THE STATUS AND NEED FOR PLANT BIOTECHNOLOGY EDUCATION IN TEXAS SECONDARY AGRICULTURAL CURRICULUM

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

The Status and Need for Plant Biotechnology Education in Texas Agricultural Science Curriculum. (May 2014)

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The purpose of this research was to examine biotechnology education in Texas secondary Agriscience programs. Historical trends in enrollment, and the current status of the curriculum utilized were assessed. This study serves to describe biotechnology education in secondary programs of agricultural education in Texas, and is part of a larger effort to improve biotech education. This project involved analyzing enrollment data, the Texas Essential Knowledge and Skills (TEKS) for Agriculture, Food and Natural Resources classes (AFNR), and the curriculum available to address these competencies. The extent of enrollment of biotechnology courses versus existing AFNR courses was also examined. The extent of biotechnology concepts incorporated into horticulture and advanced plant and soil science courses across the State of Texas was also explored. Our findings indicate biotechnology education, specifically plant-based biotechnology, are lacking in the curriculum; most surprisingly in the §130.21: Advanced Plant and Soil Science and §130.20: Horticulture Science courses, where the technology is most commonly implemented. Additionally, there was a significant gap of enrollment of biotechnology courses in comparison to overall AFNR enrollment. This study provides a starting point and benchmark data for future research in the field of biotechnology education in Texas.

DEDICATION

This research is dedicated to my parents, Richard and Melanie Sprouse. They have supported me in all my endeavors, and I greatly appreciate the opportunities they have afforded me in the past, present and future.

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NOMENCLATURE

AFNR	Agriculture, Food and Natural Resources
TEKS	Texas Essential Knowledge and Skills
STEM	Science, Technology, Engineering and Mathematics
TEA	Texas Education Agency
GMO	Genetically Modified Organism(s)
PEIMS	Public Education Information Management System

CHAPTER I

INTRODUCTION

Biotechnology plays an ever increasing role in the field of agriculture (Khush, 2012; Pinstrup and Schiøler, 2001). As such, it is frequently surrounded by a cloud of controversy, myths and misinformation that can confuse the general public (Nader, 2005). Priest's study (2000) found that even though a majority of United States citizens are supportive of biotechnology, there is a rise of opposition to biotechnology. Priest (2000) also found that 69.9% of respondents were "not very well informed" or "not informed at all" when it comes to the issue of biotechnology. Cavanagh et al. (2005) found that 87.2% of those surveyed thought the general public is not given enough information about biotechnology and its role in human health. This problem is exacerbated by the lack of secondary and tertiary student participation in scientific subjects (Hilton et al, 2011). This pronounced lack of general public understanding of biotechnology may help explain the amount of misconceptions and myths that surround agricultural biotechnology – specifically addressing transgenic applications of biotechnology.

These results should be of concern to both scientists and educators for the reason that there is a distinct gap in public understanding of biotechnology. As a result of this gap, consumers may have their perceptions of this technology influenced by opponets and special interest lobbying groups utilizing tactics that rely on the consumer's underlying fears and misunderstanding of the technology (Hoban, 2001).

Agricultural education plays a key role in the education of future consumers and agriculturalists about the science behind agriculture, and the role it plays in society (Association for Public Land-Grant Universities, 2010). However, this education is only as effective as the curriculum allows it to be. As technologies and scientific advancements progress, it is important to adapt the curriculum standards to reflect these industry changes. This can be a challenge in agriculture which has grown increasingly complex (Trexler et al., 2013). Failure to adapt the curriculum to such changes may allow the development of misinformed perceptions, as discussed earlier.

This paper examines the current status of biotechnology curriculum elements included in the Texas Essential Knowledge and Skills (TEKS) of courses across the state of Texas' Agriculture, Food and Natural Resources (AFNR) course clusters as provided by the Texas Education Agency (TEA). In addition, this paper serves to introduce important concepts and issues that a panel of experts in the fields of genetics, biotechnology and plant science have identified as being of interest in secondary-level agricultural science curriculum.

Questions Addressed

As agriculturalists, it is important to ask ourselves: how and why does the public perceive this technology negatively or positively, and how do we change that (if applicable)? The answer to that question requires a series of steps. Once we answer these questions, we must then discuss how to address any identified misconceptions. The first level of addressing biotechnology perceptions and misconceptions is to find out whether students and teachers are being exposed to biotechnology education at the secondary level. Since the secondary level is a stage where many

students solidify ideas and opinions about a subject, it is essential to expose them to correct and accurate information allowing them to formulate perceptions based on scientific evidence.

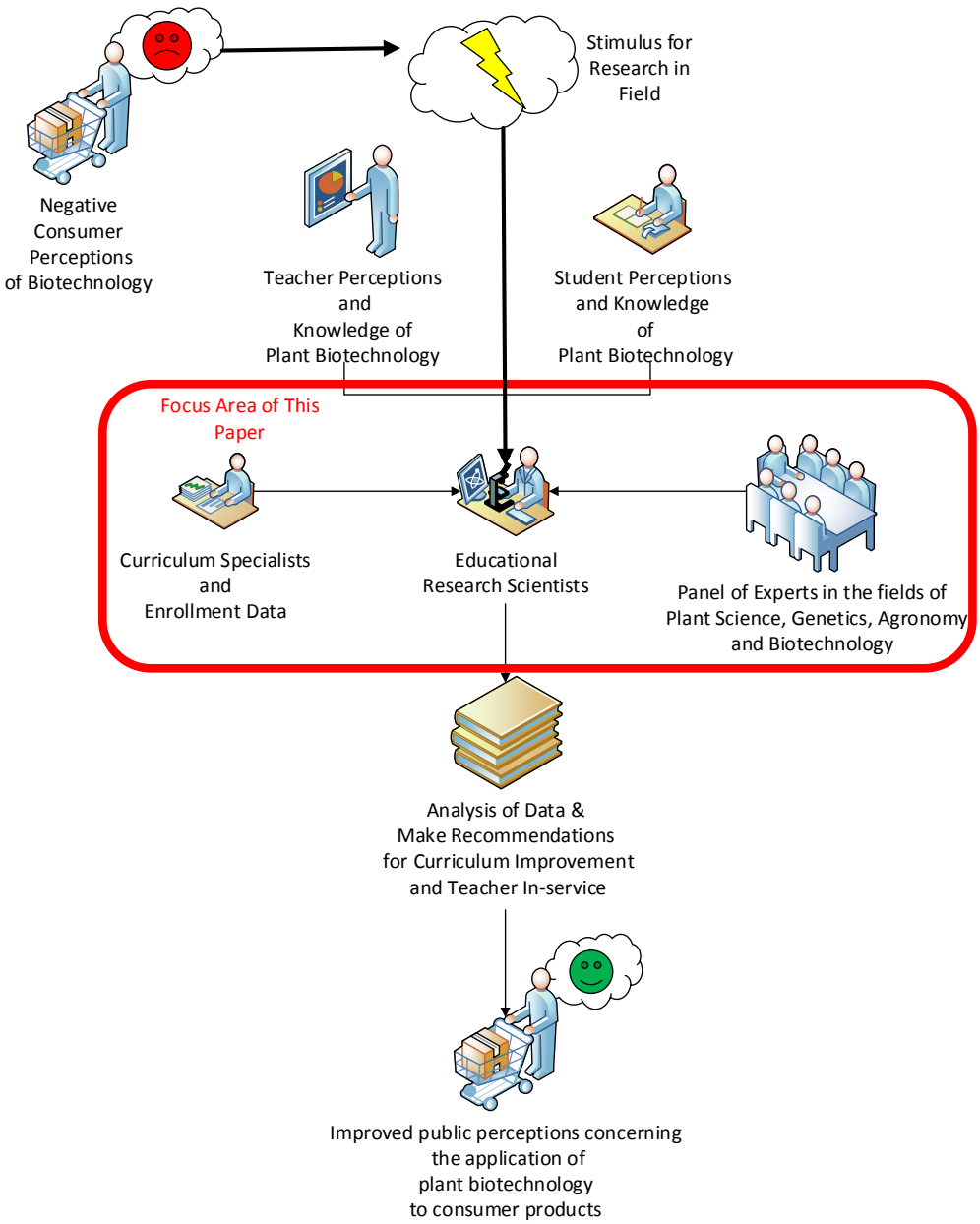
This paper serves to answer the questions:

1.) Are there biotechnology curriculum elements currently implemented in the Texas Education Agency's (TEA) Texas Essential Knowledge and Skills (TEKS)?
    a. If so, what is the extent of these biotechnology TEKS?
2.) How many students are enrolled overall in Agricultural, Food and Natural Resoruces (AFNR) course cluster?
    a. Of this, how many have been exposed to a specific biotechnology class?

CHAPTER II

METHODOLOGY

Research Operational Framework



The research operational framework plays a key role in describing the process of ultimately improving public perceptions concerning the application of plant biotechnology. Negative consumer perception has been a stimulus for research to evaluate why public opinion is negative, and evaluate possible solutions from a variety of sources.

Curriclum standards and enrollment trends are collected to assess the current status of biotechnology education. This provides a "benchmark" to illustrate the extent of biotechnology education presently occurring in secondary AgriScience courses. This benchmark will be cross-referenced with a panel of experts in the fields of Plant Science, Genetics, and Biotechnology to evaluate if the experts' assessment is related with the current curriculum standards in future research.

This paper focuses specifically on assessing the status, as discussed above, of plant biotechnology curriculum and enrollment trends, and provides a benchmark of the current status of biotechnology education in secondary AgriScience programs of Texas through addressing the needs of the 140,000+ students on the potential of plant biotechnology.

Texas Essential Knowledge and Skills

The Texas Essential Knowledge and Skills (TEKS) are the standards utilized by the Texas Education Agency (TEA) for students enrolled Kindergarten to Grade 12. TEKS outline the classroom curriculum material, and set guidelines for what students should understand upon completion of their respective courses. TEKS are divided into thirteen chapters, sorted by subject

area. This study analyzed Chapter 130: Career and Technical Education (CTE), subchapter A: Agriculture, Food and Natural Resources (AFNR) of the TEKS.

In this study, the TEKS for all of AFNR were analyzed for relevant plant biotechnology curriculum elements. TEKS for AFNR were accessed from the Texas Education Agency website via the World Wide Web.

Enrollment Data

Publicly-available enrollment data from the Texas Education Agency Public Education Information Management System (PEIMS) was utilized to assess the current status of plant biotechnology in Texas agricultural science curriculum. These data were compiled using Microsoft® Excel® in a table and a graph format.

This enrollment data, analyzed longitudally, illustrated the overall participation and utilization of biotechnology courses across Texas. In addition, it serves to demonstrate how many students on an annual basis received a form of biotechnology education.

CHAPTER III

RESULTS

Introduction

Results will be presented in the order they were outlined in Chapter I: Introduction; subheading "Questions Addressed", found on page 7.

Current Curriculum Integration of Plant Biotechnology

Are there biotechnology curriculum elements currently implemented in the Texas Education Agency's Texas Essential Knowledge and Skills (TEKS)?

The Texas Essential Knowledge and Skills (TEKS) are standards which outline specific outcomes of a course, thereby giving the educator a framework for course instruction. One of the most important aspects of secondary education is ensuring these curriculum standards are up-to-date to provide students the most current and relevant education possible. This especially holds true in the field of agricultural education, where tremendous technological advancement has occurred over the past several decades.

After reviewing the TEKS for all of the Agricultural, Food and Nautral Resources cluster, it was discovered that there is a distinct lack of all plant biotechnology curriculum in all courses. Key courses were identified in which plant biotechnology could be particularly important and influential. These were:

- §130.2. Principles of Agriculture, Food, and Natural Resources

- §130.20. Horticulture Science
- §130.21. Advanced Plant and Soil Science

Despite the influence that biotechnology could have on these courses, there is no integration of the scence and technology into these courses.

Enrollment Trends

How many students are enrolled overall in Agricultural, Food and Natural Resoruces (AFNR) course cluster?

Publicly available enrollment data was gathered from the Texas Education Agency's Public Education Information Management System. The results are displayed below (Figure 1) in a tabular format. As is shown in the data, the overall trend of AFNR enrollment has increased 55% from the years of 1992 to 2012. Despite this growth trend, enrollment in courses that address agricultural use of biotechnology have been erratic and unpredictable (Figure 2).

As evidenced in the tables, Agricultural Biotechnology was removed from Texas' AFNR curriculum at the start of the school year in 2010. This was replaced with a new course "Biotechnology" and "Advanced Biotechnology", which are included in the STEM cluster of the TEKS. Unfortunately, this removed the only course in the AFNR cluster which specifically addressed plant biotechnology compenticies. Despite the removal of the course, no provisions were made to include the TEKS from "Agricultural Biotechnology" to other courses.

School Years	Total Enrolled in AFNR	Total Enrolled in Ag. Biotechnology	Total Enrolled in Biotechnology	Total Enrolled in Adv. Biotech.
1992-93	83,841			
1993-94	82,538			
1994-95	88,824			
1995-96	93,218			
1996-97	92,977			
1997-98	90,685			
1998-98	89,172			
1999-00	89,793	126		
2000-01	91,256	86		
2001-02	95,671	65		
2002-03	101,162	53		
2003-04	104,687	102		
2004-05	109,141	240		
2005-06	109,049	151		
2006-07	110,090	185		
2007-08	109,293	98		
2008-09	114,384	88		
2009-10	139,761	135		
2010-11	136,591		450	578
2011-12	143,604		462	697
2012-13	150,349		646	664

Figure 1 – 1992-2012 Enrollment Trends

Original Year	% Change Total Enroll.	% Ag. Biotech. Enroll.
1992	-1.6%	
1993	7.6%	
1994	4.9%	
1995	-0.3%	
1996	-2.5%	
1997	-1.7%	
1998	0.7%	
1999	1.6%	-31.7%
2000	4.8%	-24.4%
2001	5.7%	-18.5%
2002	3.5%	92.5%
2003	4.3%	135.3%
2004	-0.1%	-37.1%
2005	1.0%	22.5%
2006	-0.7%	-47.0%
2007	4.7%	-10.2%
2008	22.2%	53.4%
2009	-2.3%	
2010	5.1%	
2010	4.7%	
Standard Deviation	5.3%	58.3%
Mean	3.1%	13.5%

Figure 2 – Percent Changes Annually of Total AFNR Enrollment and Ag. Biotech. Enrollment

Out of the 139,761 students in 2009-10, only 135 AgriScience students were exposed to curriculum involving plant biotechnology. In combination with the previous findings about the lack of plant biotechnology curriculum, it can concluded that only 0.09% of students enrolled in AFNR were ever exposed to stand-mandated curriculum standards about the use of biotechnology in agriculture.

CHAPTER IV

RECOMMENDATIONS AND CONCLUSIONS

Curriculum Recommendations

Our conclusions regarding the curriculum integration of biotechnology concepts should be an alarming shock to eductors in the fields of agricultural and biotechnology education. Our conclusions found that there Texas AFNR curriculum was devoid of plant biotechnology curriculum componets, despite plant biotechnology playing a major role in the agricultural industry.

Future recommendations and research should include surveying a panel of experts in the fields of plant science, biotechnology and genetics to discover which important concepts and information should best be integrated into existing curriculums.

Enrollment Data

Our research found that despite a growth in overall AFNR enrollment, biotechnology course enrollments were lacking, and did not accurately compare to the rest of AFNR course enrollments.

These results show that a single class designed for agricultural biotechnology is not the most effective means of reaching a wide audience. Instead, it is recommended to research the efficacy of integrating plant biotechnology curriculum componets into existing AFNR courses to reach a broader audience from diverse backgrounds.

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