain any quantifiable results, along with an update on their progress and data collection efforts for each of the outcomes and indicators selected in the accepted project plan. It is understood that the results may not yet be final at the time that this report is submitted; however, please provide an update on progress to date. If you do not have any data on the indicator(s) listed above, you must explain why in this section. (2,000 char.)

*Sweet corn yield was not increased by PlantCatalyst® at any nitrogen rate (Objective 1,3, Outcome 4.2.a-c). However, several quality-related indicators showed modest treatment differences. Crude protein remained consistent across all treatments (13.0–13.7%) with minimal separation between PC and non-PC plots. Potassium tended to be slightly higher in PC treatments, reaching the upper end of the 0.80–0.95 range. Micronutrients displayed clearer differences, with PC plots often showing higher zinc (up to 41 ppm) and iron (up to 47 ppm) levels. TSI values (11.0–13.0) also trended higher with PC, suggesting subtle improvements in sweetness or quality. Overall, while yield did not respond to PC, nutrient and quality measures generally favored PC-treated plots (Objective 5.7).*

*The Cornell spinach trial tested two varieties under 60%, 80%, and 100% of recommended nitrogen, each with and without PlantCatalyst, to evaluate growth, dry matter, and leaf area responses. PlantCatalyst did not increase dry matter in either variety. Rex showed small improvements in growth index and leaf area with PC at higher N rates, while Rouxai exhibited only a modest growth index increase at 100% N with PC. Overall, PC effects were limited and inconsistent, and no clear yield or biomass advantage was observed across nitrogen levels (Outcome 4.2a-c).*

NOTE: In the original project application in Microsoft Word we mistakenly entered Outcome 4 Indicators 1a., 1.b., and 1.c. The metrics which we established to report against actually relate to Outcome 4 Indicators 2.a, 2.b., and 2.c, so we report against those indicators here.

## NARRATIVE

### ACCOMPLISHMENTS (REQUIRED)

If this is an annual report, list your accomplishments for this reporting period. If this is a final report, your accomplishments should be cumulative and include all accomplishments previously reported on and updated to include activities conducted this past reporting period. Indicate how these accomplishments associated with each of your project's objective(s), outcome(s), and/or indicator(s). This listing should identify your project's partners and their contributions. Additional accomplishments can be added as needed.

| + | # | Accomplishment (1,200 char.)                                            | Related to (Objective/ Outcome)                                                                                                                                                                    |
|---|---|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - | 1 | <i>Established two years of sweet corn trials as initially proposed</i> | <i>Essential to reaching objectives of the project including Objective 1<br/>Reduce synthetic fertilizer use (reduced inputs) and Objective 4<br/>Conserve Resources, reduce carbon emissions.</i> |

|   |   |                                                                                                                                                                                                                                         |                                                                                                                                                                                            |
|---|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - | 2 | <i>Harvest complete on two years of sweet corn</i>                                                                                                                                                                                      | <i>Essential to reaching objectives of the project including Objective 3 Increase economic returns by demonstrating greater yield at lower cost</i>                                        |
| - | 3 | <i>Post-harvest soil samples completed following harvest</i>                                                                                                                                                                            | <i>Essential to reaching objectives of the project including Objective 2 Improve soil health</i>                                                                                           |
| - | 4 | <i>Post-harvest grain quality samples for two years following harvest</i>                                                                                                                                                               | <i>Essential to reaching objectives of the project, including Objective 3 Increase economic returns</i>                                                                                    |
| - | 5 | Conducted multi-treatment hydroponic lettuce trials across three nitrogen regimes using a replicated system to evaluate the growth effects of Plant Catalyst under controlled environmental conditions.                                 | <i>Essential to reaching objectives of the project, including Objective 3 Increase economic returns</i>                                                                                    |
| - | 6 | Collected morphological and physiological data—including fresh weight, dry weight, leaf area, SPAD, and growth index—from every plant across all treatments, enabling a comparison of Plant Catalyst performance across nitrogen levels | <i>Essential to reaching objectives of the project including Objective 1 Reduce synthetic fertilizer use (reduced inputs) and Objective 4 Conserve Resources, reduce carbon emissions.</i> |

#### CHALLENGES AND DEVELOPMENTS (REQUIRED)

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this reporting period. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective, outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column. For developments, you may put "N/A" under Corrective Actions. Additional challenges/developments may be added as needed.

| + | # | Challenge or Development (1,200 char.)                                                                                                                                                                       | Corrective Action                                                                                 |
|---|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| - | 1 | Year 3: The field trials for 2024 were lost due to drought. Poor germination and lack of growth in the plots resulted in no usable data collected. Another round of lab tests is needed to complete analysis | An extension to the grant was submitted and accepted to continue research for an additional year. |

|   |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                       |
|---|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - | 2 | Year 3: During the 2024 report covering 9/30/23-9/29/24 it was reported that personnel expenditures exceeded the budgeted amount, an amount which had been reduced in the previous amendment. This occurred because personnel and fringe rates rose at SDSU.                                                                                                                                                                                                                                                                                              | An extension to the grant was requested and we added a new partner, to produce a more robust result before the expiration of the award                                                                                                                                                                                                |
| - | 3 | Year 4: In conversations with specialty crop stakeholders in the state, we were encouraged to focus more on fertilizer reduction rather than nitrogen fixing capacity                                                                                                                                                                                                                                                                                                                                                                                     | A new partner (Cornell University) was adding to the project, replacing nitrogen fixing legume goals of the previous proposal, to expand on how greenhouse growers of specialty crops, such as spinach, can reduce dependence on fertilizer.                                                                                          |
| - | 4 | Year 2: Post-harvest soil samples in progress for second year data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Essential to reaching objectives of the project including Objective 2 Improve soil health                                                                                                                                                                                                                                             |
| - | 5 | Year 2: Post-harvest grain quality samples for second year harvest                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Essential to reaching objectives of the project, including Objective 3 Increase economic returns                                                                                                                                                                                                                                      |
| - | 6 | Year 2: The two years of trials have uncovered evidence that the proposed solution may be affected by soil types and growing mediums.                                                                                                                                                                                                                                                                                                                                                                                                                     | Further targeted research into various soil types is proposed                                                                                                                                                                                                                                                                         |
| - | 7 | Year 3: So far, this research has not shown that fertilizer with PC could either improve yields or profitably reduce the need for fertilizer in sweet corn. However, we found increase in certain nutritional contents of the sweet corn, which merits further study - perhaps with other specialty crops. Additionally, certain microbial indicators were moderately increased through the use of PC at the 0 N fertilizer rate. Future studies may use this information to design more in-depth studies on soil health changes and low nutrient supply. | SDSU and DANR are agreeing to a one-year no-cost extension to allow the project one more field season of research before the award concludes in September 2025.                                                                                                                                                                       |
| - | 8 | Year 1: Minor change is we decided to replace one soil sample period (mid-season) with a more comprehensive nutritional analysis of the corn grain                                                                                                                                                                                                                                                                                                                                                                                                        | We will still be able to accomplish our overall project objectives while providing additional/new data on nutritional composition of the product, thus adding new value to the overall project. The analysis is much more detailed and thus results were not immediately available. We expect to report results in the upcoming year. |

#### UPCOMING ACTIVITIES (REQUIRED FOR ANNUAL REPORTS)

Provide a description of the activities that you are planning to complete during the next reporting period. Additional activities can be added as needed. Please note, if this is a final report there should be no upcoming activities associated with the project, and this section should be left blank.

| + | # | Activity (600 char.) | Anticipated Completion |
|---|---|----------------------|------------------------|
|---|---|----------------------|------------------------|

|   |  |  |  |
|---|--|--|--|
| - |  |  |  |
|---|--|--|--|

LESSON LEARNED (REQUIRED FOR FINAL REPORTS)

The recipient or subrecipient is required to provide recommendations or advice that others may use to improve their performance in implementing similar projects. If this is an annual report, please skip this section. (1200 char.)

The results of this research do not support the primary hypothesis of this project that PC can reduce fertilizer inputs in either sweet corn or spinach. Based on these studies, PC would not increase economic returns for producers of these crops due to a lack of yield response nor improve soil health based on yield as the primary output. However, we did find evidence that PC could improve certain quality aspects like corn sweetness and certain micronutrients concentrations. This could potentially lead to marketing opportunities for higher nutritional quality, but it is unclear if there is consumer willingness to pay a premium for such qualities.

CONTINUATION AND DISSEMINATION OF RESULTS (REQUIRED FOR FINAL REPORTS)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results. If this is an annual report, please skip this section. (1200 char.)

The project objectives have been completed and funds have been expended. We do not expect that further trials will take place using a similar research design. Future studies, outside of the SCBG funding, may examine in more detail how PC affects nutrient status of high value produce to learn more about the potential mechanisms being upregulated. Dissemination of results has been ongoing through research field days offered each year of the study. Further dissemination of results will be at the discretion of CAW Industries.

PROJECT BENEFICIARIES (REQUIRED FOR FINAL REPORTS)

Provide the number of project beneficiaries. If this is an annual report, please skip this section. (12 char.)

0

FEDERAL PROJECT EXPENDITURE

EXPENDITURE (REQUIRED)

You must respond to at least one cost category. Please note, the subtotal and total rows include formulas to auto-calculate totals. The approved budget should come from the accepted project plan or any approved budget amendments.

| Cost Category   | Amount Approved in Budget | Actual Federal Expenditures (Federal Funds Only) |
|-----------------|---------------------------|--------------------------------------------------|
| Personnel       | \$28,689.60               | \$24,529.50                                      |
| Fringe Benefits | \$5,413.45                | \$7,413.78                                       |
| Travel          | \$0.00                    | \$0.00                                           |
| Equipment       | \$0.00                    | \$0.00                                           |

|                                                |                    |                    |
|------------------------------------------------|--------------------|--------------------|
| Supplies                                       | \$8,256.21         | \$9,008.30         |
| Contractual                                    | \$8,970.74         | \$8,708.93         |
| Other                                          | \$5,400.00         | \$3,922.50         |
| <b>Direct Costs Sub-Total</b>                  | <b>\$56,730.00</b> | <b>\$53,583.01</b> |
| Indirect Costs                                 | \$3,100.00         | \$4,786.40         |
| <b>Project Expenditure Total Federal Costs</b> | <b>\$59,830.00</b> | <b>\$58,369.41</b> |

#### DISCUSSION OF EXPENDITURES (REQUIRED)

For 1st Annual Reports, if total project expenditures is less than 30 percent, and for 2nd Annual Reports, if total project expenditures is less than 60 percent, include a statement explaining how the grant funds will be expended and project activities completed as planned by the end date on the grant agreement. Any state approved budget amendments should be included here; Include the line item that the funds are coming from and going to and when the state approved the budget amendment. (1,200 char.)

USDA approved requests to amend the budget in January 2024 to reduce personnel and increase supplies, and in March 2025 to add Cornell for the final phase of contractor research, increase personnel and fringe benefits, add the Other budget category for Cornell greenhouse rent, and reduce supplies, contractual, and indirect. Between the Cornell and SDSU university contractors the project exceeded the amended indirect budget rate but SD DANR limited payment to a value equal to 8% of the project budget per USDA AMS Grant Terms & Conditions. Fringe and supply expenditures exceeded totals due to variations in fringe rates and supply needs between contractors and complexity of budget total updates associated with amending the project budget and contractors multiple times.

Total variances in the fringe, supplies, and indirect cost categories were under 10% of the subrecipient project budget and reflected expenditure on costs that fell within the same category as other approved costs, so no formal amendment was required.

#### PROGRAM INCOME (IF APPLICABLE)

If program income was earned on the project, grant recipients are required to report on the source, amount, and how funds were expended. Program income is gross income --earned by a recipient or subrecipient under a grant --directly generated by the grant-supported activity or earned only because of the grant agreement during the grant period of performance. Program income includes, but is not limited to, income from fees for services performed; the sale of commodities or items fabricated under an award (this includes items sold at cost if the cost of producing the item was funded in whole or partially with grant funds); registration fees for conferences, etc.

| + | Source/Nature of Program Income (100 char.) | Amount Approved in Budget | Actual Amount Earned |
|---|---------------------------------------------|---------------------------|----------------------|
| - |                                             | \$0.00                    | \$0.00               |

#### USE OF PROGRAM INCOME (IF APPLICABLE)

Describe how the earned program income was used to further the objectives of this project during the performance period. Any income generated must be reinvested back into the project and not set aside or reserved for future expenses after the grant ends. (1,200 char.)

#### PPR ATTACHMENTS DESCRIPTION (IF APPLICABLE)

Grantors will rely on the data that is submitted in this form when they report to congress. However, if you think additional documents are necessary to support PPR, please attach then and provide a document name and description of document below.

| + | Document Name | Document Description |
|---|---------------|----------------------|
| - |               |                      |