

**The Quad Squad: Drones in Agriculture**

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### **Introduction: Need/Goals for Innovation**

The Agriculture and Food Research Initiative's priority area of Agriculture Systems and Technology emphasizes the interrelationships between agricultural system components to develop the next generation of engineered systems, products, processes, and technologies. One of the "hottest" topics in technology today—also in the area of agricultural technology—is the use of unmanned aerial vehicles (UAVs), also known as drones. These drones are either controlled by pilots from the ground or, more recently, are controlled autonomously by a pre-programmed mission (Cole & Wright, 2010). The United States Department of Agriculture (USDA) recognizes the potential of using UAVs in agriculture and, in 2014, the department's National Institute of Food and Agriculture (NIFA) announced \$3 million in grant money to advance the use of robots in American agricultural production. "We are on the cusp of seeing incredible advancement in the use of robotics and sensors supporting agriculture in this country," said Sonny Ramaswamy, NIFA director. "These technologies, which are components of the 'internet of agricultural things,' have the ability to make agriculture production more efficient, saving time and money—benefits that can be passed from producers to consumers" (United States Department of Agriculture, 2014, para. 2).

According to the U.S. Department of Education, "only 16 percent of American high school seniors are proficient in mathematics and interested in a STEM [Science, Technology, Engineering, and Mathematics] career" (2010, para. 1). The White House has recognized the need to prioritize STEM education, and consequently, the Committee on STEM Education (CoSTEM) was established in 2011 to coordinate federal programs and activities in support of STEM education. (The Department of Agriculture is an organizational member.)

As far back as 1988, educators were conducting formal research on the importance of agricultural education/literacy in schools, including the National Research Council's establishment of the Agricultural Education in Secondary Schools Committee and, more recently, the American Association for Agricultural Education National Research Agenda 2016-2020. This agriculture-specific research has continued with the creation of national standards including the National Agricultural Literacy Outcomes (NALOs) and the Standards for Technological Literacy (STL). The NALOs identify benchmarks related to agricultural literacy and academic achievement. For example, secondary students will "identify current and emerging scientific discoveries and technologies and their possible use in agriculture, and predict the types of careers and skills agricultural scientists will need in the future to support agricultural production and meet the needs of a growing population" (Spielmaker, 2013, p. 10).

The goals of the Drones in Agriculture program included: introducing secondary teachers to the STEM applications of using drones to teach agricultural concepts that tie to state core and national curriculum standards, generating students' interest and increasing their participation in STEM-related coursework, and collecting feedback using a Qualtrics-based teacher-response survey to assess the future needs of teachers integrating the Drones in Agriculture program into their curricula.

### **Methodology**

Procedures/Methods: Three statewide workshops were conducted to train secondary teachers in the building, programming, flying, trouble shooting, and repair of quadcopters. Curriculum resources including lesson plans and companion resources were incorporated into

each workshop. A ROAV (Remotely Operated Aerial Vehicle) Challenge was also developed to offer future state, regional, and national challenges in skills competition.

Target audience: The primary target audiences included secondary teachers in the content areas of agricultural education, technology and engineering education, and science education. Additional subject area teachers, including mathematics and physics, were also welcomed. Priority, through an application process, was given to teachers from the same school willing to partner and deliver an integrated STEM curriculum.

### **Results**

The resources and materials provided in the workshops were designed to increase agricultural literacy and facilitate STEM integration into secondary curriculum. The anticipated outcomes for students, educators, and others were identified in a Logic Model for Drones in Agriculture Program (based on the National Agricultural Literacy Logic Model). For example, students will: develop an appreciation and understanding of STEM and how it is integrated with agriculture, identify connections between agriculture and STEM careers, and understand relationships between agriculture, engineering, automation, and data acquisition. The teacher-response survey determined the extent to which the project's objectives and outcomes were met. Thirty-two teachers from 16 different schools participated in the workshops. They honed their flying skills using small Hubsan quadcopters and then constructed larger quadcopters based on 330 mm X-frames. Approximately 3200 students will be introduced to drones in agriculture based on the teachers' participation and adoption of the workshop resources.

### **Recommendations/Future Plans**

The primary strategy to achieve sustainability is to align curriculum resources with state core standards and integrate the curriculum into Career and Technical Education (CTE) program pathways. Consequently, CTE funds will be available to teach the curriculum. To grow the program, additional funding will be sought through industry sponsorship; research grants to assess student outcomes; the state's STEM Action Center; the National Defense Education Program through Hill Air Force Base; and the Secondary Education, Two-Year Postsecondary Education, and Agriculture in the K-12 Classroom Challenge (SPECA) Grants of USDA's National Institute of Food and Agriculture. The workshop resources are available at Utah Agriculture in the Classroom (<https://utah.agclassroom.org/htm/workshops/drones-in-agriculture/>), and the program creators are willing to share additional planning resources (e.g. the workshop application) in order to facilitate anyone wishing to replicate this program.

### **Costs/Resources**

The total cost of this initial program was approximately \$15,000. The majority of the funding was used to purchase equipment and supplies that were distributed to teachers for direct use in their classrooms. A small portion (approximately \$1000) was needed to purchase one quadcopter and supplies for workshop development. Qualifying teachers were awarded grants that included a quadcopter kit and curriculum resources. Teachers not supported by the grant were invited to the workshops, but they were required to purchase the appropriate quadcopter kit. Utah State University Extension contributed money for curriculum resources, staff preparation and delivery time, staff travel, and workshop food and supplies.

## References

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