

**C6 BioFarm iPad Game and Curriculum Workshop**

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### **Introduction/ Need for innovation**

With the increasing concern about energy independence, climate change, and rural economy, governmental agencies including U.S. Department of Energy and U.S. Department of Agriculture (USDA) have advocated to produce and use bio-renewable energy (bioenergy) (National Renewable Energy Laboratory, 2000). The U.S. 2007 Energy Independence and Security Act called for a transition from fossil fuels to renewable energy (U.S. Environmental Protection Agency, 2017). Bioenergy industry has boosted economy and employment. In the year of 2016, bioenergy sector created 130,677 jobs in the nation (U.S. Department of Energy, 2017a). This burgeoning industry need a large workforce (Iowa Workforce Development, 2015) and education has to play an essential role (Jennings & Lund, 2001). Many jobs in bioenergy industry required science, technology, engineering, and math (STEM) training (U.S. Department of Energy, 2017b). This need for STEM workforce preparation aligns with the American Association for Agricultural Education's (AAAE) research priority number three: "Sufficient scientific and professional workforce that addresses the challenges of the 21st century (Roberts, Harder & Brashears, 2016, p. 29). Agriculture teachers have also indicated their needs for training of bioenergy curriculum (Han & Martin, 2015).

C6 BioFarm is a game suite and curriculum designed to help middle and high school students learn about bio-renewable energy while strengthen their STEM and agricultural knowledge. C6 BioFarm is a 2D farming simulation game that runs on iPad. The C6 BioFarm curriculum contains six lessons. Each lesson is designed to teach about a specific subject matter related to biorenewable energy and include: 1) What and Where is Carbon; 2) Agriculture Production and Its Environmental Impacts; 3) Bioenergy and Biomass Conversion; 4) Carbon in Your Neck of the Woods; 5) STEM Careers; 6) The Triple Bottom Line. The lessons were developed to address specific educational standards from the Next Generation Science Standards (NGSS), the Agriculture, Food, and Natural Resources Career Cluster Standards (AFNRCCS), and the Common Core State Standards Initiative (CCSSI). Each lesson included background information, a lesson outline, hands-on activities, online resources, and tips for classroom implement.

### **How it works/ methodology/program phases/steps**

A four-day C6 BioFarm curriculum workshop was developed and delivered to a group of teachers by teacher educators and extension educators from Iowa State University and Morningside College sponsored by CenUSA Bioenergy. CenUSA Bioenergy aimed to create sustainable biofuels and bioproducts systems in the Midwest (CenUSA, 2017). To recruit teacher participants, the workshop was approved for teacher licensure renewal credit by Northwest Iowa Area Education Agency or a graduate credit at Morningside College. The purpose of this workshop was to improve teachers' efficacy in teaching renewable carbon and energy topics, grow their knowledge of renewable carbon and energy, and implement the C6 BioFarm curriculum content into their classroom instruction. Topics covered by this workshop included: 1) Fossil vs. renewable carbon sources; 2) Role of carbon in the energy cycle; 3) Environmental impacts of biomass production for fuels, chemicals, power; 4) Impacts of different agricultural practices on soil conservation and health, biomass collection, managing air and water pollution, bioenergy production and development; 5) Biomass conversion technologies (pyrolysis, gasification, fermentation); 6) Production of bio-renewable products in communities; 7) How to reduce personal carbon footprint; 8) Impacts of climate change on food, fuel and fiber sources; 9)

STEM careers related to bio-renewable energy; 10) Economic, social and environmental impacts of food, fuel, fiber production; 11) Tours and information from farmer who has established perennial grasses for water quality and biomass feedstocks; 12) Differentiation of starch-based ethanol and cellulosic ethanol. The first day of this workshop was delivered through a live webinar hosted on Zoom. Three speakers provided an overview of CenUSA, Ag Energy Iowa, and available educational materials. A discussion session was organized to share teachers' ideas and feedback. Teachers were divided into six groups, and each group was assigned to teach one lesson in the following three-day face-to-face component of the workshop. Lesson plans were required to be submitted before their teaching session. Each morning, two teams of teachers taught their lessons. An agricultural education professor and a bioenergy professional facilitated discussions and provided feedback on both instruction and content. Lab facilities and supplies were available for teachers' use. Two field trips were offered in the afternoon sessions: One was a tour of a local bioethanol plant, and the other was a science-based trial of row crops integrated with prairie strips (STRIPS) field. The last afternoon was used for discussion of curricular integration, processing paper work, and finishing an evaluation survey. Daily reflection and implementation plans for each lesson were a required component of the course.

### **Results to date/implications**

Fifteen teachers ( $n=15$ ) enrolled in and completed the workshop. Eighty percent ( $f=12$ ) of the teachers were male and 20% ( $f=3$ ) were female. Participants' ranged in age from 26 to 65. All 14 (100%) of the respondents taught at the high school level, 50% ( $f=7$ ) taught middle school, and 21.5% ( $f=3$ ) taught at the community college level. Ten (71.4%) teachers taught agriculture only, 7.1% ( $f=1$ ) taught science, and 21.4% ( $f=3$ ) taught both science and agriculture. A "pre" and "post" test comparison indicated participation in the C6 BioFarm curriculum workshop significantly improved participants teaching efficacy ( $p<.001$ ) and teaching outcome expectance ( $p=.003$ ) in renewable carbon and energy topics. Teachers significantly increased their knowledge in the twelve topics covered by the workshop ( $p<.05$ ). A majority of teachers (80%,  $f=13$ ) indicated to integrate BioFarm Curriculum into their classroom teaching.

### **Future plans/advice to others**

A follow-up survey will be sent during school session. The survey will focus on investigating teachers' teaching efficacy and outcome expectance of bioenergy and identify what further support teachers need. Extension personnel will continue to promote the adoption of C6 BioFarm curriculum and make sure its online resources' availability. Hubert, Frank, and Igo, (2000) suggested renewable energy is an important part of environmental and agricultural literacy. The C6 Bioenergy curriculum content can be modified to suit border elementary school students.

### **Costs/resources needed**

All costs associated with the development of the C6 BioFarm game and curriculum as well as the workshop was sponsored by CenUSA Bioenergy, a research and education grant funded by USDA-NIFA. As C6 BioFarm game and curriculum was free to the public, its development cost was not part of the workshop's cost. The grant paid each teacher \$1000 as stipend, and 15 teachers' stipend added up to \$15,000; Facility cost \$400; Meals cost \$1,545; Logistics cost \$270; Supply materials cost \$560. The total cost of this C6 BioFarm curriculum workshop was \$17,775.

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