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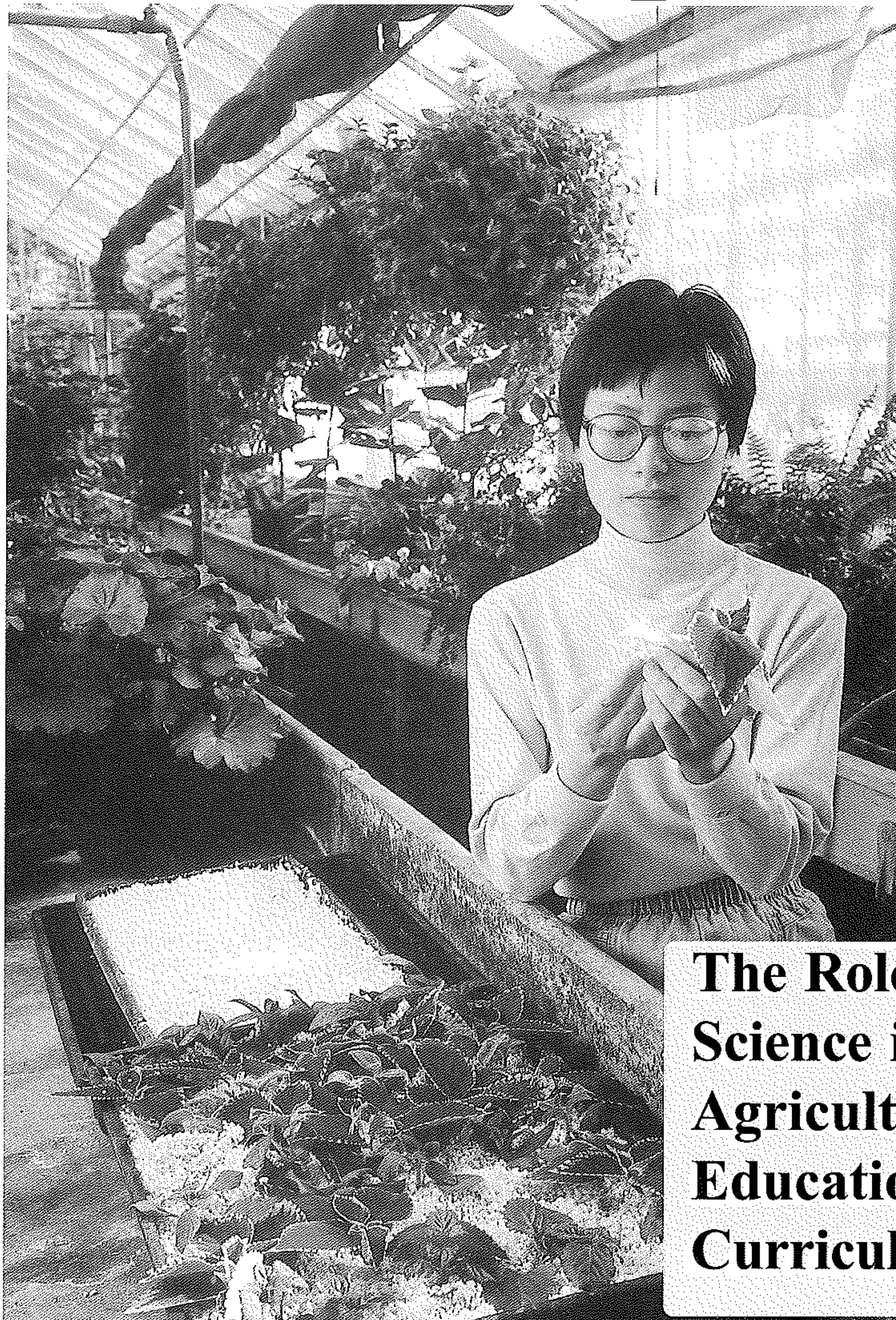


The Role of Science in the Agricultural Education Curriculum

Debunking the Myths of Science Integration into Agricultural Education

By Robert A. Martin, Editor

During a recent review of the research and literature regarding science education and agriculture, it became clear to me that in spite of the emphasis being placed on the "sciences of agriculture", agriculture teachers have not fully integrated science into the study of agriculture to a great extent. The integration of science into the agriculture curriculum is still more of a dream than a reality for some teachers. Why is this true?

There is evidence to suggest that the profession as a whole has been reluctant to move toward the integration of science into the curriculum because of what I am calling the "Twelve Myths of Science Integration".

These myths represent a serious barrier to the broadening and deepening of the curriculum in agricultural education. Please review this list of "myths" two or three times, and then read the articles in this issue of The Agricultural Education Magazine. Compare what the authors say to what the myth statements say and draw your own conclusions.

The Myths of Science Integration

1. Science integration is too difficult.

2. Students are not interested in science.

3. Science integration is too expensive.

4. Agriculture teachers don't need to know much about science.

5. Science integration will weaken agricultural education, as we know it.

6. Science integrated agriculture courses aren't really "ag classes".

7. FFA can't adjust to science integration.

8. Science integration duplicates science taught in biology, chemistry, physics etc.

9. SAE isn't helped by emphasizing science in agricultural education.

10. Science integration doesn't broaden agriculture career choices.

11. The effort to integrate science into agricultural education is not worth the outcome.

12. Science integration does not support the mission of agricultural education.

If this list of myths served as a True/False quiz, how would you have done on the quiz? Every statement is false. If you agree with any of the statements, you need to take another look at agriculture today. The sciences of agriculture provide the foundation of the "new agriculture" that is coming and the jobs that will come with it.

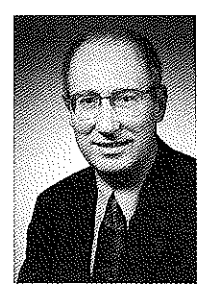
None of the listed statements are true, however the naysayers cite one or more of these items in their argument that we are losing agricultural education. Just the opposite is happening. Agricultural Education is moving ahead because science is at the heart of the study of the food, fiber & natural resource system.

A great career in agriculture awaits those people who study and are passionate about all aspects of science.

The authors of the articles in this issue of The Agricultural Education Magazine are to be congratulated on their efforts to share their views and experiences. These authors make it clear that the infusion of science activities into the agricultural education curriculum "enriches" the curriculum and enhances student learning about agriculture. In addition, the activities described in the articles are ready to use.

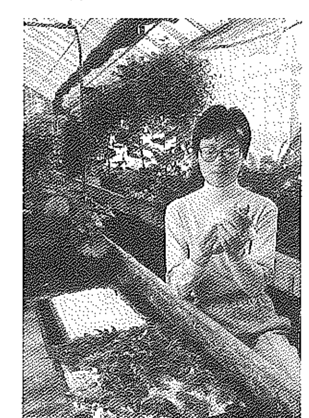
Be sure to check out the websites described on the back cover. There are some great activities and other information at these sites. A special thank you goes to Dr. Barbara Kirby for serving as the theme editor for this issue. Dr. Kirby's efforts are appreciated.

Enjoy this issue of The Agricultural Education Magazine!



Robert A. Martin is Editor of The Agricultural Education Magazine. He serves as Professor and Department Head of Agricultural Education and Studies at Iowa State University.

Theme: The Role of Science in the Agricultural Education Curriculum



The integration of science into the agriculture education curriculum represents a perfect fit, as this issue shows. The authors show that the possibilities for integration are endless. (Photo courtesy of Iowa State University, College of Agriculture.)

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Articles and photographs should be submitted to the editor or theme editors. Items to be considered for publication should be submitted at least 90 days prior to the date of the issue intended for the article or photograph. All submissions will be acknowledged by the Editor. No items are returned unless accompanied by a written request. Articles should be typed double-spaced, and include information about the author(s). One hard copy and one electronic copy of the article should be submitted. A recent, hardcopy photograph should accompany the article unless one is on file with the editor. Articles in the magazine may be reproduced without permission but should be acknowledged.

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Science in the Agricultural Education Curriculum

By Barbara M. Kirby

The science in agriculture or the agriculture in science? Are we first teachers or agriculturalists? These questions have formed the foundation of more than one heated debate. The impacts from these debates have influenced the length of teacher contracts, changed responsibilities for science and/or agriculture in the teacher's contract, moved collegiate programs from Colleges of Education to Colleges of Agriculture, awarded agri-science credit for high school graduation, and resulted in recognition of science credit by college admission offices.

In 1950, Dr. C. Hammonds asked in his first edition book, *Teaching Agriculture*, what makes agriculture science? He responded that "the organized body of knowledge which we call science of agriculture is deeply rooted in the sciences that contribute to agriculture." He further wrote that "these sciences are the sciences they are, not science of agriculture." He was clear that these sciences become agriculture when selected portions of them are focused on problems in agriculture. Thus, we arrive at a commonly held belief that agriculture is in fact an applied science. Some of those sciences applied in agriculture include: botany, mathematics, agronomy, zoology, biology, chemistry, entomology, physiology, bacteriology, geology, geography, physics, sociology, and economics.

Quality agricultural education programs respond to student, industry and community needs. Those needs now span a global environment. The role of science in agriculture is even more pronounced today. The production, processing and distribution of food, fiber and natural resources are transformed by 2002 technologies, unheard of 50 years ago. Agricultural literacy now includes explanations of terms associated with agriculture and biotechnology, genomics, proteomics, and bioinformatics. How applicable is this to high school agricultural education? While most believe it is unlikely that high school agriculture students will sequence the human genome in their laboratory, ten years ago many of us doubted that high school students could perform tissue cultures in their high school laboratories. Over the next 50 years, a very sophisticated science will impact agriculture. Students must understand the risks and benefits even if they do not perform some of the processes.

The articles in this issue reveal "the role of science in the agricultural education curriculum" from several perspectives: from students who learned the science, from those who teach agriscience and from others who deliver pre-professional teacher education and in-service workshops. Kendra and Kara Butters are successful graduates of an agriscience program. They are National FFA AgriScience Award winners. As teachers, we often ask ourselves if we are making a difference. For these two young women, the teacher and science in their agricultural curriculum made a difference.

Over the past 10 years, programs in Tennessee, West Virginia and North Carolina have experienced major change through the integration of science into the curriculum. Dr. Wilson introduces you to *Biotechnology for Plants, Animals and the Environment,* available through the National FFA Supply Service.

Agricultural Education is community based and therefore lends itself to numerous service learning activities. Through service learning, agricultural education students can impact public opinion about world hunger and the role of biotechnology in the food, fiber and natural resource systems. Young children up to and including senior citizens can learn about the science in agriculture through demonstration projects and activities. Finally, as educators, all of us are challenged to find creative ways to evaluate learning. An assessment model that employs higher order thinking skills is one approach for helping students engage in creative thinking. They will process basic to complex scientific concepts.

Students enrolled in agriscience programs will be more efficient and effective producers and processors. The students will be better prepared for opportunities in post-secondary education and in agriscience related careers. The role of science in the agricultural education curriculum is as important today as it was in 1917. The applied science practiced in agricultural education today will impact our values, our educational system, our health and our economy. The impact will be felt around the world at every dinner table.

Dr. Barbara M. Kirby served as the Theme Editor for the March-April issue of The Agricultural Education Magazine. Kirby is Professor of Agricultural & Extension Education and Assistant Director of Academic Programs at North Carolina State University.

Valuable Lessons from Agricultural Education

By Lanette Weiner

As the family farm faces decline and urban sprawl becomes more and more of a problem for many areas, it is becoming increasingly common to see less and less focus on and concern about agriculture. As a result, many agriculture teachers find themselves having to justify the need for their programs. They are faced with questions like, "Why do we still need an agriculture program in our school? There aren't any farms around here anymore," or "How can you justify the cost of agriculture classes? Isn't it more important to focus on math or science, something the students will really use?" Teachers may begin to feel like its them against the world. How are they to convince their administrators and communities that the agricultural education program is a valuable part of their students' education?

To begin with, the general public must be reminded how important the agriculture industry still is to America, even if family farms aren't as common as they used to be. Agriculture, generally defined to include food, fiber, and natural resources, is one of the largest industries in the United States, providing 23 million jobs and opportunities to the American public (American Farm Bureau Foundation for Agriculture, 2000).

Agriculture now includes a vast array of different areas from business to journalism to veterinary science. It is highly likely that there will be many students who will eventually be involved in some aspect of agriculture whether it's production, marketing, business, or any one of a number of possibilities. A basic understanding of agriculture will be of utmost importance to those students. Taking part in agriculture classes may very well spark an interest in students who may not have otherwise considered an agricultural career, starting them on a path to a fulfilling and rewarding occupation.

The agriculture industry directly affects all persons, whether or not they realize it, through the food they eat and the clothing they wear. It is therefore important that people have some general grasp of agriculture so that they understand where their food and clothing come from and can make informed decisions that affect their daily lives.

In addition to understanding the agriculture industry, it is important for communities to be able to comprehend that agricultural education classes have unique and beneficial characteristics not found in many other "traditional" content areas.

Agriculture classes, like other career and technical education classes, have the valuable characteristic of hands-on learning. Many a former high school student will no doubt admit that it always seemed a little easier to learn something when it involved the actual physical performance of a task. It has, in fact, been shown time and again that most people do indeed learn and retain information better when the learning is hands-on.

As is suggested in the National FFA Organization's motto, "doing to learn" always has been and will continue to be an integral part of agricultural education classes. Students actually get practice and experience in performing many of the things they learn about in lecture, and in the process gain basic life skills, such as evaluation and problem solving, that they can transfer into many facets of occupational experience and daily life. Similarly, good agriculture programs will help students apply what they learn in agriculture lectures and other classes to real life circumstances, both through classroom situations and in supervised agricultural experiences. For instance, an agricultural mechanics class may open one student's eyes to practical uses for algebra, while a horticulture class may enlighten another student to the usefulness of biology.

All of these characteristics aid in helping many students who struggle in the "traditional" classes succeed in agriculture classes. The hands-on learning helps these students to better understand and learn information while the application of class material to real life aids in creating an interest in the material as well as a feeling of purpose for what they are learning. As a result, students are often more motivated in agriculture classes and are better able to learn material and retain it.

As the family farm and traditional visions of agriculture become less and less prominent in today's world, agriculture teachers across the nation find themselves and their programs being considered less and less of a necessity. More and more they find themselves having to justify the importance of high school agriculture to the members of their school administrations and communities. While teachers may feel they are running a gauntlet of "why's" and "what for's," one of their best tools in their own defense is to remember the many values of agricultural education.

Lanette Weiner is a senior in the Department of Agricultural Education at the University of Wisconsin - River Falls. Weiner is the 2001 Alpha Tau Alpha Essay Contest Winner.

Agricultural Science: A Partnership for Learning Enrichment

By Paul Healsey

The Challenge

The State College High School Agricultural Science program has seen an increased enrollment over the past three years by 500 percent. There have been several program improvement processes undertaken by the school district that have impacted on this growth. The program has refined and structured educational offerings in both the career prep and tech prep programs within the curriculum to improve student career path choices.

Non-traditional agriculture students are seeing the relevance of technical education to successful career opportunities because of established educational links within the school. The program offers 15 planned courses in agricultural science sequenced in four emphasis areas including Animal Science, Plant Science, Natural Resources and Agricultural Mechanics.

Our program is seeing more college prepatory student enrollment in several of the single period, single semester courses. Few opportunities presently exist for these students to take additional or advanced selective classes in the area of their career choice.

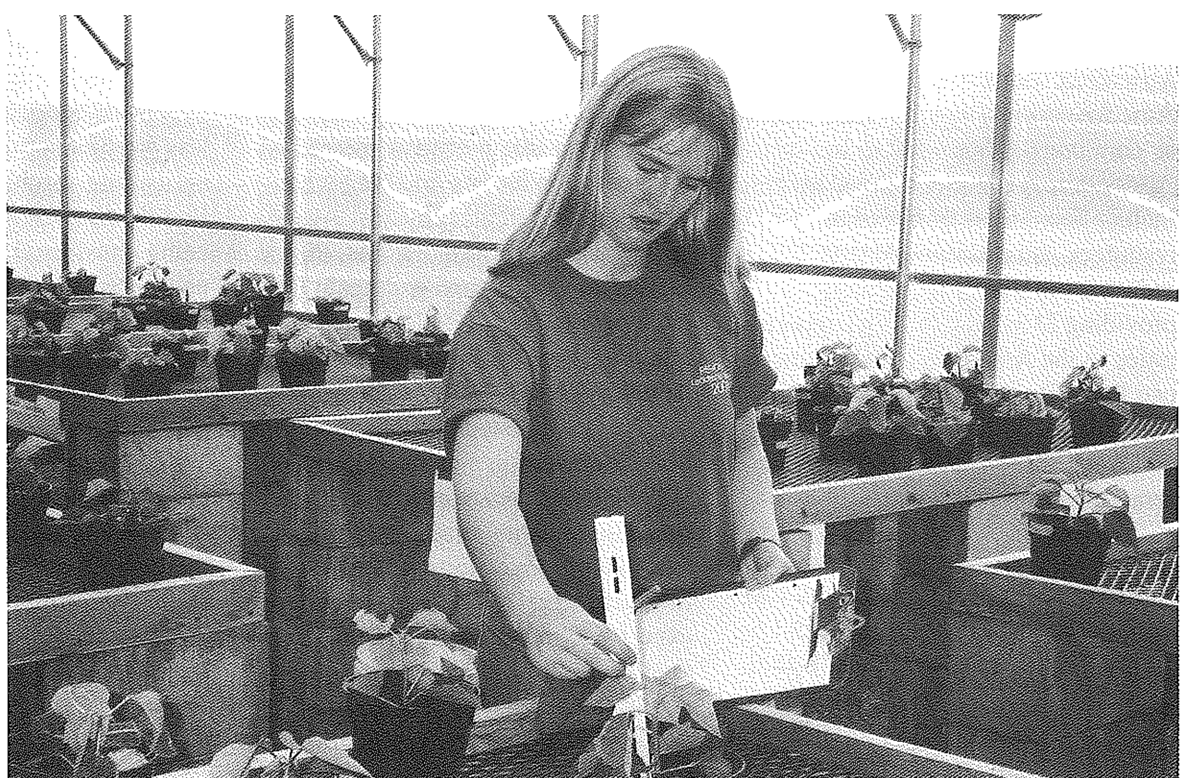
Additionally, these students express an interest in remaining in the agriculture program but are forced to seek educational alternatives in other disciplines to satisfy academic preparation for college. This lack of enrollment in our program also eliminated these students from remaining in our FFA and SAE programs their senior year.

Due to the limitations on district resources the feasibility of offering advanced courses in agriculture to meet the select needs of these students is prohibitive.

The Solution

The most effective means to serve our expanding and more specialized student population is to use existing community resources. A team of representatives from the State College School District (SCASD) and The Pennsylvania State University (PSU) met to discuss how they could work together to enhance learning opportunities for high school students through increased access, shared resources and innovative learning strategies.

This team completed the following tasks: (1) reviewed existing academic learning enrichment models between SCASD and PSU in the areas of science, math, English and social studies; (2) developed a specific learning enrichment model between the College of Agricultural Sciences at PSU and the SCASD's Agricultural Science Program that targets students interested in taking advanced courses in animal science, horticulture and/or agronomy; (3) worked with the college administration and faculty in animal science, horticulture and agronomy to establish guidelines for learning enrichment activities and advanced credit for students from State College High School.



Students, such as Kara Butters, benefit from the integration of science into the agricultural curriculum. Kara is shown collecting measurement data in a school greenhouse. (Photo courtesy of Kara Butters, Michigan State University.)

The Outcome

The outcome was an Agriculture Science-Learning Enrichment Independent Study Option. This option allows senior year students to further develop their career interest in agricultural science once they have completed the offerings in the SCASD Agriculture Science Program. While enrolled in the Ag Science Program at SCASD, students may supplement their high school course work by registering for and taking various courses (ten have been identified in the four emphasis areas offered at SCASD) offered through PSU's College of Agricultural Sciences.

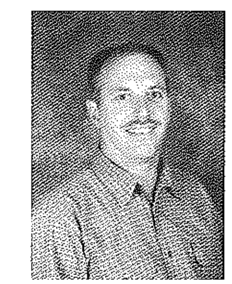
As a result of this option, students may earn duel credit at both the university and high school levels while participating in the learning enrichment independent study option contract. Upon successful completion of a university course, they are graded under university grading policy and earn credits from the university. Based on fulfillment of high school requirements, they will also earn a weighted grade and high school credits at SCASD. This allows them to complete the Agriculture Science Program and remain active in our FFA and SAE programs during their senior year.

Students are responsible for all university tuition, fees and textbook costs as well as their transportation. This option is now available for student enrollment fall semester 2002. While these students are taking courses at PSU, they will also play a vital role in the Ag Science Program at SCASD as they return to share their experiences with other high school students enrolled in our program. This additional educational avenue for our students reflects the mission statement of the SCASD: To prepare students for lifelong success through excellence in education.

It also addresses the goals of the district to achieve this mission: (1) Design and implement a future-oriented curriculum; (2) Encourage innovation in a quality faculty, staff and administration; (3) Build strong partnerships emphasizing shared responsibility among students, parents, faculty, administration and the community; and (4) Develop multiple pathways to the work force.

The benefits of this option will: (1) raise the level of visibility of the high school agricultural science program by giving it equal footing with existing academic learning enrichment programs in the school; (2) dramatically increase the awareness of career opportunities in agricultural science at PSU with a non-traditional audience; and (3) increase the number of students enrolling in post-secondary and baccalaureate programs in the Agricultural Sciences.

This project / option was completed by many faculty and staff members at SCASD and PSU College of Sciences. Without the direction and time of Dr. Dennis Scanlon, AEE Dept, PSU, Ms. Carolyn Foust, Career and Technical Director, SCASD; and Dr. George Vahoviak, project facilitator; this educational program would not be possible. Other schools that have similar community resources available to them should consider this project/option as a model to follow.



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July - August 2002 Issue

Theme: *The Role of Community Resources in the Agricultural Education Curriculum.*

How do we use community resources in making the curriculum real? Why are community resources important? What differences do they make in the curriculum?

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Articles Due to Theme Editor: June 1, 2002
Articles Due to Editor: June 15, 2002

Biosciences Enliven the Agricultural Education Curriculum

By Theresa Sikinyi and Robert A. Martin

The history of vocational/agricultural education has seen many changes both in quality and structure of programs. Some of the most recent changes have involved curriculum shifts from the traditional curriculum areas of production agriculture to a more technological and science related curriculum. The challenge to agricultural education teachers in secondary schools is to enliven the curriculum and make it relevant to the needs of their students. Biotechnology has the potential to generate non-farm employment for future agricultural education graduates. So how does the teacher bring biotechnology into the study of agriculture? What does the teacher need to do to prepare for biotechnology education, and develop and broaden the agricultural education program? Figure 1 lists specific steps to answer these questions

Many university departments of Agricultural Education have in-service training programs available for high school teachers to help them learn more about the latest developments in agricultural technology. A study conducted at Iowa State University among secondary school agricultural educators (N=610) in the North Central Region showed that many teachers have taken advantage of these inservice programs. This study showed that 61.4 percent of the teachers in this region had attended an in-service training program with some of these workshops focused on biotechnology. Only 38.6 percent had not attended any inservice training or agricultural education updates. This information suggests that in-service education is one area of great need. Thompson (1998) in his study also indicated that the teachers felt a need for more preparation time in order to integrate science into the agricultural education curriculum. If biotechnology is to have a positive impact on broadening the curriculum, an agricultural education teacher must be attracted to workshops that provide the tools and activities to make it worthwhile.

Several teachers in the North Central Region in the study conducted at Iowa State agreed that certain competencies in (1) plant science (2) genetics (3) food science (4) microbiology (5) sustainable agriculture and (6) environmental education should be integrated into the agricultural education curriculum. For instance some of the concepts needed in these competency areas, like microbiology could be readily demonstrated using simple organisms such as E. coli with little expense and with equipment that is already available in secondary school laboratories (Mayer and McInervey, 1984). The use of the age old technology of fermentation can also be used to help students understand how the process of microbiology is essential in food processing industries and post-harvest technology (Harlander and Garner, 1986). Using these simple experiments to demonstrate some of the biological principles in plant science and animal science will stimulate students to learn science as it is practiced in the real world. This is especially true in cases where agriculture and science are combined into one subject (e.g. agriscience).

At the start of the agricultural education curriculum reform in 1989, critics of the existing curriculum believed that it was still focused in the past. Duval (1988) contended that the National FFA Organization has tried to address this issue by trying to make activities relevant to the agricultural education graduates in terms of preparing them for future employment. The National FFA Organization perceives agriscience and emerging technologies such as biotechnology to be important for the future of agriculture and their organization. The FFA has shown commitment to agriscience and emerging technologies by providing award programs to recognize efforts of participants with projects in these areas (Thompson and Schumacher, 1998). Therefore agricultural education teachers can encourage the FFA chapters in their school to develop projects that are science and biotechnology based. FFA is also providing support in developing new science based instructional materials and special activities to help students understand scientific and technological developments important to the agricultural industry (Anderson, personal communication 2000).

Steps to Integrating the Biosciences into Agricultural Education

1. Deliver in-service training on biotechnology in agriculture.
2. Conduct simple basic experiments to explain or help students understand biological principles.
3. Use FFA and SAE programs to facilitate the integration of biosciences into the agricultural curriculum.
4. Aquire science credit for agriscience courses.

Figure 1: Steps to Integration

A partnership with local agricultural industries and businesses would help teachers develop meaningful SAE's (Supervised Agricultural Experiences). SAE activities would provide the students with the necessary exposure and experience in biotechnology, agriculture, animal science and other areas that are important to the students' academic and employment needs. Therefore, agricultural education teachers could help students develop further skills in plant science and greenhouse management through placement in meaningful SAEs in the local agricultural industries and businesses or even start their own business.

Perry (1989) was of the opinion that integrating science into agriculture, especially in the Supervised Agricultural Experience (SAE) programs, serves to motivate students from low-income groups and students who are potential school dropouts. Teachers should encourage students to plan their own experiences.

The "Committee on Agricultural Education in Secondary Schools" (1988) recommended that agricultural courses that were sufficiently upgraded in science content could be credited as fulfilling the science requirements for high school graduation and college entrance in addition to the core curriculum. Therefore, if teachers feel that they have sufficiently upgraded their courses in science content they could apply for the course to be given science credit. Teachers should write a proposal requesting that agricultural education courses be accepted for science credit. The advisory committee, science department, principal, and the school board should be involved in approving this proposal. Lehnert (1988) however, was of the opinion that agriscience should only be offered as a science credit if it is well integrated as a science. Agriculture teachers should request and receive science credit for their program provided they define and develop a new curriculum for agriscience (Duval, 1988). Amberson (1989) was of the opinion that agriscience teachers should teach agriscience courses that could substitute lower level science courses but not core science courses that are essential for college preparation. Connors and Elliot (1995) found that students in agriscience and natural resource courses performed as well on science achievement tests as those who were not in agriscience and natural resource classes. This indicates that the agriscience curriculum that is well integrated is just as effective as the core science curriculum in teaching the students important science concepts.

Agricultural education teachers in secondary schools need to integrate more science into their agricultural education curriculum, not only to improve the academic content of their courses, but also to adequately prepare their students for diverse careers available in the area of science and technology such as biotechnology. If agricultural education courses have been sufficiently upgraded to integrate more science content, they should be given science credit. To successfully enliven the curriculum, we need to participate in inservice education, conduct basic experiments to enhance learning, use FFA and SAE programs, and acquire science credit for these courses.

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(Note: If readers request more detailed information on the most recent study, please contact the authors.)

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Theresa Sikinyi is a graduate student in Agricultural Education and Studies at Iowa State University.

The Role of Science in Agricultural Education: A Student's Perspective

By Kendra Butters and Kara Butters

What is the relationship between females and science? Most studies show that there is not a strong relationship. Interest in science among adolescents has declined even though society is increasingly affected by scientific and technological developments (Smith & Hausafus 1988). Females are even less interested in science than males. This trend can be changed - and the key is incorporating science into the AgriScience curriculum.

As female members of a strong high school AgriScience program, our interest in science developed early in high school. Our AgriScience teacher firmly believed in using science to demonstrate the principles of agriculture and taught us those same beliefs. As sophomores majoring in AgriScience Education at Michigan State University, we recognize the importance of developing and using a curriculum centered on the core principles of science.

What is Science?

According to AgriScience Explorations, an AgriScience book that we used in high school, science is learning about the world in which we live through observation, identification, description, experimental investigation, and theoretical explanation of phenomena. Although we agree with this definition, to the typical high school student, the definition of science seems much simpler. Science provides the opportunity to be creative, experimental and experience information through entertaining avenues, such as hands-on projects, like planting seeds and observing their growth or dissecting animals. With much of today's population being visual learners, this action-oriented type of science-based learning proves extremely beneficial to students.

Science in the Classroom

Thinking back to science in junior high, we recall learning about the basic aspects of science, including biology and earth science. In these classes, we learned information from the textbook; however, we also performed projects dealing with dissections, research papers, and lab reports where textbook information was put to use.

In high school, these scientific principles were reinforced in additional science courses; however, it was not until our AgriScience courses that we really grasped the concept of science. With many different AgriScience options in our high school, including botany, veterinary science, ag economics/business management, environmental science, and horticulture/landscaping, we had a variety of choices when looking for an AgriScience class. Throughout school, we enrolled in three of these classes and found each subject to contain different aspects of science.

For example, in botany, we studied the germination of several different types of seeds. After looking at the way in which seeds germinate, we narrowed the study to look at one type of seed. Before beginning, we studied the scientific method and developed a proper experimental design to determine the hypothesis, independent/dependent variables, and control measures. At the end of the experiment, we drew conclusions, determined implications, and identified further studies.

We used the same methods in veterinary science when conducting experiments with animals. In addition, we performed many dissections, including those on a fetal pig and a Cornish hen. This allowed us to visualize the reactions that take place in animals and to identify their different organs. After dissecting, we learned how science plays a role in the functions of living organisms.

Science Applied to Life

Information and hands-on experience that we gained from within our AgriScience curriculum proved to be useful to us outside of our AgriScience classes. During our junior and senior year of high school, we served as the co-managers of our AgriScience program's greenhouse where we were in charge of plant selection, production schedules and marketing of plant material.

The principles that we learned in classes proved invaluable in this position. For example, the first crop of poinsettias that we produced did not reach a desirable height or full color. To determine the problem, Kendra researched light duration or the photoperiod of the poinsettias, and Kara researched factors that determine plant height, specifically pinching and growth regulators. Using each of the main steps of the scientific method, such as the problem, hypothesis, literature review, data collections, and conclusions, we were able to determine what was wrong with the first poinsettia crop and improve future crops. Our research allowed Kendra to capture the title of 2000 National FFA AgriScience Student of the Year Runner-up and Kara to be named the 2001 National FFA AgriScience Student of the Year.

Without learning the importance of science in our AgriScience classes, we would have been unable to raise the crop properly. Because science was an integral part of our curriculum, we were able to take the knowledge that we gained and earn national honors within the National FFA Organization.

Science in Action

We were able to use the key scientific principles gained from or AgriScience classes to help students in the local elementary school learn about both science and AgriScience. Each elementary student visited the AgriScience greenhouse where we helped him/her plant a marigold plug. Before they transplanted the plugs, we taught them about the importance of the soil and water to the plants. Throughout the growing period, the students visited the greenhouse to measure their plants and monitor their growth. At the end of the project, the students were able to take the plants home as a gift for their moms on Mother's Day. This simple project allowed the elementary students to gain an interest in agriculture and science at an early age and at the same time allowed us to explain the scientific knowledge that we had learned.

Implications from Science Emphasis

We enrolled in our school's AgriScience program with previous knowledge about agriculture as a result of living on a farm. However, we were by no means experts. As two young females, we were able to grasp onto the concept that science is important in the AgriScience curriculum. We used that knowledge to help us in contests and in life. More students should be able to do the very same thing.

Looking back on the time in the classroom, we now realize how much science we actually learned. At that time, we did not understand how much science related to agriculture and the impact it has on all studies; however, after examining the use of science in the AgriScience curriculum, we now have a better understanding. Science is an integral part of all aspects of agriculture and should be incorporated in all of its facets in the classroom. With more of an emphasis placed on science, students, especially females, will have a better understanding of how agriculture, the environment, and the world as a whole operate in conjunction with each other. This realization will open their minds and teach them more than any factual information that they might store from memorizing facts.

Seven Steps to Excite AgriScience Students

1. Hands-on Projects
   - Allow students to participate in dissections, planting seeds, and hydroponics.
2. Career Development Events
   - Tell students about contests related to their AgriScience area, such as dairy judging or landscape management.
3. Field Trips
   - Take students to visit a farm, vet. clinic, or large greenhouse operation.
4. Guest Speakers
   - Invite speakers in to talk about important AgriScience issues, such as Variable Rate Technology or Food Systems.
5. Real Life Applications
   - Compare science to things that students can relate to, such as computers, etc.
6. Experiments
   - Allow students to conduct an experiment on a question related to AgriScience, i.e. plant growth, animal hormones.
7. Service Projects
   - Have students use their new science knowledge to help the community through projects such as cleaning a waterfront.

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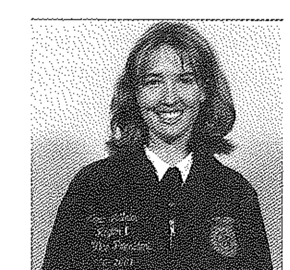

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Retooling Agricultural Education for the Biotech Century

By Elizabeth Wilson

The agricultural industry and the education of and about agriculture have experienced metamorphic change over the last 100 years. During this time, Carlson (2000) reported the agricultural industry has progressed through a biological revolution in which the content knowledge base and productiveness of agriculture have increased exponentially. New hybrids, oil-seed crops, fertilizer and herbicide manufacturing and genetically altered crops in the field of biotechnology are just a few of the key discoveries that have accelerated this revolution.

In recent years, curriculum integration of science and agriculture has accelerated due to the biological revolution that requires the agriculturist to understand more science. In order to teach students about the production of plants and animals and their relationship to the environment, an agricultural educator has to teach science. The question of whether we should teach science in agriculture has been answered. In the upcoming century, the real question to debate in agricultural education is "how much science" should we be teaching in agricultural education? How much do our students need to understand about biotechnology discoveries to work in agriculture or be an intelligent consumer of biotechnology products?

Keener and Hoban (2001) state that scientists, government agencies, industry, farmers and consumers are all involved with biotechnology. Can you think of a career in agriculture that doesn't fit in one of these categories? The mission of agricultural education developed by The National Council for Agricultural Education (1999) states that agricultural education should " prepare and support individuals for careers, build awareness and develop leadership for the food, fiber and natural resource systems" (p. 1). This mission reflects the philosophy that agricultural education plays a role in educating students about the controversial use and issues of agricultural biotechnology.

Aren't all our students consumers of agricultural biotechnology? As early as 1972, Phipps purposed that agricultural consumer education is an important part of all agricultural education programs in the high school. He stated that a type of agricultural education is taught that "is designed to teach people what they need to know about agriculture to be intelligent consumers of agricultural products. All persons need to know the role and functions of agriculture if they are to behave as effective citizens" (p.4).

Is agricultural education fulfilling the mission of preparing our students for this century? Are our students ready to support and defend the use of biotechnology in the industries or agencies for which they may work? Are our students ready to make informed consumer decisions about biotechnology products?

In 1999, the National FFA Organization commissioned the ABG Strategic Consulting firm to conduct survey research related to the status of high school agricultural education. In the student analysis, many students who completed the survey responded that they had not heard of the word "biotechnology". After given the definition, they responded they had not been taught any concepts related to biotechnology in agricultural education. This finding tells us we need to do more to prepare our students for the biotech century.

Biotechnology Curriculum

In 1994, the National FFA Foundation published The National Voluntary Occupational Skill Standards for an Agricultural Biotechnology Technician, which included skill standards developed by biotechnology education and industry experts. This was a result of the FFA Foundation's dedication "to broadening the recognized scope of agricultural careers beyond production agriculture" (p.5). Most of the skill standards included in this document are technical science skills intended to assist educators in creating related courses of study (National FFA Foundation, 1994).

In 2000, the National Agricultural Education Council sponsored the development of a curriculum manual titled "Biotechnology for Plants, Animals, and the Environment" that is now available to secondary agricultural education programs. Several states participated in a train-the-trainer workshop in 2000 to encourage the adoption of these materials.

The "Biotechnology for Plants, Animals, and the Environment" curriculum is composed of stand-alone lessons and labs that can be pulled out to be integrated into existing high school courses such as horticulture, animal science and natural resources. The curriculum includes a fundamentals section that teaches basic and advanced genetic and microbiology concepts that one must understand in order to communicate about biotechnology.

The "Biotechnology for Plants, Animals, and the Environment" curriculum provides multiple activities and internet resources related to each biotechnology concept.

The student manual includes student and teacher instructions along with student hand-outs and lab sheets for thirty-five different activities. A separate student manual is under development at this time and will be available for purchase in 2002.

How to "Retool"

Cy Vernon, high school agricultural educator, piloted the "Biotechnology for Plants, Animals and the Environment" curriculum at Barlett Yancey High School in North Carolina in 1999. He now teaches the curriculum in his agricultural education program each fall. "By teaching biotechnology I have sparked the interest of students and administrators," states Cy Vernon agricultural educator of over 30 years.

Cy also states that his biggest challenge "has been to retool myself to learn what is needed to teach the class". Cy found that by attending state sponsored hands-on workshops and by utilizing educational and industry resources he could "retool". He understood that he had to seek out and attend training to meet the challenges of teaching agricultural education in the biotech century.

The most important step any agricultural educator can take to "retool" for the biotech century is to attend training. The National FFA and the National Agricultural Education Council will be conducting hands-on biotechnology training in the upcoming year. State agricultural education leaders should have more information about these opportunities in the Spring of 2002.

Agricultural educators need to keep abreast of new curriculum products such as the "Biotechnology for Plants, Animals and the Environment" and try to adopt new concepts and technology into their programs whenever the opportunity exists. Agricultural educators should be prepared for the changes in agriculture so they can understand the many issues related to biotechnology and the consumer and career choices their students will face in the century of biotech.

According to many futurists, the agricultural industry and our lives will continue to change at a phenomenal rate due to biotechnology. If this is so, then all agricultural educators need to decide "how deep" they should teach the agricultural science that is at the foundation of this change. Just keep asking "am I adequately preparing my students for the biotech century"?

Hands-on training in biotechnology can retool teachers for the biotech century.

Biotechnology for Plants Animals and the Environment
Content Outline

Unit I Fundamentals of Biotechnology: 1. Biotechnology for Plants, Animals and the Environment, 2. Cells and DNA, 3. Recombinant DNA, 4. Selecting Genes

Unit II Biotechnology and Plants: 1. Products of Plant Biotechnology, 2. Impacts of Plant Biotechnology, 3. Regulating Plant Biotechnology, 4. Careers in Plant Biotechnology, 5. Classical Plant Breeding, 6. Gene Transfer, 7. Plant Tissue Culture, 8. Growth Chamber, 9. Field Trials, 10. Genetic Verification

Unit III Biotechnology and Animals: 1. Products and Producers of Animal Biotechnology, 2. Impacts of Animal Biotechnology, 3. Animal Reproductive Techniques, 4. Cloning and Genetic Engineering of Animals

Unit IV Biotechnology and the Environment: 1. Biotechnology Techniques for the Environment, 2. Using Microbes to Clean Up the Environment, 3. Detecting Environmental Pollutants, 4. Using Plants to Clean Up the Environment

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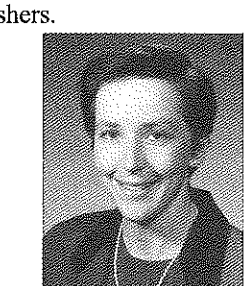

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It's Not Rocket Science. It's Better!

By Dale Gruis

First of all, for those that may discredit my comments because of my current job title, let me reassure you that less than two years ago I was still a valuable member of society…I was a classroom agriculture teacher. Seriously, working at the department of education has helped intensify some of the beliefs I have developed after 14 years of working to build a strong, comprehensive, high school agricultural education program. (If you continue to read you may also be corrupted by my beliefs.)

Why Integrate Science?

I distinctly remember a discussion with my high school principal in 1993. He had observed that several of the students who were failing high school biology were doing quite well in agriculture classes. He then inquired if I had ever considered utilizing my biology endorsement to create a class to help these students succeed in science.

One year later, I started teaching an Applied Biology course. In addition to teaching my traditional sophomore Ag 2 class, I taught an additional period of Applied Biology to the same group of students. The Applied Biology course fulfilled their high school biology requirement and enhanced my Ag 2 curriculum. The relationship between the animal science content of my Ag 2 course and the Applied Biology curriculum was amazing.

By coordinating the instructional units I could mesh the teaching of scientific theory with the application. It was a perfect fit. I enjoyed watching as students became more interested in science and developed a better understanding of the agricultural applications.

During my 14 years as a classroom teacher and 2 years as a state supervisor of agricultural education, I have developed some definite opinions about the integration of science.

I will outline my opinions based on the following perspectives: 1. The parent perspective; 2. The business and industry perspective; 3. The school administrator perspective; and 4. The instructor perspective.

The Parent Perspective

A common parental concern is that career and technical education programs will limit their student's opportunity to go to college. Parents want their children to be prepared for a broad range of opportunities, and to succeed in college.

Altering my curriculum to include more science gave the program more credibility. The contextual learning approach offered in agricultural education provided the opportunity to take students to a higher level of understanding, and activities like DNA extraction, gel electrophoresis, and conjugative plasmid transfer generated a new appreciation for the challenging curriculum of the agricultural education program.

The Business & Industry Perspective

Human resource managers from business and industry speak about the importance of developing employees with a strong grasp of science, math, and communication skills. From their perspective, employees with a comprehensive knowledge of science are best suited to grow and adapt within a rapidly changing workplace. They want employees with the raw skills to adapt and thrive as they transition through different careers.

The Administrator Perspective

Standardized scores are considered an indicator of success and are highly visible to the public. Many school administrators want programs to develop students who can perform well on standardized tests. Some estimates show that 80% of the future jobs will require postsecondary education; the old vocational education model of preparing students for entry-level jobs upon graduation is out-of-date.

The Instructor Perspective

"But I just want to teach ag!" (How many times have you heard this comment?)

Animal science, plant science and soil science allowed me to teach the application of science to agriculture. But with a little extra planning, I could connect the scientific theory and help students understand the importance of science to agriculture. In my opinion, no other program was better suited to help students learn and understand the life sciences.

Criticisms

In 1997, I vividly remember being scolded during a parent-teacher conference. "We don't understand why you are teaching all of this science (excrement)," yelled the parent.

Two years later, the family was no longer farming. This story is an unfortunate but realistic example of why I believe my decision to change the curriculum was correct. Given the economic climate in production agriculture I could not guarantee that students would be successful in production agriculture, but I could help them develop the skills they needed to become critical thinkers and problem solvers.

Suggestions (Tips from teachers)

My teaching situation was unique and I realize that my approach may not work for everyone. However, in my discussions with agricultural education and science teachers I have developed the following tips to help teachers integrate more science into agricultural education:

1. *Juggle your sequence.*

Work with your district's science teachers to shift the timing of specific topics so they correspond with other courses in your school.

For example, I moved my genetics, nutrition, and reproduction units to start immediately after my sophomore students had completed these units in biology. This allowed me to spend less time reviewing, and more time taking them to higher levels of complexity.

2. *Identify the gaps.*

Work with your district's science teachers to identify topics that receive less attention in the science curriculum. For example: If instruction in microbiology is limited you could increase your emphasis on microbiology concepts when you teach students about diseases, food safety and soil science.

3. *Think long term.*

Approach curriculum development with an understanding that some of tomorrow's jobs do not even exist today. Use the hands-on, contextual nature of agricultural education to help students develop a thorough understanding of science concepts that will stand the test of time.

4. *Be a part of the solution.*

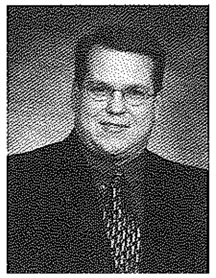
Many of us are frustrated by the abstract, theoretical nature of some sectors of our educational system. As an agricultural educator utilize your practical knowledge to increase your students' understanding and retention.

It's Not Rocket Science

Increased integration of science into agricultural education makes sense to parents, business and industry, and school administrators. Unfortunately, many instructors underestimate their ability to integrate science even though they probably have the basic science knowledge required to integrate more science concepts. (I find that using a shop vac to vacuum the cobwebs from between my ears helps uncover some of that old, unused knowledge.)

The agricultural education classroom is a perfect setting to mesh theory with application. Integrate science into agricultural education to improve program credibility and increase student achievement.

But you just wanna' teach ag? You will be.



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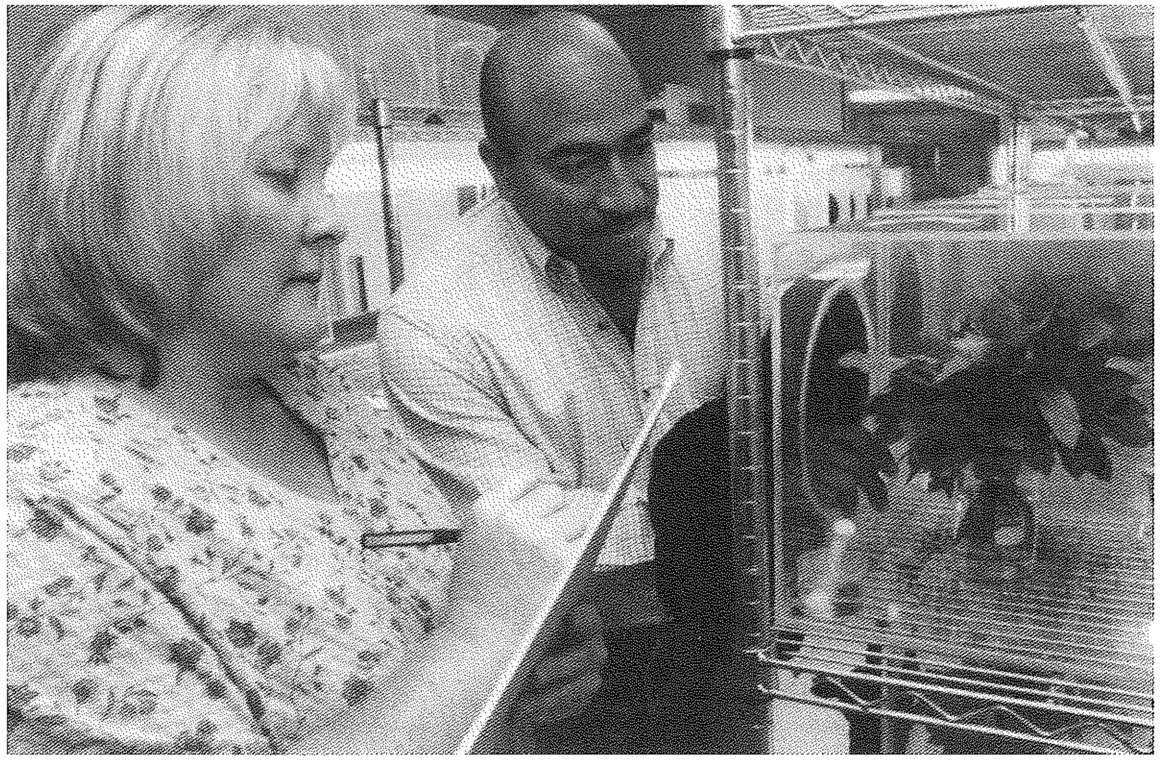

New agriscience curricula will likely include such topics as: molecular genetics, environmental management, micropropagation, biomechanics. (Photo by Eric Zamora, courtesy of University of Florida, Institute of Food and Agricultural Sciences.)

The Agriscience Curriculum in the Volunteer State

By John C. Ricketts and Cliff Ricketts

The Volunteer State of Tennessee is where we began our career in agricultural education. The Tennessee agriculture students and teachers have been blessed with the presence of a specific "agriscience" course that blends biology, chemistry, and physics into agriculture. The teacher-designed and written curriculum efforts started in 1987 and by 1989, the state Board of Education, Tennessee Board of Regents, and the University of Tennessee Board of Trustees approved this course as an acceptable science credit for college entrance. We believe it to be one of the first such efforts in the country.

The course consists of 33 units in six major sections, which are Orientation, Leadership, Experiential Learning, Animal Science, Plant Science, and Agricultural Mechanics. Each section contains units and specific objectives that must be taught if students are to receive science credit. Originally, the agricultural education teachers that teach the class must have teaching endorsements in both agricultural education and science, but recently Tennessee added a teaching endorsement in Agriscience, which makes teaching the course much more feasible.

The agricultural curriculum has been a success for many reasons, but primarily because teachers have been working together to design, enhance, and maintain quality materials to use in their programs. Not only did they work together on the curriculum itself, they have also collaborated to develop a lab manual of science experiments that are within the context of specific areas of agriculture. Their most recent collaborative experience yielded over 100 science experiments for agriculture mechanics and physics, animal science, chemistry, genetics, plant science, soil science, and miscellaneous topics to be used in the agriscience curriculum and in other courses as needed.

The point is that two heads are better than one and 50 to 100 heads are much better than that. You may not be able to organize an entire curriculum project, but you can take a leadership role and organize as many of the competent teachers that you know to capitalize on their knowledge, skills, abilities and experience to create a pool of scientific applications to be used that are relevant to your community and the specific type of agriculture that you teach. Following are some abbreviated examples of simple science implementation activities that the agriculture teachers in Tennessee were able to develop from their collaborative experiences. Try these in your class as soon as possible. They are a lot of fun.

We challenge every agricultural education professional at all levels to form collaborative ventures that will give teachers more tools to use to incorporate science into the agricultural education curriculum. Maintaining the integrity of the course is an ongoing goal of the State Department of Education, and the sample agriscience labs are a result of accreditation requirements for a 40-hour workshop in order to teach agriscience in Tennessee. The exchange of ideas resulting from the collaborative efforts in the Volunteer State enhanced creativity, critical thinking, and the teaching repertoires of all of the teachers involved.

Teacher creativity is often a necessary component of agriscience instruction. Here, a student injects an orange with a solution of red food coloring to practice subcutaneous and intramuscular injections. (Photo courtesy of University of Florida Department of Agricultural Education and Communication.)

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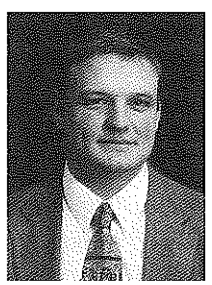

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How to Kill a Potato

Objective:
To demonstrate the relationship between osmosis and living cells.

Materials:
Two potatoes, knife, sugar, water

Procedure:
1. Boil one potato 20 minutes to kill it.
2. Slice the top and bottom from each potato and scoop a hollow in each.
3. Remove a complete circle of peel from the lower half of each potato.
4. Place a spoon of sugar in each cavity and place both potatoes in a container of water.
5. Leave potatoes for 24 hours.

Conclusion:
- The cavity of the raw potato will be full of water and sugar, but the sugar in the cooked potato will be undisturbed.
- Osmosis occurred in the uncooked potato because of the living cells.
- Osmosis did not occur in the cooked potato because the boiling killed the cells.

Micro-organism Action in the Rumen of Cattle

Objective:
To demonstrate the effects of the microorganism action on the rumen of cattle.

Materials:
1 gallon small mouth jar, 1 quart of molasses, 2 quarts of water, 1 balloon, Yeast

Procedure:
1. Mix molasses, water, and yeast in the jug and stretch the balloon over the mouth of the jug.
2. Secure with a rubber band.
3. Let mixture stand and observe.

Conclusion:
Microorganisms in the rumen of cattle produce large amounts of gas in breaking down materials.

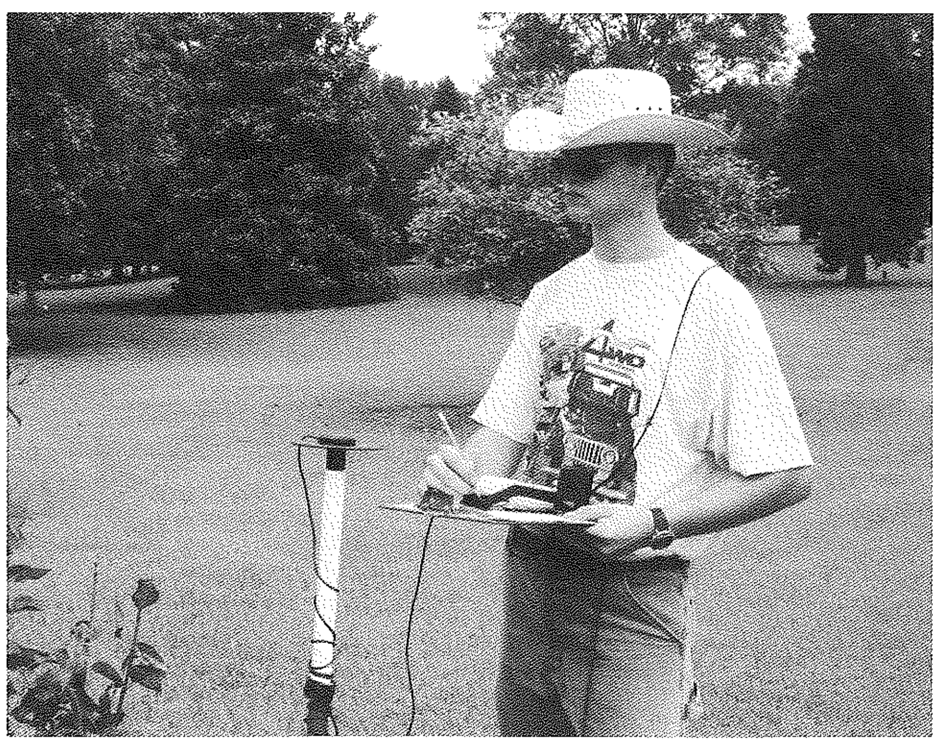
Meeting the Challenge: Strengthening Agriscience in West Virginia

By Gene A. Hovatter and Kerry S. Odell

A quick look at history will show that science has always played an important role in the agricultural education curriculum. Stewart and Getman in their 1927 book, *Teaching Agricultural Vocations* stated that "the scientific point of view is essential to successful teaching . . ." (pg. 3).

John Dewey's influence on the philosophy and character of agricultural education has been well documented. The problem solving approach and an emphasis on experiential learning has provided agriculture teachers with unlimited opportunities to advance the science of agriculture. So what is the basis for the renewed interest in the role of science in the agricultural education curriculum? Much of the concern about infusing academics (e.g. math, science) into the agricultural education curriculum seems to be the result of larger changes taking place in education brought about by declining performance on standardized tests, renewed awareness of the importance of the application of knowledge and experiential learning and the explosion of new technologies.

Deborah C. Fort, in the May, 1993 issue of the *Phi Delta Kappan*, stated that "without the opportunity to learn and understand science and its contributions to society, ... we are in trouble. This is why science must both grow from and equip us for real-word experiences, for approaching and coping with realities and problems that may not have solutions" (pg. 681).



Oconee County High School agriscience student, Jason Smith, establishes and records a GPS coordinate while mapping the Thompson Mills Memorial Garden, Georgia State Arboretum. (Photo courtesy of Sidney Bill, Agriscience Teacher, Oconee County High School, Watkinsville, GA.)

In 1990, the West Virginia State Department of Education through the Bureau of Vocational, Technical and Adult Education provided funding for a statewide initiative that teamed agriculture and science teachers in structured collaborative instructional activities to provide science and agriculture students opportunities to apply scientific principles and concepts. Another collaborative effort was funded in 1993 and the results of the initiative were reported at statewide meetings of school superintendents, agriculture and science teachers and parent-teacher organizations.

The primary purpose of the initiative was to promote a better understanding of the role of science and technology in agriculture and to explore strategies for reinforcing scientific concepts and principles in the instructional process. Partnerships were formed at participating schools that included agriculture and science teachers. Partners explored opportunities for collaboration, shared ideas and developed projects aimed at strengthening instruction in the sciences and agriculture.

Fifteen collaborative projects were subsequently funded by the Department of Education. These projects included tissue culturing, aquaculture, water quality, small animal care, plant growth and physiology and beam design and construction to name a few. Enthusiasm for the projects was contagious. Dialogue among teachers increased. Students and teachers shared facilities and experiences.

Team teaching occurred and barriers between "academics" and "agriculture" were brought down. School administrators were impressed. John D. Todd (1993) pointed out that "to bring about this type of integration [academics with agriculture] would require complete cooperation of both vocational and academic teachers and with support from administration and guidance counselors" (pg. 2). This proved to be true in West Virginia.

So where are we now, about ten years later? In West Virginia, agriculture teachers have seen this infusion of science into the agricultural education curriculum as a welcomed opportunity, allowing them to branch out and enhance the learning experiences of their students.

At St. Mary's High School the agricultural teacher established a biotechnology class for his students, providing them an opportunity to learn and apply scientific techniques important in the advancement of agriculture. This curricular change and others have resulted in funding for new equipment and facilities to enhance biotechnology instruction.

At the Marion County Vocational Center, other curricular innovations have been tested. A veterinary sciences program has been developed that complements a two-year veterinary assistant program at a local college. Again, equipment and facility enhancements have followed curricular change. Aquaculture has become the mainstay in helping bring science concepts and applications alive in the agricultural science curriculum and over 40 percent of the agriculture departments in West Virginia offer some type of exposure to aquaculture.

Experiential learning has not been abandoned. Supervised experience programs have been developed to fit the needs and interests of students. Placements and entrepreneurships have been developed, particularly in aquaculture. Where these opportunities do not exist, students are using science fair projects and the National FFA's Agriscience program as avenues to apply and demonstrate what they have learned.

As a result of the renewed emphasis on science in the agriculture curriculum, the State of West Virginia now allows certain students to use some agriscience courses to satisfy a portion of the State's graduation requirements in the sciences. Agriculture teachers in West Virginia have noticed that their students really enjoy learning new things and that they place a greater value on their other science courses because of the application opportunities the agriscience courses provide.

Teachers, too, have changed. There is much more collaboration between agriculture and science teachers. Agriculture teachers must keep abreast of new scientific knowledge and address the ethical, economic and social issues that have come with the technological explosion in agriculture.

Carefully planned and implemented, infusing more science in the agricultural curriculum can be a win-win situation for students and teachers. This has proven to be the case in many West Virginia high schools, as it has in other states as well. As the rate of technological change increases so will the need to modify the curriculum of our agricultural programs.

Who would have dreamed, even ten years ago, that our students would be facile at using global position satellite technology, reproducing plants using tissue culturing techniques and producing food once only harvested from the sea. The changes and challenges will be many. We believe our programs have met and will continue to meet the challenges as we prepare our students for the "future of agriculture."

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Agriscience and Technology: The Key to Program Survival and Success

By Rosco Vaughn, Kevin Woodward and Steve Rocca

Agriculture teachers are often reluctant to make curriculum changes that increase their workload. However, teachers willing to give the extra effort soon become caught up in the excitement and challenge of making positive things happen for their students. Clovis East High School is a prime example of how curricular change can have a positive impact on an agriculture department. At Clovis, the shift in the instructional program began in 1994, when Agriculture Biology was added to the curriculum. In 1994, the enrollment at Clovis was less than 250 students. In fact, in 1992, the school system was seriously considering reducing the program to a single-teacher department. The plan was to eliminate the existing school agriculture laboratory facilities and teach agriculture in a single classroom.

The Vision of the Clovis Agricultural Education Advisory Committee

Although funding was limited in California during this time and many elective programs were being eliminated, the Clovis Agriculture Advisory Committee, the Clovis School District, and the Clovis agriculture teachers made a commitment to improve and expand the agricultural education program. Their vision began to unfold when they received a four million dollar grant from the state of California to establish the Central Valley Applied Agriculture and Technology Center. Through the committee's efforts, the Clovis agriculture program now operates in a state-of-the-art facility on the new Reagan Education Center Campus. For the 2001-2002 school year, the enrollment is over 450 high school students from the district's four high schools and the program serves nearly 300 students from the nearby intermediate school. Since 1994, the agriculture department has grown from a two-teacher program to four full-time teachers and the department hopes to add another teacher in the near future. Table 1 shows how the high school agriculture enrollment has grown over the past ten years.

Table 1: Clovis East High School Annual Agriculture Enrollment by Grade Level

School Year	Freshmen	Sophomores	Juniors	Seniors	Total Enrollment
1992-1993	68	69	40	25	202
1993-1994	88	55	30	30	203
1994-1995	89	80	54	22	245
1995-1996	65	65	43	40	213
1996-1997	63	59	64	29	215
1997-1998	61	58	31	34	184
1998-1999	111	34	56	48	249
1999-2000	153	75	31	50	309
2000-2001	208	91	45	12	356
2001-2002	175	194	71	23	463

The Strategic Plan

The Clovis Unified Agriculture Department has a strategic plan that addresses curriculum needs and emphasizes modern uses of science and technology. Most schools have technology but they don't have a specific plan for utilizing the available technology. At Clovis, the keys to successfully changing the curriculum to make it science- and technology-based included: (1) creativity and commitment on the part of the school district, advisory committee, and the teachers, (2) selecting technology that enhances student achievement and the agriscience curriculum, (3) maintaining flexibility among the teachers.

The current program serves all the Clovis high schools and also offers classes for over 150 seventh- and eighth-graders each semester. In addition to the Agriculture Biology class, the program offers Applied Environmental Science, Plant and Animal Physiology, and Botany. These four courses are all approved in California for science credit. The Clovis students also have the opportunity to take a variety of agriculture courses including:

- Introduction to Agricultural Science
- Agricultural Engineering
- Veterinary Science
- Global Agriculture Marketing and Trade
- Emerging Technologies in Agriculture

Implementing the Strategic Plan

At the start of the 2000-2001 school year, the agriculture department moved into the new agriculture facility. The final cost of this facility will be nine million dollars when completed. Today, this new agriculture center includes two fully equipped agriscience classrooms; a distance education room; a traditional classroom; an agricultural engineering facility; and animal science facilities for beef, sheep, and swine. Two greenhouses and a state-of-the-art biotechnology facility will be added in the near future. Long-range plans are to involve over 60 schools in the Central Valley of California via distance learning and cooperative instruction

According to Kevin Woodard, Agriculture Department Chairperson, Clovis Unified School District, the scientific focus of the program coupled with the technology capabilities have made the agriculture classes more popular with the student body. He believes that technology is cost-effective only when it contributes to student achievement. At Clovis, technology is used for the purpose of enhancing the process of learning agricultural science.

A grant recently obtained by Clovis Schools will again expand the scope of this program. Total funding available for the program through this grant will be $835,000. These funds will upgrade the distance education laboratory to make it a hub and allow Clovis to connect with a smaller high school in Sanger, California, a Sanger elementary school, and one Clovis elementary school. Via the Internet, it is planned to bring agricultural education to elementary school students.

High school students throughout the Central Valley will be able to participate in mirrored classes and will plan and communicate project information through teleconferences. In this plan, teachers will team teach with other instructors from throughout the region to provide a comprehensive program of agricultural literacy. Part of the plan includes having elementary students become "e-mail buddies" with high school students. The high school agriculture students will mentor the elementary students and help them learn about agricultural science.

All of the agricultural science facilities are designed to allow for wireless computer connectivity. Students at each site will have access to twenty or more laptop computers that can be used by anyone, anytime, and anywhere (including the livestock and plant science laboratory facilities) throughout the department. The other three schools to be connected with Clovis East will each have funding to purchase distance learning equipment and twenty laptops for their students. At the Clovis site, the computers will also be used for an Advanced Agricultural Research Class.

Expanding and Enhancing the Curriculum

Teaching students with outdated technology is a lesson in history. Using current technology opens doors to the future. According to Kevin Woodard, "There is nothing like a good old fashioned field trip to bring it all together". Business and industry field trips provide students with "real world experiences" that help them build on the classroom and laboratory instruction provided by the Clovis Agriculture Teachers.

A prime example of teaming with other teachers in the school is the drafting teacher and the agricultural engineering teacher cooperating by rotating these two classes every six weeks. The drafting teacher provides basic computer instruction and teaches Computer Assisted Drafting (CAD), allowing the students to design their own projects from a rough description outlined by the teacher. When they move to the agricultural engineering laboratory, they construct their own individual project based on their CAD design. Under the supervision of the agriculture teacher, students construct projects that are similar in function but reflect the individualized design and dimensions developed by each student.

The Central Valley Applied Agriculture and Technology Center is still in the embryonic stage. This is the second year of operation in the new facilities with additions coming on line over the next several years. Similar connections with an additional 56 schools and with the Agricultural Education Department at California State University, Fresno are part of the future plans. The current Clovis Agriculture Program is a success story that would have been only another failure without the vision, strategic planning and implementation provided by a dedicated school district, a strong advisory committee and the agricultural education staff serving the Clovis Schools. It is a success story that can be replicated in other schools across the nation.

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Agricultural Biotechnology Education

By Michael Zeller

Less than 3% of the United States population lives on what is today defined as "farms." The question has been raised, "Why spend time on agricultural education (ag ed) in schools when such a small population would use it?" The answer should be as simple as, "Do you eat food and care about how it is produced?"

As witnessed in the press, an increasing number of people are interested in the food they eat. Unfortunately, their judgment of food is based on very little knowledge of the production, handling, processing and commercialization of this food. Returning to the question "Is agricultural education necessary?", the answer should be "It's a requirement." No one academic discipline has and will continue to experience the kinds of pressure to explain to the public the practical relationships among food, consumers and biotechnology like the educators involved in agriculture. Yet many agriculture educators find themselves ill-equipped to communicate the science and technical knowledge needed to meet these present and future challenges in agriculture.

The biotechnology program at Iowa State University (ISU) since 1994 has concentrated on helping classroom ag ed teachers meet these challenges.

In 1992, ISU biotechnology director Dr. Walter Fehr convened a group of secondary, extension and college educators to the first Biotechnology Education Council meeting on campus in Ames, Iowa. In those early meetings it became apparent from research and the members' own experiences that in order to get biotechnology integrated into K-12 school curriculums, the program would have to overcome three major hurdles.

1. Educators lacked the content and technical knowledge to feel comfortable about integrating biotechnology into their curriculums.
2. There was a serious shortage of money for supplies, equipment and release time for educators to obtain training.
3. There was little time during the day and in classrooms to prepare and present biotechnology.

With the securing of a Roy J. Carver Charitable Trust grant and industry support, ISU launched the Biotechnology Public Education program in 1994. The philosophy then continues today –"teachers-teach-teachers" biotechnology. The program would be centered around the inquiry-based or hands-on pedagogy of instruction. Each set of classroom activities would be tested by teachers and would focus on the basic scientific principles and technical skills of biotechnology.

Fifteen teachers, each representing an Area Education Agency (AEA), were trained by ISU faculty and staff and were given the title "Master Teachers." This was later expanded to include the seven regional extension areas in Iowa. The original activities were DNA extraction, DNA fingerprinting (restriction analysis) and bacterial transformation. The master teachers' responsibilities were to hold workshops in their regions to train other educators in the preparation and delivery of these activities. These educators, in turn, would receive free supplies, equipment and technical support to help them integrate the biotechnology activities into their curriculums.

Many of the first workshops were hosted in one of the regional Area Education Agencies or Local Education Agencies (LEA) in the state. Targeted educators taught science (biology), ag ed, family and consumer sciences or were extension educators. Later, workshops were moved to ISU's campus and divided into three specific workshops to better address the different needs of each discipline. All the activities have been tested by educators to meet their needs, particularly the need to fit activities into a 45-minute classroom period. For activities that take longer than 45 minutes, stopping points were built into the procedures. This helped alleviate the concern of time to do some of the activities.

Each workshop group receives training in the three basic activities: DNA extraction, DNA bacterial transformation and DNA fingerprinting (restriction analysis). These activities are viewed as the ones that will give educators the basic concepts and technical skills to successfully implement biotechnology into their curriculums. The agricultural education workshop also introduced activities involving Bt corn, a Bt lateral flow test, chymosin, soybean flavor, careers, bioethics, food safety and regulation, and two full curriculums using soybeans. A review of Figure 1 below gives an overview of the objectives and proficiencies in the workshops.

Even though agriculture educators do not, for the most part, integrate the bacterial transformation into their curriculums, the concepts from the activity are vital to understanding the insertion and uptake of DNA into plants and animals. For agricultural educators, the Bt corn activities, soybean flavor activity, chymosin activities, careers information and bioethics were favorites.

The program gave a boost to the training of over 1000 teachers and extension educators who have brought biotechnology activities to more than 100,000 students since the program began. Educators receive free supplies and support through "ask the expert" contact information and a web site that features classroom activities, step-by-step tutorials on the preparation and delivery of the activities, available curriculums, useful web sites, publications, career information and more.

The three hurdles preventing the integration of agricultural biotechnology into the curriculums have not been completely overcome, but have been addressed through ISU's Biotechnology Public Education program. Workshop training, free supplies and equipment, technical support and teacher-friendly activities have all combined to get agricultural biotechnology into Iowa classrooms. To date, we have not been able to influence the amount of time educators are given to prepare for an inquiry-based, hands-on rich curriculum. State education departments, legislatures, and local school districts are eager to embrace inquiry-based learning strategies for their students, but are still insensitive to the time required of the agriculture educator to prepare and deliver such activities.

Our society continues to become more urban. Students and adults have lost the connection between the farm and the supermarket. The best vehicle available to help students realize where their food comes from is through agricultural education programs at their schools. Leave it to reason that agricultural education offerings in schools should increase, not decrease, before a generation of citizens has no idea of the origins of their food. Agricultural educators have been given the responsibility, by lieu of their training and teaching assignments, to establish that relationship between the grocery shelf and agriculture for their students. The dangers of a generation lost will lead to ignorance and even arrogance about food safety and nutrition, depleted land and water quality, and respect for an industry that fuels many Midwest states' economies. Who better to bring the realities of plants' and animals' roles in the production of human vaccines and other medical products, and the risks and benefits of biotechnology than well-trained agricultural educators? We cannot afford a citizenry minus the knowledge that agricultural education can offer.

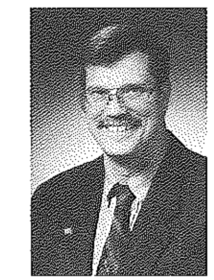

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Figure 1:

Content Objectives	Technical Proficiencies	Activities
DNA Structure and Function, "How DNA Works"	Structure of DNA, physical appearance of DNA, chemistry involved in the extraction DNA extraction	DNA extraction
DNA Analysis	Micropipetting, agarose gel electrophoresis, restriction digests, TBE preparation, analysis of gels	DNA fingerprinting, restriction analysis
DNA Manipulation and Gene Transfer	Sterile technique, sterile preparation of liquid and solid bacterial media, proper handling and analysis of bacterial cultures	Bacterial transformation
Transgenic Technology	Use and analysis of lateral flow test, analyze the European Corn Borer (ECB) activity on the	Bt corn (ECB and lateral flow test), plant transformation simulation
Gene Discovery and Expression	Crick's dogma	Soybean flavor test, chymosin activities, Reebops
Consumer Issues and Food Safety	Sources of information about social and economics aspects	Guest speakers
Bioethics	Formulate a moral/ethical position based on moral values and factual analysis	Golden (Vitamin A) rice scenario

Making Science Applicable - The Need for a Modern Agricultural Education Curriculum

By Brian Myers and James E. Dyer

The philosophy that guides agricultural education instruction appears to have finally completed a full circle. Beginning as an academic subject matter area, agricultural education was vocationalized by the Smith-Hughes Act as a program that was intended to focus on preparing students for careers in farming. Subject matter focused on "how" to do, rather than "why" it should be done. While a vocational approach may have been needed at the time, the academic side of agriculture was virtually abandoned in favor of this vocational mission. However, that approach was contrary to the manner by which agricultural education was envisioned at the time – as a science.

With the issuance of the 1988 report, *Understanding Agriculture: New Directions for Education*, the National Research Council suggested that agricultural education needed to re-evaluate what it had become, and to refocus on its roots (pun intended). The Council suggested that agricultural education address the fact that agriculture IS a science, not merely a set of skills to be developed. The Council vocalized what many had been unprepared to acknowledge: If formal education in agriculture were to survive, it would do so only by developing an understanding of the scientific principles that are the foundation of the subject matter. No longer could agricultural educators teach students the "how" without also teaching the "why."

In response to the agricultural recession of the late 1970s and early 1980s, agricultural educators reassessed the role of agricultural education in the high school classroom. In many states agricultural education curricula moved away from a focus on production agriculture to a more scientific approach. The term "agriscience" became synonymous with agricultural education. New courses were created that integrated science and agriculture subject matter into a hybrid curriculum that focused on science, but did so as an application of scientific principles in an agricultural context.

With this renewed interest in science, comes the inherent possibility that agriculture courses become little more than science courses – that students could enroll in either subject and learn the same information. "If this is true," it is asked, "why do we need agricultural education?" Although agriculture is clearly a science, it is an applied science. Not only is it applied, but that application must take place in the context of an agricultural setting. As such, agriculture teachers should not duplicate information learned in other classes, but teach both agriculture and science in a more meaningful context. The incorporation of science into the agricultural education curriculum must be done carefully, yet thoroughly. Again, agriculture should be taught as an applied science.

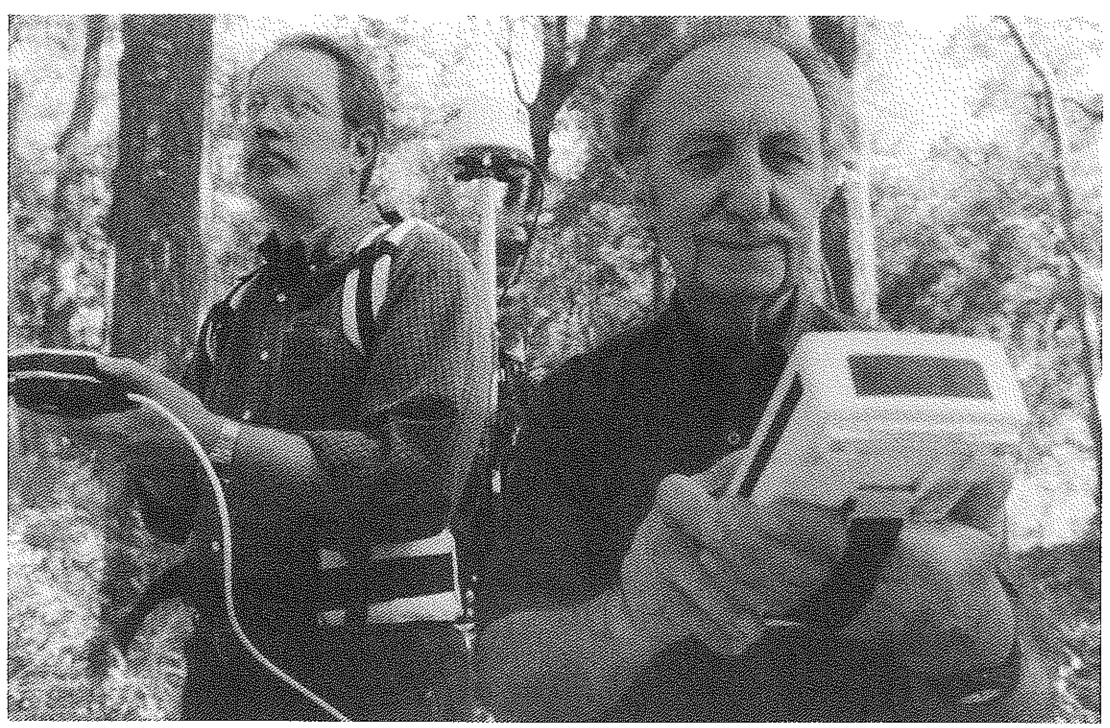
Lab activities must be chosen carefully. They should be selected to supplement instruction – not to be the instruction. In order to help students make the connection between the basic science concepts and practical application, instructors need to make learning active with the inclusion of laboratory activities. These activities should be carefully selected by the instructor to ensure that each activity performed clearly illustrates the practical application of the science concept studied in class. It is very easy for agriculture teachers to fall into the trap of completing exciting laboratory exercises that do not clearly provide an application component to what is being studied in the regular classroom setting. When this happens, students generally fail to make the connection between the scientific principle and the activity being performed.

There are some outstanding resources for agriculture teachers to use in finding activities to incorporate into the classroom. However, the integration of science is not accomplished by just inserting a few science laboratory activities into the course. A deliberate and intensive effort must be made by the instructor to show students why it is important for them to understand a particular concept in an agriculture class. In many states there is a push to allow students to earn science credits toward high school graduation and in some cases admission to college through agriculture courses. They must be sure to have the course reflect the applied nature of agriculture, while still meeting the science requirements.

Agricultural education curricula should be grounded in developing problem solving, critical thinking, and higher order thinking skills. For nearly a century agricultural educators have promoted the concept that the curriculum for agricultural education should be built upon the scientific method – a blueprint for problem solution and critical thinking. Agricultural education that focuses on the science of agriculture provides an excellent opportunity for developing these skills. By its very nature agriculture is filled with opportunities for educators to use the scientific method to teach agriculture concepts. Virtually every subject area of agriculture can be outlined so that it fits this model of problem solution.

Agricultural education must change from a production-oriented curriculum to a consumer-oriented curriculum. Less than 2% of the population is involved in production agriculture. One hundred percent of the population is involved in consumption agriculture. One of the keystones of motivation theory is that we are interested in those things that affect us. Most high school students could care less about what is going on in agriculture, so long as they are able to get their "Big Mac" when and how they want it. Few are able to make the connection between food, fiber, natural resources, environmental education, leadership, etc. – all those things that make up agriculture – and their own lives. Curriculum focused on consumption agriculture rather than production agriculture has a chance to bridge this gap – if the curriculum is interesting. A scientific approach to agriculture should accomplish this. It affords the opportunity to make agriculture relevant and active.

The reasons for incorporating science into the agricultural education curriculum are clear. We as educators must continue to change and adapt the curriculum to meet the needs of the agricultural industry in our communities. That industry is continually becoming more science based. We must change what we do and/or the way we do it in order recruit and retain the highest quality students and to prepare them to fill the growing number of career opportunities in the industry. In doing so, we must continue to include the "why," as well as the "how." We must make agricultural education science-applicable. Finally, we must continue to change the curriculum to meet the growing accountability demands of our clients. When we examine all of these items, it is clear that we must continue to incorporate science into the agricultural education curriculum for one major reason: It is the educationally sound thing to do. It is what we must do to continue to teach and to serve some of the best and brightest minds in the world.



Applying agriscience principles often means that we just need to think in different contexts. Many agriculturalists think of the use of a global positioning system (GPS) to be primarily for production agriculture. However, it has many uses in other areas, such as identifying exact locations of trees, trails, and other landscape features. (Photo by Eric Zamora, courtesy of the University of Florida, Institute of Food and Agricultural Sciences.)

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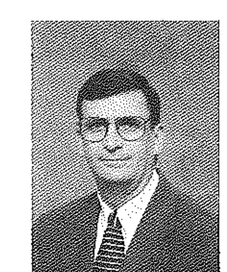

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Cultivating AgriScience through Service Learning

By Michael Woods

Scientific Literacy in Agriculture

While the concept of scientific literacy has been grounded in agricultural education since its inception, it remains a universal, timeless goal. The American Association for the Advancement of Science document, *"Science for All Americans"*, describes a scientifically literate person as one who 1) is aware that science and technology are human enterprises with strengths and limitations, 2) understands key concepts and principles of science, 3) is familiar with the natural world and recognizes both its diversity and unity, and 4) applies scientific knowledge and skills for individual and social purposes (AAAS, 1990).

"Science for All Americans" offers the premise that less is more, indicating a shift away from the emphasis on rote memory to higher levels of cognition such as critical thinking. Bybee and DeBore (1994) sum up the basic dimensions for scientific literacy as follows.

Scientific literacy continuously develops when the science curriculum incorporates a wide variety of learning episodes that clearly emphasize:

* learning from the concrete to abstract and from the familiar to the unfamiliar;
* learning from the local setting to the global setting;
* real-world doing (hands-on);
* cooperative and individual performance;
* learner self-evaluation and curriculum embedded assessment;
* developmental appropriateness of process and content;
* cooperative planning by learners and leaders;
* interdisciplinary connections;
* assessment of the risks and benefits while making choices;
* movement toward independence; and
* responsible decision-making in real-world situations.

For agricultural educators, this means that an agriscience program that is enriching enough to facilitate the continuous development of scientific literacy requires powerful learning opportunities that are relevant and engaging to all learners. It is the intent of this article to encourage the development of new and effective agriscience curriculum that present students with experientially based curriculum that emphasize the general assumptions put forth by Bybee and DeBore (1994). Ultimately, it is recommended that service learning may be a means to advance Bybee and DeBore's (1994) basic dimensions for scientific literacy.

AgriScience Learning-by-Doing

In *Nurturing Scientific Literacy Among Youth Through Experientially Based Curriculum Materials* (1999), Horton and Hutchinson assert that, "if content is the meat of the curriculum plan, experiences are the heart. Horton and Hutchinson, offer the premise that, experiences are the key factors that shape learners' orientation to the content and, ultimately, their understanding of it. Similarly, Taba (1962) noted that learning experiences, not content, are the means for achieving a wide range of objectives; knowledge and understanding are the exceptions.

Experiencing AgriScience Through Service Learning

As expressed by Bybee and DeBoer (1994), "there appears to be little difference in a lesson that trains a monkey, versus a small child, to plant a seed, if the only goal is getting the seed into the ground." There is quite a difference, on the other hand, if planting the seed is just part of several carefully mediated events about plants, their role in food production, and our cultivation of them to advance society.

If we are to achieve the basic dimensions for scientific literacy as proposed by Bybee and DeBore (1994) in our agriscience programs, mechanisms are needed to bring experiential learning opportunities into the mainstream of agriscience education. One such experiential learning methodology that lends itself well to meeting Bybee and DeBore's dimensions of scientific literacy is service learning.

Service learning is an engaged method, premised on experiential education as the foundation for intellectual, moral and civic growth. Like other forms of experiential education, service learning allows students to test skills and facts learned in their agriscience program, sharpen problem-solving abilities, and work collaboratively with diverse groups of people for collective action. By providing the opportunity to students to reach beyond the agriscience laboratory, service learning encourages students to develop civic skills along with scientific expertise.

It is important to note that service learning differs from other forms of experiential education. Rather than focusing simply on preparing students for a particular job, service learning prepares students for practical community-based, "real world" problem solving. It offers students an opportunity to explore the connections between the theoretical realm of AgriScience in the classroom and the practical scientific needs of the community. Service learning is inherently linked to civic purposes: it reinforces the skills of critical thinking, public discourse, collective activity, and community building. Skills that have long been associated with agricultural education and the FFA. Perhaps the most important long-term benefit of service learning is the opportunity it can provide for agriscience students to connect to a community and identify their civic roles in that community.

Cultivating AgriScience through Service Learning

As described throughout the article, service learning offers students and instructors a wealth of innovative opportunities to cultivate agriscience education. Not to mention the considerable potential to achieve the basic dimensions for scientific literacy proposed by Bybee and DeBore (1994). As the National Research Council document *"Understanding Agriculture: New Directions for Education"* states formal and informal cooperation is needed among all organizations within a community to contribute to education in and about agriculture (NRC, 1988). From my perspective, service learning is an excellent example of how agriscience instruction can be extended to the real world and how high school agricultural education programs can become more deeply involved in their communities. Service learning is an unparalleled means of 1) achieving the FFA's motto: *Learning to Do; Doing to Learn; Earning to Live; Living to Serve*, while linking agricultural education to our communities.

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AgriScience Units That Link to Service Projects

1st year students - AgriScience Systems and Society: The primary goal of this unit is for students to gain an understanding of the integrated nature of AgriScience and its relationship with society. Students engage in a variety of in- and out-of class investigative activities as well as data collection, analysis and synthesis, and formulation and evaluation of societal policies impacting agriculture. Unit topics could focus on fundamentals of scientific processes and stresses AgriScience and human interaction within and between the hydrosphere, lithosphere, atmosphere, and biosphere.

2nd Year Students - The Global Change: Facing the consequences of AgriScience: The science of agriculture is a topic about which many world citizens are concerned, but of which they have little knowledge. This unit can provoke students with a firm scientific foundation in scientific changes in agriculture, while defining the boundary between knowledge that is generally accepted by the scientific community and that which remains uncertain.

3rd Year Students - Insects and Human Health: This unit would explore the involvement of insects in human disease, from the obsessive fear of insects to malaria and West Nile encephalitis. Among the topics that could be explored are concepts of epidemiology, entomology, a historical survey of the insects that transmit disease agents, and an in-depth look at some insect-borne disease complexes.

4th Year Students - Use and Abuse of Land Resources: Land resources are practically defined as that part of the Earth's crust which is used to provide food, fiber, habitat, and watershed. This unit could examine the nature of these land resources as well as their use by society. With a rapidly increasing human population, societal impacts upon these resources will increase accordingly. This unit could be designed to provide students with a basic understanding of land resources and their value to society. Emphasis could be placed on the current and past impacts of land use on the quality and sustainability of these resources.

Biotechnology Education Web Sites

- Access Excellence - a national educational program to enhance high school biology education. www.gene.com/ae/

- Ag Biosafety - University of Nebraska-Lincoln site on biotechnology and food safety that has an Education Center with lesson plans, curricula, and interactive instructional modules; database of risk assessment information on biotech crops; and product-specific background information on crops. www.agbiosafety.unl.edu/

- Ag-West Biotech, Inc. - contains issues of AgBiotech InfoSource, a two-page fact sheet about agricultural biotechnology topics aimed at high school students and teachers. www.agwest.sk.ca/

- BioChemNet - a directory of biology and chemistry educational resources. schmidel.com/bionet.cfm

- Bioethics Discussions in the Science Classroom - Oklahoma State University site with links that help science educators integrate bioethics discussions into their classes. www.agr.okstate.edu/bioethics

- Bioethics Program at Iowa State University - homepage of ISU's bioethics program and bioethics newsletter. www.biotech.iastate.edu/Bioethics.html

- BioQUEST - a site for educators interested in the reform of undergraduate biology and contains curriculum and workshop information for secondary teachers. bioquest.org/

- BIOTECH Project - a site sponsored by the University of Arizona that has laboratory activities and oher resources designed to help high school teachers use hands-on biotechnology in the classroom. biotech.biology.arizona.edu/

- Biotechnology Information Center - a site of publications and educational resources maintained by the National Agriculture Library, U.S. Department of Agriculture. www.nal.usda.gov/bic

- Biotechnology Workshop for Teachers - biotechnology activities and course outlines developed by biology and agriculture teachers who attended summer workshops at the University of Wisconsin-River Falls. www.uwrf.edu/biotech/workshop/project.htm

- Eisenhower National Clearinghouse for Mathematics and Science Education - an information source for K-12 mathematics and science teachers. www.enc.org/

- Explore More: Genetic Engineering - lesson plans, ICN events, and other student and teacher resources to explore genetic engineering; made available through a project by Iowa Public Television. www3.iptv.org/exploremore/ge/

- Iowa Agriculture Awareness Coalition - agricultural information and activities for grades K-6, plus information on other sources of agricultural materials for teachers. www.agaware.iastate.edu

- National Agricultural Biotechnology Council - Council homepage and a list of their publications. www.cals.cornell.edu/extension/nabc.

- National Science Teachers Association - programs, projects, and other resources of the NSTA. www.nsta.org

- Natural History of Genes - genetics teaching kits and activities for youth. raven.umnh.utah.edu/

- Plant Science - Iowa State University site for teachers and students; includes demonstrations, experiments, plant science resources, and information about plant science careers. www.agron.iastate.edu/plantscience

- Purdue Agriculture Biotech Education - Purdue University site that has online self-study lessons about the science and issues of agricultural biotechnology; includes quizzes about genetically modified crops and foods. persephone.agcom.purdue.edu/AgCom/news/backgrd/biotech_edu.htm

- Science News Online - weekly online science news service for educators, including a searchable archive. www.scinecenews.org/

- University of Wisconsin Biotechnology Center - connections to biotechnology resources in Wisconsin and the world. www.biotech.wisc.edu/

- Waksman Student Scholars - site at Rutgers University provides student challenges, online DNA and RNA tutorials, and other resources for high school students and educators. avery.rutgers.edu/WSSP/Begin/index.html

Note: Lesson plans and/or classroom activities can be found on these web-sites. This listing is provided by Iowa State University, Office of Biotechnology. A more comprehensive listing of additional sites can be found through its web site at: http://www.biotech.iastate.edu/.