

Submission Date: April 27, 2018

REPORTING PERIOD:

- Biannual 1: Date of execution through March 31, 2017
 - o (due no later than April 30, 2017)
- Biannual 2: April 1, 2017 through September 30, 2017
 - o (due no later than October 30, 2017)
- Biannual 3: October 1, 2017 through March 31, 2018
 - o (due no later than April 30, 2018)
- Biannual 4: April 1, 2018 through September 30, 2018
 - o (due no later than October 30, 2018)
 - o Expenditure end date March 31, 2019

YEAR GRANTED: FY2016
GRANT #: ODA-3928-GR
PCA #: 20422
TO: Shannon Brubaker, Oregon Department of Agriculture
CONTACT NAME: Jennifer Fletcher
SUBJ: Project Progress Report

Submission

For login site specifically for reporting and invoicing:
<http://files.oda.state.or.us/?login=scbgp-rpt>

ORGANIZATION NAME

Oregon Processed Vegetable Commission

PROJECT TITLE

Enhancing Oregon broccoli and cauliflower competitiveness by improving harvest efficiency

FUNDING EXTENDED TO DATE

EXPENDITURES:

Biannual Report One (Date of execution through March 31, 2017)

| Cost Category | Amount Approved in Budget | Actual Federal Expenditures (Federal Funds ONLY) |
|-------------------------------|----------------------------------|---|
| Supplies | \$69,000 | \$3,084.68 |
| Contractual | \$48,270 | |
| Other | \$55,980 | \$10,800 |
| | | |
| Direct Costs Sub-Total | | 13,884.68 |

Biannual Report Two (April 1, 2017 through September 30, 2017)

| Cost Category | Amount Approved in Budget | Actual Federal Expenditures (Federal Funds ONLY) |
|-------------------------------|----------------------------------|---|
| Supplies | \$69,000 | \$8,995.65 |
| Contractual | \$48,270 | \$0 |
| Other | \$55,980 | \$0 |
| | | |
| Direct Costs Sub-Total | | \$8,995.65 |

Biannual Report Three (October 1, 2017 through March 31, 2018)

| Cost Category | Amount Approved in Budget | Actual Federal Expenditures (Federal Funds ONLY) |
|----------------------|----------------------------------|---|
| Supplies | \$69,000 | \$32,393.19 |
| Contractual | \$48,270 | \$21,450 |
| Other | \$55,980 | \$45,180 |

| Cost Category | Amount Approved in Budget | Actual Federal Expenditures (Federal Funds ONLY) |
|-------------------------------|---------------------------|---|
| | | |
| Direct Costs Sub-Total | | \$99,023.19 |
| | | |
| Total Federal Costs | | \$121,903.52 |

ACTIVITIES PERFORMED:

ACCOMPLISHMENTS

Biannual Report One (Date of execution through March 31, 2017)

The robotics team has successfully developed the software needed for the automation of broccoli harvest. The software is capable of accepting live video stream data. Using this data, the software is able to calculate the exact position of any broccoli head in the camera field of view. The software then outputs this information to a hardware system designed to move a harvester into the appropriate position for harvest.

The first prototypes of harvester have been field tested using the vision system, which consists of the camera and software. Both of the first prototypes were designed to move an arm into position to simulate harvest, but neither prototype actually cut (harvested) the broccoli head from the plant. To date, the robotics team has been working on a new prototype harvester that will accept the vision system and will complete the mechanical cutting to successfully harvest broccoli in a normal field environment. The prototype is in the initial design phase, with plans to complete the prototype by early July.

Video of the original prototype working under simulated and field conditions can be found here: <https://www.youtube.com/watch?v=EI9ZJs56EJk>

Biannual Report Two (April 1, 2017 through September 30, 2017)

The production of commercial quantities of the OSU broccoli hybrid seed is currently underway. Crop progress reports indicate that the production is on track to complete the target seed quantity. P&R Seeds is also producing more inbred seed stock of the parent lines. These productions are also on target.

The robotics team has successfully field tested their fourth prototype automated mechanical broccoli harvester. This harvester was field tested multiple times at the Oregon State University

Vegetable Farm in Corvallis. The vision system is working, and providing the correct information to controls allowing the broccoli to be cut at any desired length. The prototype is not yet capable of harvesting broccoli in such a manner that the broccoli heads could be directly packed and trucked into a processing facility. This limitation is going to be addressed in the next prototype.

The robotics team also, beyond the scope of the original grant plan, has begun working directly with farmers to adapt their vision system to large field harvesting equipment. Thus far, this testing has produced disappointing results. The feedback from this testing has revealed some of the limitations of currently available farm machinery. However, the farmers involved in this work were all very pleased with the work of the robotics group. And the robotics team learned much that will facilitate improvements in the next year's development of prototypes.

Peter Mes has reported on the progress of this project to the Oregon Department of Agriculture secretary and commissioners at their fall meeting, and to the Western States Commodity Inspection members.

Biannual Report Three (October 1, 2017 through March 31, 2018)

The production of commercial quantities of the OSU broccoli hybrid seed has been completed. The hybrid has been named "Cascadia", and is in its first season of commercial production with growers in Oregon. P&R Seeds also produced more inbred seed stock of the parent lines. Seeds for quality testing have been provided to researchers at OSU for seed gradient, density, and size testing, as well as for field density trials.

The robotics team has acquired supplies and further developed their programming for further prototyping this summer. The team began designing the next prototype for fabrication in April, with a target date of completion in early summer of 2018. This prototype harvester will be field tested multiple times at the Oregon State University Vegetable Farm in Corvallis, and also on commercial farms in Oregon. The vision system is has been tweaked and improved, and providing the correct information to controls allowing the broccoli to be cut at any desired length. Current prototype development is oriented towards broccoli heads being harvested and directly packed and trucked into a processing facility.

Peter Mes has reported on the progress of this project at the Oregon Processed Vegetable Commission winter meeting held at the Linn County Fairgrounds.

Video of the current status of the broccoli harvester prototype development has been published. The video can be seen here:

<http://team955.org/pages/broccolibot.php>

Estimate the Total Percentage (%) of Work Completed on the Project 70%

| Accomplishment | Relevance to Objective, Outcome, and/or Indicator |
|--|---|
| Successful seed production of hybrid seed stock (Outcome 4, Indicator 1 and outcome 5, Indicator 2-2, and Objective 2) | This is the final step which facilitates the commercialization of Cascadia. Approximately 200 acres of broccoli in Oregon are being planted with Cascadia in 2018 |
| Further development of broccoli-recognizing software and hardware (Outcome 5, Indicator 1, and Objective 1.) | Developing software and hardware together in a working vision system is critical to mechanization of broccoli harvest |
| Objective 4. Successful fabrication and testing of multiple broccoli harvester prototypes by a high school robotics team | Exposing students to challenges in agriculture. Utilizing student ingenuity and creativity to tackle an industry challenge. |

CHALLENGES AND DEVELOPMENTS

| Challenges or Developments | Corrective Action and/or Project Change(s) |
|----------------------------|--|
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| | |

Future Project Plans:

Large scale field trials of the OSU-developed broccoli Cascadia will be made in the 2018 growing season to determine commercial acceptance. Plots of Cascadia will also be planted with the intention of testing the broccoli harvester prototype. This testing will demonstrate the adaptability of Cascadia to a mechanical harvester compared with other broccoli hybrids.

The robotics group will further improve the vision system capability. The improvements will allow the prototype harvester to be rebuilt with additional capabilities. The goal is to produce a fully operational, autonomous (self driving) harvester that fills an industry-standard box with broccoli. This will represent the complete idea of mechanizing broccoli harvest. The robotics team is also working on developing ‘box’ units of the vision system which is completely weather safe and portable.