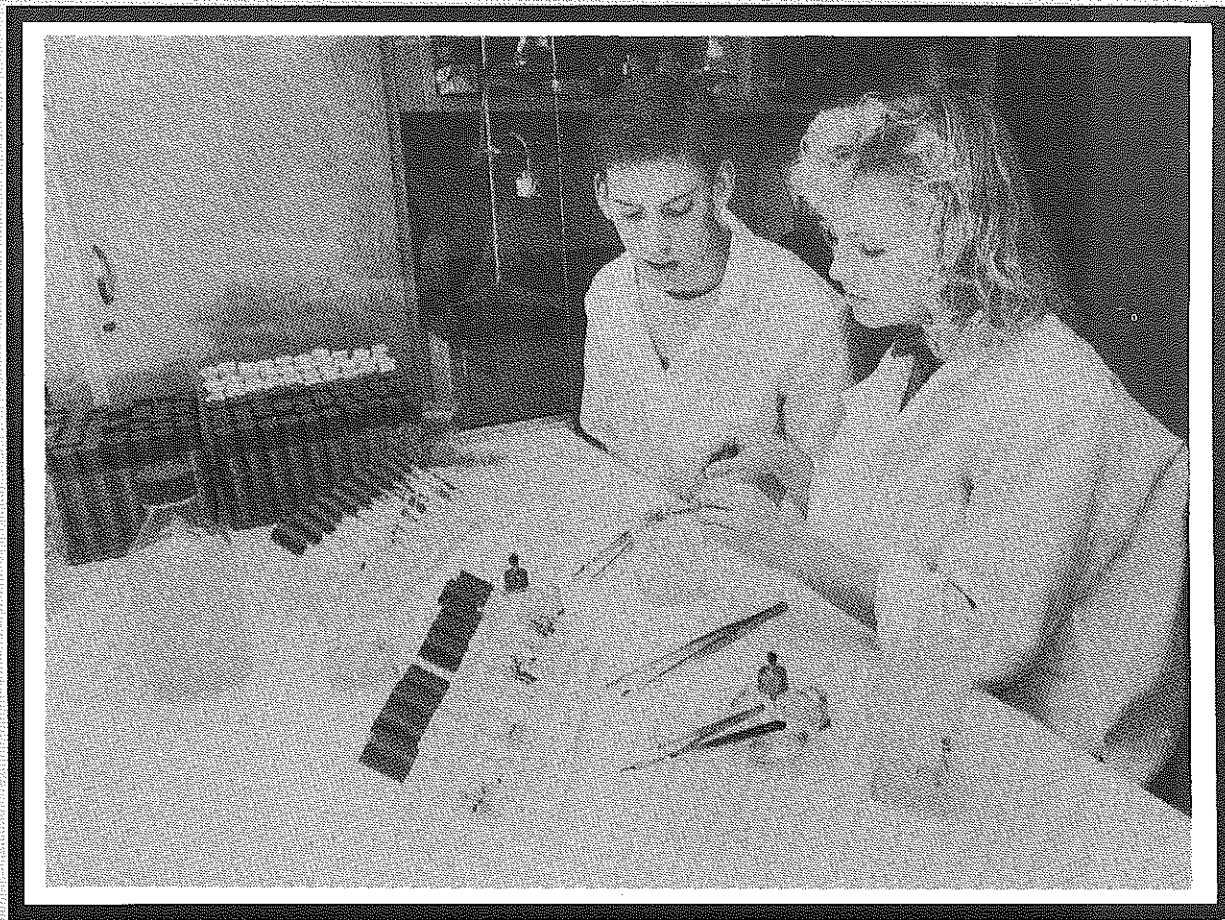


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THEME: Emerging Technologies

THE AGRICULTURAL EDUCATION MAGAZINE



February, 1989

Volume 61

Number 8

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Damn the Torpedoes, Full Speed Ahead!

The soothsayers, doomsday prophets, and "gloom and doomers" are forever practicing their trade even in the agricultural education profession. I wish these prophets would stop for a minute and take stock of where we are and from where we have come as a profession. Further, these individuals need to get out of their normal routines and listen to what others outside of the profession have to say about agricultural education. It is not nearly as dismal as many would have us believe!

I wish the "gloom and doomers" could have accompanied me on a recent emergency trip across this country. Simply by chance and coincidence, I encountered two very different individuals who both had considerable things to say about vocational agriculture and FFA. The beauty of both encounters were that neither individual knew me or my professional association. Thus, neither individual was attempting to flatter or please me with their comments.

Sitting in the restaurant dining room near the Boise airport after an early morning flight from Phoenix, a group of airline pilots, copilots, etc. were overheard discussing their flight schedules and general topics of the day. The discussion soon got around to the upcoming election and support of the local school budget. One of the pilots commented, "You would never guess the best 'course' I ever had in high school!" His answer was vocational agriculture! The pilot observed that he was, perhaps, the only airline pilot in the entire country who had taken five years of vocational agriculture in high school. He explained to the others that it was a good program that provided him with a lot of opportunities and taught him the importance of hard work and responsibility. I sure wish I would have had a tape recording of his unrehearsed, spontaneous and unpaid testimonial to his vocational agriculture teacher and the vocational agriculture program. It was enough to put a lump in your throat and to swell your chest with pride. Here was an individual who occupationally was far removed from agriculture explaining the value of the program to others who had no agricultural interests. There was no doubt that if this pilot were to replan his high school education in light of his profession, he would most certainly enroll again in vocational agriculture.

The next several days were spent in a hospital room in eastern Oregon comforting and encouraging a very important person in my life — my father. Sharing the hospital room for several days was a "crusty" old character who had little good to say about anything or anyone. This seventy-five year old character was a retired "railroader" who, as it turned out, was the father of a high school classmate. As we attempted to identify people of mutual acquaintance, the discussion focused upon teachers in the local school system. All of a sudden this crusty old character warmed noticeably as he talked about the vocational agriculture program and the former teacher of vocational agriculture. According to him, "the FFA program was the best thing the local high



BY PHILLIP R. ZURBRICK, EDITOR

(Dr. Zurbrick is a Professor in the Department of Agricultural Education at The University of Arizona.)

school had to offer. That program sure did a lot for my boys — it kept them in school and off of the streets," he observed with a great deal of feeling. Neither of his sons, it turned out, were occupationally associated with agriculture or agricultural business. There was no doubt in his mind that it was the best program offered in the local high school and one he would recommend for everyone including his own children.

While the above two incidents represent no scientific study of the perceptions of the general public and cannot be generalized to any group or region of the country, I would guess they are more common than most of us recognize and far more positive than the rhetoric of our "doubting john" colleagues.

The National Study

The long awaited national study of agricultural education in secondary schools has finally been released. The reaction to the report within the profession spans the spectrum from "salvation" to "ruination." Further, the individuals' weltanschauung or world view influences how the report is interpreted and thus assessed. Those who believe in the present emphasis upon vocational education in agriculture see the report as a positive testimonial for that program and fear a change to "about agriculture" will replace or supplant vocational agriculture programs at the secondary level. These individuals become very defensive towards change and are branded as conservative, traditionalists, fearful of change.

On the other hand, you have "doomsdayers" who interpret *The Report* as ratification of their belief that vocational education in agriculture is no longer viable at the secondary school level. These individuals and their followers are taking the report as a mandate to dismantle the current vocational agricultural education program in a "head over heels" rush to develop a program "about agriculture." These individuals overlook the recognized value and need of vocational agricultural programs and the positive image of the FFA reported by Miller (1988). Such individuals are considered liberals who lack a vocational philosophy and are ready to scuttle the soundest "ship" to ever sail the "educational seas" flying the United States' flag.

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Damn the Torpedoes, Full Speed Ahead

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Agricultural Science

In such "turbulent seas," leadership that fears neither the torpedoes to the right or the left is needed, leadership capable of steering the "ship" to better days. Recognition that the best defense is a good offense, the profession should not be wasting our time and energy "name calling" or defending ourselves. Let's take the National Study and construct another "ship" with the same "materials" used in building the vocational agriculture program, but with different "rigging" and designed to sail additional "waters." Let's not scuttle or attempt a superficial facelift of the vocational agriculture program.

Surely, we have the talent and the mandate (National Study) to create another (an additional) agricultural education program at the secondary level. Reading the theme articles in this issue of *The Agricultural Education Magazine*, one is impressed with the content and success of agricultural science programs. Programs having waiting lists of students desiring to enroll. Could these programs be a prototype of an additional program delivery system for agricultural education at the secondary level? Perhaps the agricultural education profession's contribution to agricultural literacy at the secondary level could be built upon agricultural science. We must recognize that agricultural literacy covers a vast

spectrum of subject matter content and ranges from elementary to adult levels. We should not assume that the agricultural education profession can nor should assume responsibility for all aspects of agricultural literacy. Perhaps our contribution to the movement should be developing an understanding and biotechnology in agriculture by students at the secondary school level.

Future Discussion

The May, 1989, issue of *The Agricultural Education Magazine* has as its theme "The Profession Reacts — National Study of Agricultural Education at the Secondary Level." I suspect that the actions taken by the profession to this study will have a profound influence on the nature of agricultural education for years to come. Dr. Stacy Gartin, West Virginia University, is serving as Theme Editor for the May issue. If you have questions, strong opinions or suggestions on how the profession should or has reacted to The National Study, please share them with the profession. It is time to stop talking in glowing generalities and come forth with specific suggestions. It is time to stand up and be heard, damn the torpedoes.

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THEME

Agriscience and Emerging Technologies: Today's Science, Tomorrow's Agriculture

"Today's Science, Tomorrow's Agriculture" was a fitting theme for the 1988 National Conference on Agriscience and Emerging Occupations and Technology, held in Orlando, Florida this past October. Dr. Williams and Mr. Pope highlight the conference. Science and Agriculture are not separable. They have not been in the past; they are not now; and I do not expect that they ever will be in the future. The concern for science in the agriculture curriculum has been brought to our attention by three movements: a) the back to basics emphasis on mathematics and science; b) The National Study on Agricultural Education in the United States which stated that "The subject matter about agriculture and in agriculture must be broadened"; and c) the rapid pace by which agriculture is changing as a result of technological advances.

Back to Basics

Science in agriculture involves the application of chemistry, biology, and zoology concepts and principles in studies such as agronomy, crop science, animal science,



By BARBARA J. MALPIEDI, THEME EDITOR
(Dr. Malpiedi is an Assistant Professor of Agricultural Education at North Carolina State University.)

forestry, natural resources, poultry science, and horticulture. Mathematical principles and concepts are necessary to agricultural engineering. Why is this perfectly obvious to agricultural educators and to no one else? Perhaps because our efforts to point out science applications in agricultural education often fall on deaf ears or some of our programs have "watered down" the science applications and carry reputations as "crib courses" in the school. Curriculum developers are being very meticulous in their efforts to cross basic

science and mathematical concepts and principles with agricultural competencies. Roy and Pearson indicate to us how science oriented Natural Resources and Forestry programs need to be structured if our graduates are to be successful.

Broadening Subject Matter

North Dakota, Texas and others have been successful in their efforts to "broaden" the curriculum. We are involved in several challenges: identifying subject matter in agriculture and about agriculture, reaching all the target audiences, and securing the financial and human resources necessary. Dr. Luft and Mr. Peterson share with us the results of meeting the challenges in a successful effort to revitalize a program.

Technological Advances

Are we ready for blue cotton and goat's with cheetah fur? Dr. Lowell Catlett unsettled his audiences in North Carolina and again at the National FFA Convention with his prognosis for genetic engineering and artificial intelligence applications in agriculture for the year 2001. I like the more solid tomatoes for spaghetti sauce as well as hydroponically grown vegetables.

Help Us, Teachers

Whether we call this beast agriscience - the application

of science in agriculture, agritechnology - applying the latest technological advances to agriculture, or biotechnology - the integration of genetic engineering, cellular hybridizations, and fermentation and bioprocessing, it is evident that studies in and about agriculture are changing. Agriscience and emerging technology scare many of us who are unfamiliar with the terminology and processes. Agricultural educators, are among the best at teaching people how to grow and adapt with change. Susan Forte encourages teachers and students to be recognized for their leadership efforts in agriscience through her article. Kansas has agriscience leaders who are not in Oz, Mr. Smith. We need to find ways to help our students deal with the ethics of biotechnology as well as how to benefit from the opportunities created in the food and fiber industry. I am ready for blue cotton and goat's with cheetah fur. Are you?

About the Cover

Students develop basic laboratory science skills through experimental projects. Photo courtesy of Susan Torte, Gulf Breeze, FL.

THEME

Shaping Agricultural Education For the Twenty-first Century

Two hundred and ten teachers of agriculture, teacher educators and state department personnel from 43 states left Orlando, Florida on October 16, 1988, with a new vision of agricultural education. These state and national leaders were participants in the National Conference on Agriscience and Emerging Occupations and Technologies presented by the National Council for Vocational and Technical Education in Agriculture. The conference was designed to accelerate curriculum reform in vocational and technical education in agriculture, and carried the theme "Today's Science, Tomorrow's Agriculture."

Orlando, Florida was selected as the site for this conference because of the Walt Disney EPCOT Center, the Experimental Prototype Community of Tomorrow. A major attraction at EPCOT is The Land, a six-acre pavilion showcasing new technologies that will play an important role in future agriculture. The Land also tells the story of good nutrition using audio-animaltronics figures, and emphasizes the interdependence between humans and their environment through a film entitled "Symbiosis." Dr. Hank Robitaille, Agricultural Director of The Land at EPCOT, played a major role in planning and conducting the conference.



By DAVID L. WILLIAMS AND JOHN POPE

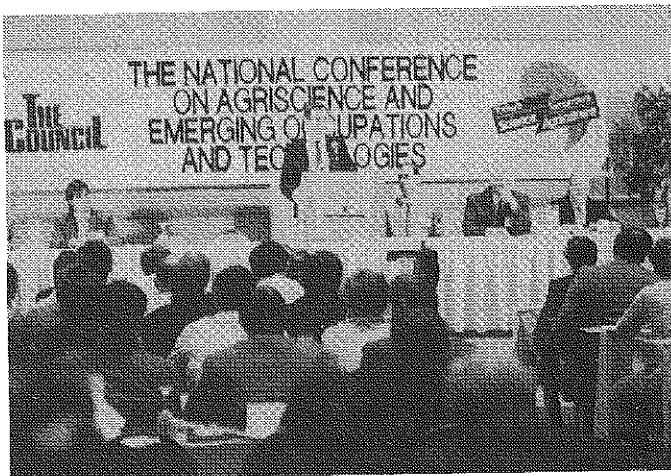
(Dr. Williams is Professor and Head of the Department of Agricultural Education, Iowa State University. Mr. Pope is Executive Assistant to the Chairman, National Council for Vocational and Technical Education.)

Other pavilions at EPCOT demonstrate the dazzling technologies of the years to come in the areas of energy, communications, space, seas, and transportation. EPCOT provides education about new technologies and futuristic developments in an entertaining way while appealing to the imagination and creativity of the individual.

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Shaping Agricultural Education For the Twenty-first Century

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Dr. Larry D. Case, Senior Program Specialist in Agricultural Education, USDE, addressing the opening session of the National Conference on Agriscience and Emerging Occupations and Technologies. (Photo courtesy of Andrew Markwart, *The National Future Farmer Magazine*).

Conference Activities

The conference introduced participants to new and emerging technologies and occupations, emphasized scientific principles related to agriculture, demonstrated classroom and laboratory techniques, provided curriculum materials, shared ideas for new supervised occupational experience programs and explored ways to emphasize agriscience in FFA, PAS and NYFEA. Special features of the conference included the following:

- Workshops on crop science, animal science, water resources, agricultural engineering technology, biotechnology, integrated pest management and food technology. There is an explosion of new technologies and occupations in agriculture.
- Field trip to the Controlled Ecological Life Support System (CELSS) at Kennedy Space Center. Agriculture will play an important role in future space missions. Plants will be used to assist in regenerating oxygen, water, and food from gaseous liquid and solid wastes produced from living in space. Aquaculture has the potential to supply food for people living in space.
- Horticulture demonstrations at the EPCOT Center. New technologies are flourishing in floriculture, plant propagation and landscape design.
- Field trip to a fish farm. Aquaculture is a growing industry in the United States with emerging technologies and occupations.
- Field trip to the Florida Citrus Research and Education Center. Biotechnology is providing significant advances in the citrus industry.
- Tour through The Land greenhouses. New technologies provide new ways for growing food and fiber products.
- Presentations by leaders in agriculture and education. Science will play an important role in tomorrow's agriculture. Agriscience must be emphasized in vocational and technical education in agriculture. Emerging

technologies will yield new occupations requiring education in agriculture. The demand for agriculturally-trained people is expected to exceed the supply in the near future.

Agricultural Developments

The following agricultural developments were identified at the conference that have major implications for planning and conducting future educational programs in agriculture:

- Agriculture is a changing industry.
- Science yields technology.
- Scientific principles are applied in agriculture.
- Agriculture will play an important role in future space missions.
- Biotechnology promises significant advances for agriculture: more productive plants and animals; biological control of weeds, diseases and insects; additional nitrogen-fixing plants; and improved nutritional levels of food products.
- The agricultural industry includes nine functions: manufacturing, communicating, financing, selling and servicing, producing, transporting, processing, marketing and merchandising.
- Agriculture is a global enterprise.
- Aquaculture is a growing segment of the agricultural industry.
- Agricultural products are being used for non-food, industrial purposes, e.g. lubricants and biodegradable trash bags.
- Food science is a growing dimension of agriculture.
- The use of robots, lasers, sensors, and computers is expanding in agriculture.
- Drip irrigation conserves water and also provides advantages to plants.
- Integrated pest management combines technologies to improve crop production.
- The seas provide important resources for humans.
- Intercropping, a system of growing two or more crops on the same piece of land at the same time, is an important part of agriculture in many areas of the world.
- Hydroponics, the growing of plants in water (without soil), is an agricultural technology receiving new emphasis.
- The use of tissue cultures in agriculture shows significant promise.
- Genetic engineering has great promise in the plant and animal industry.
- Natural resources (soil and water) provide an important base for the agricultural industry.

Future Directions

While at the conference, state teams were challenged to develop a plan of action for infusing agriscience and emerging technologies into agriculture instruction when they return home. Some of the exciting state action plans for upgrading and expanding agricultural education programs shared at the conference included the following:

- Forming curriculum improvement committees.
- Evaluating teacher education programs.

- Upgrading agriculture programs.
- Developing agriculture courses to serve as science credits.
- Infusing agriscience into the curriculum.
- Emphasizing scientific principles in classroom and laboratory activities.
- Appointing task force to examine agricultural education.
- Cooperating with other states in developing new curriculum materials.
- Developing aquaculture programs.
- Developing agriscience laboratory activities.
- Expanding biotechnology instruction.
- Expanding SOE options.
- Expanding biotechnology instruction.
- Sharing conference information with other teachers.
- Providing inservice for teachers on new technologies by cooperating with universities.
- Upgrading the technical skills of teachers.
- Infusing agriscience concepts into the Agriculture in the Classroom Program.
- Changing instructional programs from "Vocational Agriculture" to "Agriculture Science and Technology."
- Developing an agriscience center at the FFA summer camp.
- Utilizing the scientific method in class and laboratory activities.
- Developing an institute training program to upgrade science and technical skills of teachers.

- Providing staff development in cooperation with other states.
- Maintaining occupational and vocational focus of the program.
- Building an agriscience library.

Upgrading and Expanding Programs

This conference could be described as a beginning point in shaping agricultural education for the twenty-first century. The conference helped agricultural education leaders recognize that the pipeline is full of new technology impacting agriculture. New developments in science will continue the flow of emerging technologies, and new technologies will result in new occupations in agriculture. Participants left the conference with an understanding that programs must be upgraded and expanded to reflect the entire agricultural industry. John Block, former U.S. Secretary of Agriculture, in the closing session of the conference, told the participants that vocational and technical education in agriculture had to shift from a focus on the 2% of the population involved in production agriculture to the 20% of the population involved in the entire agricultural industry.

As participants were preparing to leave the Florida dreamland, they were reminded of the following words inprinted on one of the EPCOT pavilions, "If you can dream it, you can do it!" There was no doubt about the dreaming; participants had received a vision of future agriculture; but we will need to remind one another that "you can do it."

FEATURE COLUMN

Computer Technology But I Only Have One Computer

The national study of agricultural education has been completed and the National Academy of Science has issued its report. In that report, we are encouraged to increase our use of computer technology in the classroom. Many teachers would like to use the computer more in the classroom but are limited by one simple fact. Most classrooms do not have enough computers for each student to use; in fact some teachers feel fortunate to have one computer for the entire class. Whenever you want to use the computer in a demonstration you may have to move more computers into your room, or connect several monitors together, or try to schedule your class into the school's computer lab. Each of these solutions requires extra time and effort, with the result that many instructors find it easier to forego the demonstration. The question still remains: How can you teach class with only one computer? Until recently, there was no satisfactory answer to that question. Now, there is an answer and it's called a data projection panel.

What is a data projection panel?

This is a new computer peripheral which uses an overhead



BY W. WADE MILLER, SPECIAL EDITOR
(Dr. Miller is an Associate Professor in the Department of Agricultural Education, Iowa State University.)

projector to project the image from your computer's monitor on to the large wall screen in your classroom. It uses liquid crystal display technology to project sharp images, even in 80-column format. Most panels display in monochrome; a dark blue or pale blue color. (RGB video card, or adapter) and sits on top of your overhead projector.

The data projection panel is useful in many ways. It can be used by you or your students. It allows you to "show"

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Computer Technology

But I Only Have One Computer

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students a concept in addition to "telling" them. For example, if you are teaching students how to duplicate a formula in a spreadsheet, you can show them how the commands work, rather than just tell them.

The data projection panel can be a tool to help you teach problem-solving or decision-making. Many computer programs allow you to vary the inputs. Each time you change the inputs, the outputs also change. You can pose "what if . . . ?" questions to your students and enter their choices to see how the results change.

This system can be used by your students in class. It is an effective tool to use for summarizing and reviewing. For example, students can come up to the front of the class and answer questions or demonstrate their knowledge of a computer program or application. They can show off their work.

In many cases, you can use the data projection panel to replace the chalkboard, transparencies, and handouts. You can write your class notes on a word processing program and display it to the class. You can use a graphics program (such as a paint or draw program) to create your own "transparencies." You can use a word processing program to give exams to your class.

What are the options?

Kodak made the first data projection panel, the DataShow, almost two years ago. It was an instant hit. Since

its introduction, several other manufacturers have brought out their own products and Kodak has improved its original product. Prices range from about \$750 to \$2,000. Some of the manufacturers of data projection panel are:

Brand	Compatibility
DataDisplay by Computer Associates	IBM PC, PS/2, Apple II, Macintosh
DataShow (several models) by Kodak EIKI	IBM PC, Apple II with adaptor, Macintosh IBM PC, Apple II with adaptor
InFocus PCV (several models)	IBM PC, Apple II with adaptor, Macintosh
MagnaView 200 by Dukane	IBM PC, Apple II
nView	IBM PC, Apple II with adaptor, Macintosh
PC Projector by Visulon	IBM PC, Apple II
Sharp	IBM PC, PS/2, Apple II with adaptor, Macintosh
Telex MagnaByte	IBM PC, PS/2, Apple II, Macintosh, Compaq

The data projection panel is one answer to the question on how to teach class with only one computer. It allows you to explain information and concepts by "showing" as well as "telling." If one picture is worth a thousand words, then this innovation is indeed valuable. In fact, you may find you want one even if you have a room full of computers.

THEME

Toto, I Don't Think We're in Kansas Anymore — Agricultural Education in a Land of Biotechnology

Rapidly evolving technologies have always pressured agricultural educators to keep abreast of developments and create fresh curricula. Biotechnology is no exception. Biotechnology is the collection of techniques used to influence living things at the cellular level to produce commercial products. The techniques of biotechnology range from genetic engineering to fermentation, and they are among the most complex and widely applied innovations of our time. Biotechnology is already applied to agriculture in more ways than most of us suspect. How will we prepare future agriculturalists to use it competitively?

The Educational Need

Dairy, beef, and pork producers' recent use of genetically engineered growth hormones provides an example of the



BY DAVE SMITH

(Mr. Smith is Education Projects Manager, North Carolina Biotechnology Center, Research Triangle Park, North Carolina.)

need to teach about biotechnology. As the hormones are first tried, farmers need to know of the new possibility to

increase milk, beef, and pork production. They also need to know of problems associated with the hormones. To plan business strategy, farmers need to determine if the hormones will damage the competitiveness of small operations, or pose a marketing risk. Finally, although farmers do not need to learn about genetic engineering, they do need to learn how to administer the hormones.

Similarly, genetically engineered plants now under development could allow farmers to control ripening and harvest to maximize profit in fluctuating markets. New herbicide-resistant crops will create flexibility in crop-rotation patterns. Control of ripening and greater flexibility in crop rotation will complicate agricultural strategies. For horticulturalists, plant tissue culture techniques will require learning to manipulate and manage a new technology. In the future, biotechnology will potentially make agriculture more like agriscience. To integrate biotechnology into agriculture, farmers and extension agents will need to learn the advantages and disadvantages of innovations, learn to plan competitive business strategies, and learn to use new products or processes.

Many new products of biotechnology are on the immediate horizon. Last March, the USDA licensed a genetically engineered vaccine against a major swine disease, and the EPA approved a new biological nematicide. In April, the USDA licensed equine gamma globulin manufactured by a biotechnology company, and the patent office issued the first patent on a genetically engineered mammal. In May, the EPA registered a new biological pesticide used against Colorado potato beetles and granted a permit to field test a bioinsecticide for controlling gypsy moth and spruce budworm. The innovations below will contribute to a predicted 60% annual growth in agricultural biotechnology output and \$2 billion in sales by 1995. This adds up to a large task for agricultural educators.

Now on the Market:

- genetically engineered animal vaccines and growth-promoting hormones.
- simpler and more effective diagnostic tests for plant and animal diseases.
- DNA analysis techniques identifying traits early in the development of plants and animals. The techniques greatly shortcut traditional breeding methods.
- techniques to transfer embryos from prize breeds to existing livestock.

Under Field Test:

- varieties of genetically engineered plants resistant to herbicides, insects, and diseases.
- genetically engineered plants with improved nutrition, color, texture, and harvesting qualities.
- biological antifungal agents, biological nematicides, snail killers, biological herbicides, and many biopesticides.
- genetically engineered plant/bacteria systems better able to fix nitrogen.

Under Development:

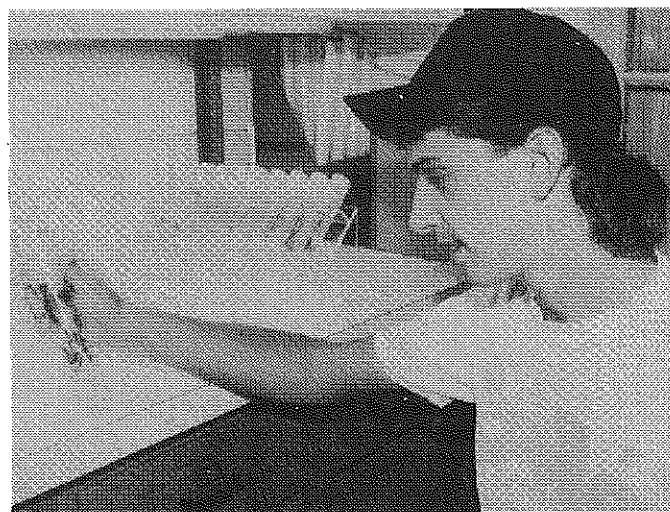
- food products and nutritional supplements from yeast and milk whey, and other food by-products.
- efficient mass production of plants through plant tissue culture and other new plant propagation technologies.

- biological detection of minute amounts of pollution in the air, soil, and water.

Art Bundy, a retired farmer, believes that most farmers will accept biotechnology if they see it brings them an economic advantage. However, he believes that farmers must first be educated about biotechnology. Mr. Bundy says that extension, farm magazines, and agricultural suppliers have been reliable educators for use of existing technologies, but biotechnology will add to their responsibility. Mr. Bundy feels it is especially important to give commodity groups enough information to be persuasive with legislators on the subject of biotechnology. A properly informed legislature would be more likely to fund land grant institutions to conduct research related to local farmers' specific needs.

Who Is Responsible for Biotechnology Education?

Many groups appear willing to take responsibility for teaching about biotechnology in agriculture. Vocational agriculture, 4-H, and FFA instructors are already introducing biotechnology to future farmers. Through the Carl Perkins Vocational Education Act, the United States Congress appropriated funds to help vocational students learn about new technologies. The USDA, state agricultural extension programs, land grant universities, and state departments of agriculture are also assuming educational responsibility. Agricultural publications are beginning to introduce current farmers to agricultural biotechnologies. Agriculture curricula in universities, independent colleges, and community colleges have begun to teach agriculturalists in all fields how to take advantage of biotechnology.



A high school vocational agriculture student examines a plant grown from a single cell using tissue culture techniques.

On October 25, 1988, the USDA, USDE, and National Academy of Sciences sponsored a one-hour videoconference titled "The National Forum on Agricultural Education in the United States." The forum focused on a 1984 study of agricultural education in secondary schools called "Understanding Agriculture: New Directions for Education." On November 17, 1988, the USDA's extension service, the Cooperative Extension Service, and Virginia Polytechnic Institute offered

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Toto, I Don't Think We're in Kansas Anymore — Agricultural Education in a Land of Biotechnology

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a two-hour televideo on agricultural biotechnology for state agricultural extension programs. State extension specialists and county agents had the opportunity to learn about agricultural biotechnology from scientists and agriculturalists. During the broadcast, extension agents were able to discuss the program with experts in Virginia by phone.

In North Carolina, a state-funded biotechnology center is working with Beth Wilson, a progressive vocational agriculture teacher to develop and field test biotechnology lessons in the horticulture curriculum. The North Carolina Biotechnology Center is a non-profit corporation that promotes biotechnology research, business, and educational projects statewide. As a part of its educational mission, the Center is conducting an ongoing project to educate the state's biology teachers about biotechnology. The project aims to educate 400 teachers by 1990. The effort to create agricultural biotechnology lessons is an adjunct to that project. The Center is also preparing to assist the state in assessing educational needs and developing educational materials on agricultural biotechnology. Technological development agencies rarely conduct educational programs, and the North Carolina Biotechnology Center's effort leads the way for state-sponsored initiatives in biotechnology education.

Corporations involved in agricultural biotechnology are an essential source of information and training about the use of biotechnological products. Monsanto is a leader in this field, producing readily available videotapes and brochures about agricultural biotechnology. The Industrial Biotechnology Association is another important information source. Industries and associations such as these distribute information and help train the users of their products, but do not usually undertake broader educational programs.

Farm associations of various types also have educational responsibility. In North Carolina, the Farm Bureau's "Ag in the Classroom" program is integrating agriculture into many aspects of the K-12 curriculum. The "Ag in the Classroom" program infuses agricultural lessons into science, social studies, and other areas, and is looking to incorporate biotechnology. The Farm Bureau, various seed trade organizations, commodity groups, and livestock producers' groups publish magazines that are important sources of agricultural biotechnology information for farmers.

What Should We Teach?

Many educators question what needs to be taught. How much should be taught in vocational agricultural programs? Is biotechnology likely to have an impact that would warrant a specialized curriculum effort? Should information on biotechnology be integrated into all aspects of agricul-

ture curricula? Which existing resource materials can best help teach about biotechnology in agriculture?

In 1984, Iowa's state department of education established a Technical Curriculum Improvement Cadre of educators and businessmen to help shape Iowa's vocational agriculture curriculum. The Cadre's Biotechnology Technical Committee listed the major topics in agronomy, horticulture, and animal science essential to a program they called "Agriculture Science and Technology." An excellent article written by the committee's chairman, Robert A. Martin, appears in the May 1988 *Vocational Education Journal*. During its first two years, Iowa's model vocational agricultural program teaches career awareness and basic principles of biotechnology's application to agriculture. Secondary and post-secondary programs allow students to specialize in an area of agriculture.

In 1987, the national FFA, the USDA, and Ag Biotechnology News collaborated in a curriculum development conference designed to establish content guidelines and educational methods. In the fall of 1988, the first results of that effort were unveiled at another conference.

New curricula will likely emphasize career awareness because biotechnology is creating many unexpected opportunities. For instance, it is likely that new high-value crops will be developed, enabling farmers to produce new raw materials for pharmaceuticals, specialized proteins, and oils. The advent of new high-value crops will be especially important for small farmers and people seeking specialized careers in the supply or processing of emerging agricultural products.

New curricula will also emphasize the impact of biotechnology on the international agricultural economy. Breakthroughs in biotechnology will likely have a profound impact on international competition. For instance, genetically engineered bacteria can now cheaply produce genuine vanillin. Since this will likely put vanilla growers out of business, knowledge of this breakthrough is essential. Breakthroughs in biotechnology might give one nation the capacity to outcompete another in a relatively short time. Educators will need to explain this new kind of market volatility.

Other areas of emphasis are the impact of biotechnology on the environment, energy, and resource conservation. New biotechnological techniques will allow for sensitive monitoring of soil and water, expanded low-till farming, and decreased use of pesticides. If nitrogen-fixing or drought-resistant crops are developed, they will decrease use of fertilizer and water. Agricultural educators will soon begin to teach the new soil and water monitoring techniques, and speculate with their students on possible changes to come from nitrogen-fixing or drought-resistant plants. An even more significant environmental impact of biotechnology could result from new techniques to produce energy from plants. If the United States attempts to supply 20% of its energy needs from plant products, grain production would have to be increased by 150%. The environmental impact of such an increase would be enormous, and would require a significant educational effort.

Farmers must also learn the appropriate use of technology for specific types of farming operations. Small tobacco farms with little access to capital will apply biotechnology very differently than large grain operations. Small low-capital farming operations need to maximize yield at low cost while maintaining soil fertility. Inexpensive biotechnological soil conditioners, alternative high-value crops, and inexpensive non-chemical techniques against pests, diseases, and weeds are most useful for these small farms. Large operations will likely concentrate on improving the efficiency of traditional crop varieties, applying more expensive biotechnologies if benefits justify cost. Agricultural educators will need to help farmers choose appropriate technologies.

The Future

Agricultural biotechnology will create new problems for agricultural educators. Some authors note that agricultural research at land grant universities has shifted toward the basic general science involved in biotechnology, and away from the specific needs of the local agricultural community. Critics say that as a result, land grant universities might erode their funding base and produce too little information of use to agricultural extension agents and farmers. Such an imbalance could pose difficulties in creating viable agricultural curricula.

The future of agricultural biotechnology is difficult to predict: some analysts predict explosive growth in agricultural biotechnology while others claim that growth will remain stable at its present rate. Those who argue for explosive growth point to the far-reaching power of our ability to place specific genes in specific organisms, greatly short-cutting and refining traditional breeding. Tissue culture, monoclonal antibody diagnostics, DNA probes, and a host of other forms of biotechnology are also applied to agriculture.

However, biotechnology has serious limitations that agriculturalists must consider. Most crop and animal biotechnologies now involve single gene traits such as specific

disease resistances. The single-gene traits are refinements but are not major modifications that drastically increase productivity. Some research is now directed at major genetic modifications that would improve photosynthesis or allow more plant varieties to fix nitrogen, but these multiple-gene traits are very difficult to engineer, and researchers might take a long time to solve the problems involved. Furthermore, genetic engineering is currently limited to a few varieties of dicot plants, including such plants as tobacco, tomatoes, and soybeans. Genetic engineering of all monocots such as corn, or gymnosperms such as pine trees is still in an early experimental phase. No one can say when it will be possible to manipulate significantly the genes of these plants. Biotechnology does not offer limitless immediate possibilities. It is still a collection of techniques in its early stages.

A Do-able Task

The need to learn about biotechnology extends from high school students to legislators, and the gap between agriculture and science is narrowing. Through genetic engineering, today's tobacco farm could become tomorrow's factory producing raw materials for pharmaceuticals. As a result, the education of tomorrow's agriculture worker will become more complex and more interesting. High school vocational agricultural courses could begin to hold more interest for academic students interested in biochemistry and genetics.

The increasing complexity of agricultural technology make the educator's job seem difficult. However, the applications of biotechnology are not now limitless. Biotechnology will be limited to specific areas in the near future, and the new products techniques are understandable and teachable. If the concepts and products of biotechnology are well taught, we will achieve a smooth transition to agriculture that uses this technology. Much of this transition from Kansas to Oz is in the hands of educators.

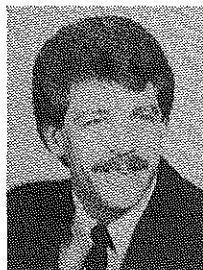
FEATURE COLUMN

The Software Sampler

Software Sources

The superior agricultural productivity of the United States has resulted from the rapid integration of technology. Microcomputers are an example of this technological integration. The use of microcomputers on farms and in agribusinesses is now an essential part of good management.

As agricultural educators, we have tried to keep pace with our industry by providing instruction in agricultural applications of the microcomputer. Early adopters found many problems associated with their enthusiastic use of this new technology. Not only was the hardware expensive, but software related to agriculture and particularly agricultural education was almost nonexistent. Many teachers became frustrated or lost interest trying to develop or modify programs for agricultural instruction. In less than ten years the



BY KERRY S. ODELL, SPECIAL EDITOR
(Dr. Odell is an Assistant Professor of Agricultural Education at West Virginia University.)

problem has changed from one of scarcity to one of plenty. Hundreds of software distributors have sprung up, each making a concerted effort to get your business.

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The Software Sampler Software Sources

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The source of computer programs is an important consideration for anyone purchasing software. This is of special concern for teachers of agriculture because we have precious few dollars to spend. Software, review and purchase policies should be closely scrutinized. Does the supplier provide a review or trial period? What are the purchase policies? Are replacement copies and updated versions available free or at a reasonable price? What is the return policy for defective software? What kinds of user support is available? Answer these questions to your satisfaction before purchasing software from a supplier.

Shipping procedures and times are factors to consider if purchasing software from a mail order or telephone supplier. You can avoid these acquisition problems by purchasing software from a local computer dealer, but the cost may be higher.

If you enjoy catalog shopping, you will have a hay day looking for agricultural software. The sources of agricultural software continue to grow at a substantial rate. Many of the agricultural textbook companies now carry agricultural software. State instructional materials services are also good sources. Another convenient and comprehensive source is ACCESS. Sponsored by the National FFA Supply Service, ACCESS provides agricultural software for all major brands of computers at retail prices. By paying an annual membership fee of \$45.00 you can purchase software from ACCESS at up to 50% off the retail price.

Computer software consortiums or institutes are good sources of inexpensive agricultural software. These groups gather and evaluate software developed by non-commercial individuals or groups. Consortiums then offer these programs to members at a reasonable cost. If you are considering the purchase of software from one of these sources, be sure to check prices. Sometimes the software is cheaper from the developer (primary source) than distributors (secondary sources).

Remember local computer and software businesses. Many carry a good supply of general-purpose applications programs. They may also be able to purchase agricultural soft-

ware directly from the developer, thereby saving you a few dollars.

The once frustrating problem of finding good agricultural software no longer exists. It is now replaced with an equally perplexing problem, getting quality software at a reasonable cost. There is an abundance of agricultural software out there. It just takes a little time to go through the catalogs and shelves to identify the best buy.

The following are only a few of the agricultural software sources that may be of interest to you. If you have any favored sources not listed here, please send them to me. Happy computing!

ACCESS (Operated by the National FFA Supply Service)
5632 Mt. Vernon Memorial Highway
P.O. Box 15160
Alexandria, VA 22309-0160
Information: (703) 360-3600
Orders: (703) 780-5600

A.C.S. Software Publishing
256 Warner Milne Rd. #4
P.O. Box 5034
Oregon City, OR 97045
1-800-843-8493
In Oregon: 656-2175

Deere & Company
Distribution Service Center
1400 Third Avenue
Moline, IL 61265
(309) 757-5903

Midwest Agribusiness Services, Inc.
6739 Glacier Drive
West Bend, WI 53095-9360
(414) 629-5302

National Farm Book Company
Box 206
Amherst, WI 54406

Northeast Computer Institute
1315 S. Allen Street
State College, PA 16801
(814) 863-4678

Attention — Coming May, 1989

The Profession Reacts — The National Study

Stacy Gartin, Theme Editor
West Virginia University

Agriscience and Technology: The Answer to Program Revitalization

Declining enrollments, a lack of student interest, and an inability to meet minimum class sizes as required by the State Board of Vocational Education were problems of a vocational agriculture program. Does this situation sound familiar?

Despite a population of approximately 900 students in grades 9-12, this problem faced the administration and vocational agriculture instructor at the Lake Area Vocational Center in Devils Lake, North Dakota. Something obviously needed to be done which would turn the program around.

With the help of the vocational agriculture advisory committee, several factors were identified which contributed to the decline in vocational agriculture enrollments. Some of those factors were: (1) that very few students sought employment in production agriculture upon graduation; (2) that student interest in production agriculture was low due to the stressed farm economy; and (3) that the agriculture curriculum could not compete with other sciences offered at the Devils Lake High School.

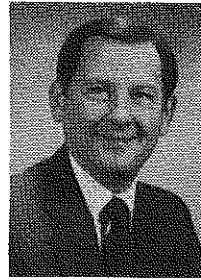
The Solution

In consultation with the program advisory board, the development of agriscience and technology in vocational agriculture was made a priority for program revitaliation. "Biotechnology" and "Principles of Technology" were the two courses identified for development and subsequent administrative approval.

Additionally a workshop entitled "Teaching Science in Agriculture" was offered during the summer of 1987 at North Dakota State University coordinated by faculty in the Department of Agricultural Education in cooperation with several faculty members and departments in the agricultural sciences. This course enabled vocational agriculture teachers to gain awareness of new science concepts such as tissue culturing that could be adapted and taught in secondary programs. Dennis Peterson, Devils Lake vocational agricultural instructor, attended the workshop and then developed the biotechnology class currently in place at the Lake Area Vocational Center. Student interest in the class has been excellent.

Whereas tissue culturing is presently the primary emphasis of laboratory work, individual units in the year-long biotechnology class include:

- Opportunities in Biotechnology
- Exploring Biotechnology Applications
- Biotechnology in Industry
- Biotechnology in Agriculture
- Genetic Engineering Technology



By VERNON D. LUFT AND DENNIS PETERSON

(Dr. Luft is Professor in the Department of Agricultural Education at North Dakota State University. Mr. Peterson is Vocational Agriculture Teacher at Lake Area Vocational Center, Devils Lake, North Dakota.)

- Human Applications of Biotechnology
- Environmental Considerations of Biotechnology
- Regulations of Biotechnology
- Biotechnological Products and Patents
- Role of Higher Education in Biotechnology
- International Aspects of Biotechnology

The "Principles of Technology" course is an applied physics course developed by the Center for Occupational Research and Development (CORD). Although it is an applied physics course, it was adopted into the vocational agriculture program largely because the instructor was willing to teach it and because it relates to many of the principles emphasized in agricultural mechanics instruction. Specific concepts include: force, work, rate, resistance, energy, power, and force transformers.

Both courses were first taught during the 1987-88 school year, and both attracted a new clientele of students to the vocational agriculture program. Students enrolled in the courses, which included two from the nearby North Dakota State School for the Deaf, had a wide range of learning ability.

The Results

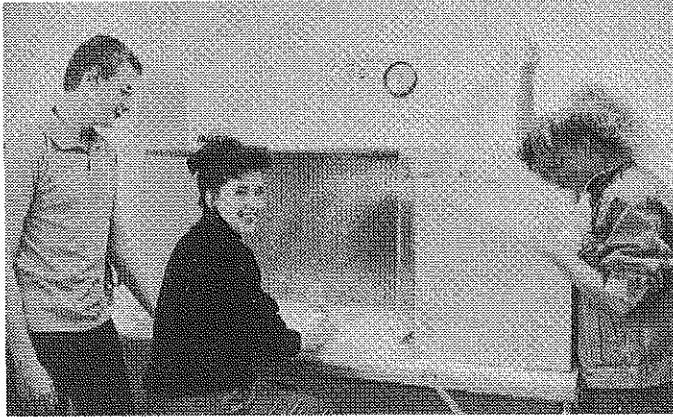
Many positive results occurred after only one year of the revised program. Most important among them was that a dying vocational agriculture program has been revitalized! Other benefits include expanded offerings in the agrisciences and technology, the development of curriculum, and an articulation agreement developed in cooperation with the local community college.

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Agriscience and Technology: The Answer to Program Revitalization

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This year the vocational agriculture program at the Lake Area Vocational Center includes the biotechnology course, two levels of "Principles of Technology," and "Introduction to Technology." The "Introduction to Technology" course is designed to apply basic mathematical skills to technology and agriculture. It was designed so that students with limited mathematical skills could gain technological concepts at their own level of understanding. The biotechnology course currently has a waiting list of students who want to enroll. An additional section of the class will be added next year.



Biotechnology students prepare materials for plant tissue cultures. (Devils Lake Daily Journal photo by Joy Day.)

"Agricultural Skills," another course in the program, is available to ninth and tenth grade students. This class is heavily oriented to agricultural mechanics but also applies basic mathematical skills to the other concepts taught in the course.

A competency-based unit of instruction on biotechnology/tissue culturing was developed as a result of Peterson's year of experience teaching in the program. Developmental support of the unit was provided by the Mid-America Vocational Curriculum Consortium, and a draft copy of the unit was distributed to the vocational agriculture teachers of the state during their annual summer vocational conference.

Recently, an articulation agreement has been developed between the University of North Dakota-Lake Region Community College (UND-LRCC) and the Lake Area Vocational Center whereby high school students can participate in agricultural management and computer science courses at

the community college. Conversely, college students can participate in the biotechnology course at the vocational center and receive college credit. Six students are presently involved in this exchange. An evening course in biotechnology is also being developed as part of the community college outreach program.

Difficulties

Two primary difficulties have surfaced relating to the development of science and technology in agriculture: the need for curriculum materials and for teacher inservice.

Biotechnology curriculum for the secondary level is currently being developed, but the gathering of available resource materials is a piecemeal effort at best. Materials suited for high school students are greatly needed. "Principles of Technology" has well developed physical science materials, but those materials will need to be revised so that the principles and concepts may be integrated with agricultural technology.

Continuing education opportunities are essential for further development of instructor competence in the agricultural sciences. Many vocational agricultural teachers completed their science courses before much of the current technology was taught. Ongoing efforts must be made to provide teachers with opportunities for updating and keeping current their skills in science.

Conclusion

The implementation of an agriscience and technology curriculum requires a great deal of support from many sources. Enthusiastic support for the revitalization of the vocational agricultural program in Devils Lake was provided by the advisory board, the school administration, and the Board of Education. The Agricultural Education Supervisors of the State Board for Vocational Education showed exceptional leadership and support. Technical and program assistance were contributed by staff in several departments at North Dakota State University. In addition, the cooperative effort with UND-Lake Region Community College was outstanding.

Commercial development of biotechnology is rapidly growing, and many career opportunities exist. It is an exciting and growing profession for which vocational agriculture teachers can begin preparing students. In Devils Lake, agriscience and technology provided the answer to program revitalization. It may spark additional interest in other programs as well.

Attention — Coming July, 1989

Vocational Agriculture Education — Value Adding

Lou Riesenber, Theme Editor
University of Idaho

The Agriscience Teacher of the Year Program

We all understand that agriculture is a complex, dynamic and rapidly changing industry playing a major role in the current world-wide explosion of scientific research and technology. To keep pace with the agricultural industry, our vocational agricultural programs must be involved in these technological advancements. In an effort to encourage teachers of agriculture to emphasize the role of science in agriculture, and to begin incorporating new areas of technology into their curriculum, the Agriscience Teacher of the Year award program was created. It is a special project of the National FFA Foundation and is sponsored by ICI Americas Inc., Agricultural Products, Wilmington, Delaware.

As I have the opportunity to travel across the country, I am seeing and hearing exciting, positive movements towards the future. I am witnessing more industry-related technology incorporated into the classroom to give our vocational agriscience students a competitive edge in job placement and in many cases, higher education. True, it's just a beginning, but that's just what we need. I am very excited about AGRISCIENCE, but more importantly so are our students. Their eagerness and enthusiasm for agriscience is the real explosion. I trust our vocational agricultural community will respond to our students' enthusiasm and maintain a viable network of futuristic leadership that will bring our agricultural curriculum up to date and keep it that way.

The Agriscience Teacher of the Year program, and the new Agriscience Student of the Year program, are serving as excellent catalysts to help vocational agriculture and FFA move forward into the twenty-first century.

These two programs are stimulating teachers and students to:

- Utilize creative techniques in understanding advanced aspects of the science and agricultural world.
- Relate real situations with laboratory experiments.
- Conduct basic scientific research.
- Learn and practice critical thinking skills.
- Better understand and appreciate how science interrelates with agriculture.

With proper and purposeful publicity, these programs can also increase the public's awareness of the role of science in agriculture — stretching their "agricultural perception" and enhance the image of the agricultural education program.

The Need for the Program

This incentive and encouragement program for agricultural teachers comes at a critical time when our vocational agricultural program emphasis and curriculum need to reflect the shift from traditional production agriculture to



BY SUSAN FORTE

(Ms. Forte is a former agriscience teacher and currently a National Agriscience Ambassador, sponsored by USDA.)

the areas of agricultural business, marketing, research and education, so that our students have the competitive advantage as they enter the employment ranks.

Agriscience is not new. We have always had science in agriculture. But we have arrived at a time when it is important for our students that we emphasize and position the science we already teach, increasing its visibility. At the same time, agriscience is new, because it encompasses the infusion of new and rapidly developing technologies into our programs.

Science in the Curriculum

My involvement in the first Agriscience Teacher of the Year recognition program as the 1986 Southern Region national finalist made me (and others) realize just how much science I teach in my vocational agricultural curriculum. It wasn't perceived as science, because I did not emphasize it as such, nor did I make it visible enough. I realized I had been relating applied agricultural skills and concepts to pure science concepts. Much of this was due to the fact that I enjoyed it and wanted to share it with my students. The instruction seemed to provide students with an understanding and meaning for many of their daily activities and special projects.

Project Examples:

Planting Seeds/Raising Seedlings

Planting seeds and raising seedlings is a rather common agricultural skill. Class discussions include topics such as media, moisture, planting depth, temperature, aeration, etc. Each student planted their own crop. During the process of raising and growing the crop, we did experiments studying these related scientific phenomena: Seed Dissection, Photosynthesis, Respiration, Transpiration, Germination, Genetics, Auxins, Absorption vs. Adsorption. The more advanced students conducted basic research on the effect of various auxins on flower bud development of gerbera daisies.

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The Agriscience Teacher of the Year Program

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Listing/Studying Nutrients Supplied by Various Feeds

We listed nutrients, examined them, learned to identify, handle, mix, weigh and feed them to animals. In addition, we did experiments studying these related scientific principles: solubility; metabolism (energy transfer); caloric values; decomposition; and the food chain. Advanced students conducted basic research with feed rations deficient in either minerals or vitamins and their resulting effects on chick development. We used basic laboratory equipment during our experiments: microscopes, stereoscopes, test tubes, bunsen burners, fans, funnels, flasks, petri dishes, and various chemicals. Students actually learned why things occurred and why they had to perform certain tasks very carefully and often many times.

Other Science Project Ideas

Science has two categories, **pure and applied**. Pure science is developing new principles and products. **Applied science** is putting those new principles and products to work. Our vocational agricultural students put those scientific principles, phenomena and laws to work in **agriscience**.



Students analyzing wheat quality have the classroom computer available for data entry and processing. (Photo courtesy of Jay Bohnenblust, Clay Center, Kansas.)

There are many other examples like these that agricultural teachers across the country are using. Some of the "agriscience" activities I see agricultural teachers and students working with include: embryo transfer; artificial insemina-

tion; in-vitro fertilization; estrus synchronization; and animal genetics. Teachers and students should investigate bioethics. They could conduct activities involving the following: analysis of agricultural chemicals on water quality; Land-Sat monitoring of crops through satellite imagery; developing ration formulation programs as well as cash flows, budget sheets, beef performance testing records and fertilizer formulation programs through the use of integrated computer programs. Other ideas include: analyzing variables affecting plant growth; plant tissue culture; animal tissue culture; computer-based market charting; computer-assisted record keeping and management; enzymatic browning of fruits and vegetables; oxidative rancidity of food components; watering plants in zero-gravity; and implanting hormones in fish.

The Challenge for Teachers

We need to do a better job of cross-referencing the agricultural skills that we do teach with their corresponding science competency and scientific principle. It would make everyone, ourselves, our students, fellow teachers, counselors, administrators, and parents more aware of and more appreciative of the "science in agriculture." We, perhaps, also need some curriculum development and inservice for agricultural teachers to "cue" them into knowing how and when to teach and use corresponding scientific principles.

My participation in the **Agriscience Teacher of the Year Program**, and the **NASA Teacher in Space Program**, makes me realize how much work we have before us to begin infusing new and rapidly developing technologies into our instruction. Here, I believe, lies our greatest challenge. Because it is here that we must develop completely new instructional curriculum in areas such as: Biotechnology, Robotics, Satellite Remote Sensing, Aquaculture, Food Technology, Computers, Management, Agricultural Law (Bioethics), International Marketing, etc. It is in these numerous areas of developing technology that agricultural teachers need education and inservice training. We need leadership and assistance from our state staffs, our teacher educators, our land grant colleges and USDA. We as teachers of agriculture, in turn, need to provide leadership by catalyzing change, accepting the new and moving into the future.

Summary

AGRISCIENCE is not a new or additional program, but merely a new approach to encouraging students to study agriculture and to consider agricultural careers. **AGRISCIENCE** still utilizes those teaching methods that have made the vocational agricultural program so successful, and should encourage students to investigate (question) new ways of determining solutions to problems encountered in their agricultural enterprises. Through **AGRISCIENCE**, we hope to develop creative, adaptable students who will meet the demands of a changing agriculture and a changing world.

Natural Resources And Forestry: More Than Fishing and Cutting Trees

Natural resources programs in vocational agriculture have traditionally focused on forestry, providing instruction in the areas of forest management, harvesting, product utilization, and business management. In addition, most programs offer some instruction in wildlife management and fisheries (both salt and freshwater). Highlights from an east coast natural resources program and a west coast forestry program reveal instructional needs and activities in these two areas.

New Career Options for Natural Resources Students

Many traditional agricultural education programs are not meeting the needs of all our students or the needs of industry or society. Many vocational agricultural curricula offer unique natural resources programs in response to these needs. In some locations, aquaculture (fisheries, commercial fishing, fish farming) is an area of growing importance. Our problems with solid waste disposal, air and water pollution also indicate to us that students must be prepared to deal with these problems and provide input to the labor force.

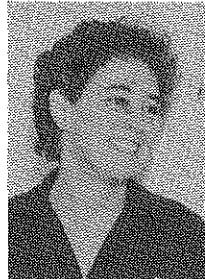
Aquaculture as an Area of Study

Aquaculture is a unique aspect of vocational agriculture. Some programs have existed for many years involving students in the local fishing industries. Students acquire basic skills unique to the industry such as net making and mending, trap construction, boat handling, navigation, boat construction and repair, and product handling and storage. Students are also able to apply those skills taught in most agricultural programs (i.e. welding, marketing, hydraulics, engine repair, etc.) in a setting that seems far removed from traditional land-based agriculture.

Connecticut is in the process of revitalizing oyster beds, a once productive industry. Students have been involved in projects ranging from cleaning out years of accumulated muck from creeks and streams to the laying out of clean shell for spat collection to the harvesting and transplanting of seed oysters for grow-out in certified clean waters. These activities are correlated with other agricultural areas — tilling the soil, planting seeds, and transplanting stock. Unfortunately, technology in aquaculture lags behind that of agriculture. It is only recently that we have discovered that cultivating the soil under water encourages shellfish production.

Education in Environmental Science

Another area that is not often part of an agriculture curriculum is that of environmental protection. Many agricultural programs include basic units covering environmental issues. Agricultural industries depend on the quality of air, water, and soil. Environmental problems have become more of a concern in the past few years and this will undoubtedly



BY SHELLY ROY AND CLARENCE PEARSON

(Ms. Roy is a National Resources Instructor at Ledyard High School in Ledyard, Connecticut. Mr. Pearson is a Vocational Agriculture and Forestry Instructor at Elma High School in Elma, Washington.)

result in the need for more individuals to be employed in the testing, management, and regulation aspects of environmental protection.

Increasing numbers of private companies provide testing services and more communities now employ environmental planners. We are beginning to see the affects of acid rain, ocean dumping, and ground water pollution. The greenhouse effect may be proving to be a reality. It appears that we don't truly understand the consequences of our actions and although we have learned some lessons we fail to apply this knowledge to other situations. Ocean dumping is a good example. We wouldn't dream of allowing sewage sludge to be deposited in a lake or pond but the ocean is so large and far away we don't notice it. Although we don't know for certain, it appears this may be developing into a very serious problem for coastal areas with respect to recreation as well as fishing. We need to train students to see beyond next week or next year in finding solutions to environmental problems.



After selecting Super Tree research sites, the areas are fenced to keep out deer and rabbit. The area is then carefully measured and pinned to receive the tree seedlings. (Courtesy of Clarence Pearson, Elma, WA.)

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Natural Resources and Forestry: More Than Fishing and Cutting Trees

(Continued from Page 17)

Students need to understand the interrelationships that exist in our environment and thus, the consequences of their actions. Only with this understanding can they adopt or develop practices and technology that will prevent environmental problems in the future. Working with students to increase their environmental awareness can be easily incorporated into most curricula. Vocational agriculture needs to address environmental concerns and prepare students for employment in environmental fields. Basic skills such as collecting and testing procedures can be learned in high school but students may need further training.

International Competition and Our Educational Needs

The lag in technology is greater when compared to that of other countries. Many European and Asian countries, particularly the Soviet Union and Japan, are far ahead of the United States in aquaculture and fishing technology. Most fish and shellfish consumed in this country are imported; our fishermen cannot compete with other countries especially with the relatively primitive technology we use. Furthermore, there are few educational facilities in this country that offer programs in these areas. This poses a dilemma: where will interested individuals learn the skills needed to be successful in aquaculture and commercial fishing? Practical experience is one avenue but this may not provide the exposure to new and emerging technology.

Some programs do exist on the secondary and post-secondary levels. In addition, Sea Grant/Marine Advisory Service and fishing organizations provide workshops and seminars for industry personnel and educators. Instruction is needed not only for students and those in the industry but for present and future instructors as well.

We need to provide educational programs designed to teach commercial fishing skills, culturing procedures, product handling, marketing and business management. In addition, we need to support research into culturing and fishing technology. Admittedly, this goes beyond high school agriculture, but students can gain the practical experience needed on which to base future research. Of course, not all interested agricultural students are located near enough to water to gain practical experiences. A possible solution is to provide a "summer camp" in which students are able to participate in intensive "hands-on" activities unavailable in or near their own schools.

Agriscience Applications in Forestry

Modern day forestry education is more than growing trees just as agriculture is more than farming. The study of forestry is not possible without including sciences. More botany and biology can be taught in a forestry class which uses a land laboratory than could ever be taught in traditional classrooms.

The Elma, Washington Ag Boosters developed a unique contracting business with Weyerhaeuser and several other timber companies for students enrolled in the Elma School Forestry program so that they might "do, learn, earn, and

serve" simultaneously. These students have "hands-on" scientific experiences for one-half day, every school day, through the contracting business started in 1974. The students work with professional foresters and research personnel during the job experience. One job involves the "Super Tree" Program.

The "Super Tree" Program

The "Super Tree" program is industry's attempt to develop the fastest growing trees from the forest population. The original stock for this program was obtained by shooting limb tips off the trees with rifles, then grafting the tips on selected root stock. The grafted limb tips are grown into trees at the nursery site and become the seed orchard genetic pool for the "Super Tree".



Students work with professionals in measuring tree height and diameter after 3 years growth. (Courtesy of Clarence Pearson, Elma, Washington.)

In the seed orchard, nearly all seed is collected as the result of natural cross pollination. Some seedlings are developed with specifically known parents. Some people fear the development of a tree species with too narrow of a genetic background. In this program, some 300 or more totally unrelated trees are brought to the research site. This genetic base far exceeds what naturally occurs on the hillsides where trees reseed themselves to expand the forested area.

The "Super Tree" is an individual that grows fast, can withstand much competition, and grows well under a variety of stressful situations (poor soil, different hillside aspects, damaging soil organisms, frost pockets, etc.) It has small limbs, no tendency for multiple tops, and tends to be aggressive wherever grown.

Student Forest Researchers

Students have not only witnessed, but also have had a part in developing the "Super Tree" for the 21st century. They work continuously with research personnel laying out "Super Tree" test plots. The plots are carefully mapped, pinned, tagged, planted, and monitored. Yearly data are collected on each tree and each plot. This research work not only provides students with knowledge about cloning and tree bulk density, but also gives them a chance to study and compare the results. All of this highly specialized forestry research work requires competent mathematics and knowledge skills. Students collecting the data assume a great deal of responsibility and demonstrate an ability for extreme accuracy in their work.

Student Career Opportunities

In spite of what has been said about opportunities in the forest industry, especially with the economic slump of the mid 1980s, outstanding jobs are still available for those willing to work hard and prepare themselves. Most high school students lack job experience. The high school forestry program can prepare students for the opportunities by providing the necessary knowledge base and work experience. Industry and state departments of natural resources are willing to employ high school graduates when they discover the degree of job experience possessed by the graduates. In some instances, if the high school graduate plans to pursue upper level jobs in the forest industry, a college degree is needed.

Unfortunately, one of the dilemmas facing high school forestry programs is the lack of recognition by institutions of higher learning as to the scientific nature of forestry courses. Students are often limited in the number of forestry courses they can take in high school because they must complete the university's "acceptable" science requirements. It is time to communicate to the colleges the scientific basis of high school forestry courses. As instructors, we must be

flexible, receptive, and innovative toward developing a new label for our programs. We need to teach the scientific principles and concepts of forestry, along with applied experiences, if we are to attract students into one of the most in-depth learning programs offered in the secondary school.

Teacher Education

Instructor training is essential if students are to have access to educational programs which meet our future environmental challenges. Emerging technologies in forestry represent futuristic trends and the cutting edge for the industry. As a forester, I have always taught myself to stay away from the cutting edge as in there lies the danger. Forestry educators definitely need to don their traditional chaps, hard hat, axes, and boots as they teach basic forestry harvesting and management skills. However, teaching forestry for the future also requires college level forestry courses. In addition, other agricultural science courses such as horticulture and natural resources should be included in the college curriculum. The changing nature of our society demands quality instructor preparation and continued education if we are to meet the demands of forestry students in the future.

FEATURE COLUMN

Teaching Tips

Teaching and Using Science Principles in Agriculture - Hydraulic Lifts

We are now in the process of making curriculum changes in our secondary agricultural program by seeking meaningful ways to integrate more science. The teaching tip described herein follows this emerging trend. It was presented at a recent agricultural workshop by Dr. Gary Trammell, Associate Professor of Chemistry at Sangamon State University in Springfield, Illinois.

Objective:

To demonstrate how hydraulic lifts operate by application of Pascal's Law.

Materials Needed:

(Note: These items are inexpensive and are available from any biological supply company.)

- two plastic syringes of different sizes
- plastic tubing to connect tips of syringes
- water
- food coloring

Procedure:

Fill each syringe with colored water and remove any air. Connect the two syringes with about six inches of the small diameter plastic tubing. Give one syringe to each of two students to see if either can push their syringe in all the way while pressure is applied to the opposite syringe. Mount the syringes vertically on ring stands with the plastic tubing still



By ED OSBORNE, SPECIAL EDITOR

(Dr. Osborne is an Assistant Professor in Agricultural Education at University of Illinois, Urbana-Champaign.)

in place. The plungers should be up. Ask your students to hypothesize what would happen in each of the following cases and write their prediction on paper:

1. One or both of the syringes has air in it.
2. A heavier (denser) liquid than water is used.
3. The plunger on the larger syringe is moved in $\frac{1}{2}$ inch. How far will the plunger on the smaller syringe be moved.
4. If a one pound weight is placed on top of the plunger in the larger syringe, how much weight must be placed on the plunger of the smaller syringe to support (equalize) it?

(Continued on Page 20)

Teaching Tips Teaching and Using Science Principles in Agriculture — Hydraulic Lifts

(Continued from Page 19)

Discussion:

Hydraulic lifts operate by Pascal's Law. In the case of the two syringes, the small syringe and the large syringe balance each other when the pressure on each plunger is equal. This pressure is found by dividing the force on the plunger by the area of the plunger. Since the smaller syringe has a smaller surface area than the larger syringe, it requires a smaller force to exert the same pressure and balance the weight on the larger syringe. When the small syringe is pushed, equal pressure is exerted on the larger syringe but with smaller force.

In mathematical terms Pascal's Law is stated:

$$F_{1s} = F_{ss}$$

$$A_{1s} = A_{ss}$$

where

F_{1s} = force on the large syringe

A_{1s} = area of large syringe plunger

F_{ss} = force on the small syringe

A_{ss} = area of small syringe plunger

Applications:

This simple demonstration/experiment can be used to explain the basic principles of operation behind hydraulic lifts and hydraulic control systems on machinery of various types. Automobile braking systems also operate by Pascal's Law. Students can test Pascal's Law by planning and conducting experiments on different systems or models that may be available in agricultural laboratories.

ASSISTANTSHIPS AND FELLOWSHIPS

Assistantships and Fellowships in Agricultural Education 1989-1990

The 1989-90 survey of institutions offering assistantships and fellowships in agricultural education is provided by the Publications Committee of the American Association of Teacher Educators in Agriculture. This survey is published annually to assist those in the profession who are seeking information about graduate studies. Twenty-six institutions responded to a request for details concerning assistantships and fellowships.

Key To Understanding

The information is provided in the following order: nature of assistantships (number available); number of months available during the year; beginning month of employment; amount of work expected; monthly remuneration and other consideration, such as remission of fees; whether aid is for master's advanced graduate program, or doctoral students; source of funds; the 1989 deadline for application; and the person to be contacted. Slight variations in this pattern are due to the nature of the data provided by reporting institutions.

University of Alaska Fairbanks

Graduate Research Assistantship (1); 9 months; September through May; one-half time, 20 hours/week; \$866/month; an out-of-state tuition waiver is available; master's; internal — School of Agriculture and Land Resources Management discretionary funds; March 15; Dr. Carla A. Kirts, Agricultural Education, 301 O'Neill Resources Building, University of Alaska Fairbanks, Fairbanks, AK 99775-0100, Telephone (907) 474-7471.

University of Arizona

Research Assistantship (1); 12 months; July; one-half time, 20 hours/week; \$666 per month; out-of-state tuition waived; master's; department budget; March 1 or 6 months prior to enrollment; Floyd G. McCormick, Department of Agricultural Education, The University of Arizona, Tucson, Arizona 85721, Telephone (602) 621-1523.



By JOHN HILLISON

(Dr. Hillison is an Associate Professor and Program Area Leader, Agricultural Education at Virginia Polytechnic Institute and State University.)

University of Arkansas

Research Assistantship (1); July 1; one-half time, 20 hours/week; \$500-650 per month; full tuition and fees provided, master's or doctoral; May 1; Dr. Nolan Arthur, Department Head, Department of Agricultural & Extension Education, Agriculture Building Room 301-B, University of Arkansas, Fayetteville, Arkansas 72701, Telephone (501) 575-2035.

Teaching Assistantship (1); September 1; one-half time, 20 hours/week; \$500-650 per month; full tuition and fees provided; master's or doctoral; May 1; contact same as above.

Cornell University

Teaching Assistantship (1); June or September; 15 hours/week; \$9,331 annually (\$357-89 bi-weekly); waiver of tuition and fees; doctoral, State funding, April 15, 1989. Arthur L. Berkey, Department of Education, Roberts Hall, Cornell University, Ithaca, New York (14853, Telephone (607) 255-2197.

Research Assistantships (2); 9 or 12 months; June or September 15; 15 hours/week; \$6,800 for 9 months, \$9,331 for 12 months (\$357.89 bi-weekly); waiver of tuition and fees; master's and doctoral; Hatch Act and other research funds; April 15, 1989; contact same as above.

University of Florida

Research Assistantships (3-5); 9-12 months; August 1, 1989; 14-20 hours/week; out-of-state fees waived; Master's; remuneration varies depending upon position; April 1; Dr. Carl E. Beeman, Department of Agricultural and Extension Education, 305 Rolfs Hall, University of Florida, Gainesville, Florida 32611, Telephone (904) 392-0502.

University of Georgia

Research Assistantships (1-2); 12 months; September 1, 1989 or until filled; one-quarter to one-half time; \$667 to \$1000/month plus waiver of fees; Master's, Ed.S., or doctoral (EdD) students; State Department of Education grants for curriculum of Agricultural Education, University of Georgia, Telephone (404) 542-1204.

Iowa State University

Research Assistantships (5); 9 or 12 months; July or September; one-half time, 20 hours/week; \$850 per month; fee reduction; master's or doctoral; Agricultural Experiment Station; March 1; Dr. David L. Williams, Head, Department of Agricultural Education, Iowa State University, Ames, Iowa 50011, Telephone (515) 294-0241.

Fellowships (2); 12 months; September; 20 hours/week; \$850 per month; full fees paid; master's or doctoral; March 1; USOE for Minorities and Women; contact same as above.

Kansas State University

Teaching Assistantship (1); 9 months; August 21; 16 hours/week; \$660 per month; out-of-state fees waived; in-state fees reduced; master's and doctoral; March 15; John Parmeley; Faculty of Agricultural Business and Home Economics Education; Kansas State University, Manhattan, Kansas 66506, Telephone (913) 532-5535.

University of Maryland

Graduate Assistantships for minority students; 9½ months; approximately August 15; 20 hours/week; remission of tuition for 10 credits per semester; \$8,175-9,175 per year (1988-89 rates); aid for qualified graduate students (M.S., AGS, Ph.D) March 15; Dr. Merl E. Miller, Professor & Chairman, Department of Agricultural and Extension Education, University of Maryland, College Park, MD 20742, Telephone (301) 454-3738.

Michigan State University

Graduate Teaching and Research Assistantships (3); 10 months in duration September 15 through June 15, (summer extensions possible); 20 hours per week, \$838 MS, \$922 PhD; waiver of out-of-state tuition fees; additional graduate fellowships available for prospective candidates. Funds are from projects with Agricultural Experiment Station, Cooperative Extension Service, and General Education. Deadline for applications May 1; Dr. Carroll H. Wamhoff, Chairperson, Department of Agricultural & Extension Education, Michigan State University, East Lansing, MI 48824-1039, Telephone (517) 355-6580.

University of Minnesota

Research Assistantships (2-5); 9-12 months; July or September 15; 10-20 hours; \$866-1,081 per month (50%); tuition reduced by two times % time appointed; master's or doctoral students; University; April 15; Dr. Edgar Persons, Head, Division of Agricultural Education, 320 Vocational and Technical Education Building, University of Min-

nesota, 1954 Buford Avenue, St. Paul, Minnesota 55108, Telephone (612) 624-2221.

Graduate School Fellowships in Vocational Education (2); 9 months; September 15; none, but full-time students; \$1,500-2,000; master's or doctoral students of outstanding potential; Graduate School; April 15; Director of Graduate Studies; Department of Vocational and Technical Education Building, University of Minnesota, 1954 Buford Avenue, St. Paul, Minnesota 55108, Telephone (612) 624-2258.

Mississippi State University

Research Assistantships (2); 9 or 12 months; July or August; \$600-1,000; tuition waived; doctoral; March 1; Jasper S. Lee, Department of Agricultural and Extension Education, Post Office Drawer AV, Mississippi State University, Mississippi State, Mississippi 39762, Telephone (601) 325-3326.

Teaching Assistantship (1); 9 months; August; \$600-1,000, tuition waived; master's, educational specialist, or doctoral, March 1; contact same as above.

Montana State University

Teaching Assistantships (1-3); September 15-June 15; 15-20 hours/week; \$450-600/month for masters; in and out-of-state fees waived. Number and salary are dependent on grant activity.

Research Assistant (1); September 15-June 15; 10-15 hours/week; \$450/month for masters' in and out-of-state fees waived, based on grant activity; Dr. Max L. Amberston, Professor and Head, Department of Agriculture and Technology Education, 126 Cheever Hall, Montana State University, Bozeman, MT 59717, Telephone (406) 994-3201.

University of Nebraska

Graduate Teaching Assistant/Graduate Research Assistant (1); 9-12 months; July 1; 20 hours/week; \$500-700 per month plus remission of tuition; master's candidate; department budget appointment; April 1 or until filled; Allen G. Blezek, Telephone (402) 472-2807.

Graduate Project Assistant (1); 9-12 months; July 1; 10 hours/week; \$500-700 per month plus remission of tuition; master's or doctoral candidate, grant budget appointment; April 1 or until filled; Allen G. Blezek, Telephone (402) 472-2807.

North Dakota State University

Graduate Research Assistant (1); 12 months; July 1; one-half time; \$550 per month; masters; Agricultural Experiment Station; February 1; Dr. Don Priebe, Professor and Chairman, Agricultural Education Department, 155 Home Economics Building, North Dakota State University, Fargo, North Dakota 58105, Telephone (701) 237-7437.

The Ohio State University

Teaching Associateships (2); 12 months; July or later; one-half time; \$800 per month; in and out-of-state fees waived; doctoral; February 1, Dr. L.H. Newcomb, Chairman, Department of Agricultural Education, The Ohio State University, Agricultural Administration Building, 2120 Fyffe Road, Columbus, Ohio 43210-1099, Telephone (614) 292-6321.

Research Associateships (4-6); 9-12 months; July or later; one-half time; \$670-800 per month; masters or doctoral; February 1; contact same as above.

(Continued on Page 22)

Assistantships and Fellowships in Agricultural Education 1989-1990

(Continued from Page 21)

Administrative Associateships (2-3) with emphasis on Extension Education (same as above).

Teaching Associateships (2); 12 months; July or later; one-half time; \$800 per month; in and out-of-state fees waived; doctoral; March 1; Dr. Joe Gliem, Department of Agricultural Engineering, 590 Woody Hayes Drive, Columbus, Ohio 43210, Telephone (614) 292-9356.

Research Associateships (6); July 1 or later; one-half time; \$805 per month; doctoral; \$665 per month; masters; in and out-of-state fees waived; February 1 (will accept applications year round); Executive Director, National Center for Research in Vocational Education, The Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210, Telephone (614) 486-3655.

Oklahoma State University

Teaching assistantship (1); 9 months; starting September 1, 20 hours per week; remuneration, up to \$888 per month; out-of-state fees waived, partial fee waiver scholarships and competitive college fellowships available; application deadline August 1; duties would include: teaching undergraduate professional courses, working with state vocational-technical staff, assisting with undergraduate student advisement.

Teaching assistantship (1); 9 months; starting September 1, 20 hours per week; remuneration, up to \$888 per month; out-of-state fees waived, partial fee waiver scholarships and competitive college fellowships available; application deadline August 1; duties would include: teaching undergraduate professional course, working with state vocational-technical staff, assisting with undergraduate student advisement, serving as assistant director of student teachers, supervising of student teachers in the field.

Teaching assistantship (1); 12 months; starting September 1, 20 hours per week; remuneration, up to \$888 per month; out-of-state fees waived, partial fee waiver scholarships and competitive college fellowships available; application deadline August 1; duties would include: operation, maintenance and scheduling videotape and other types of audio-visual equipment for the department and the Division of Agriculture faculty.

Teaching assistantship (1); 12 months, starting September 1, 20 hours per week; remuneration, up to \$888 per month; out-of-state fees waived, partial fee waiver scholarships and competitive college fellowships available; application deadline August 1; duties would include: assistance in writing RFP's, computer programming, conducting literature searches, developing literature reviews for staff research, and assisting with a research design course.

Persons interested or requiring additional information concerning these assistantships should contact: Dr. Robert Terry, Professor and Head, Department of Agricultural Education, 448 Agriculture Hall, Oklahoma State University, Stillwater, OK 74078, Phone (405) 744-5129.

The Pennsylvania State University

Teaching and Research Assistantships (4); 12 months; August 20; 20 hours/week; \$3,990 per semester; remission

of fees; out-of-state; master's and doctoral; March 1; Dr. Samuel M. Curtis, Head, Department of Agricultural and Extension Education, 102 Armsby Building, University Park, Pennsylvania 16802. Telephone (814) 865-1668.

Purdue University

Teaching Assistantships (2); 10 months; August; one-half time; \$660 per month; tuition and fee waiver; doctoral or masters; February 1. Dr. James P. Greenan, Chairman, Vocational Education, Purdue University, South Campus Courts F-25, West Lafayette, Indiana 47907, Telephone (317) 494-7290.

Research Assistantships (3-5); 10-12 months; August; one-half time; \$660 per month; tuition and fee waiver; doctoral or masters; February 1; contact same as above.

Southern Illinois University

Teaching Assistantship (1); 12 months; Summer or Fall; 20 hours/week; \$652-700 per month; tuition waiver; April 1; Dr. Robert Wolff, Department of Agricultural Education and Mechanization, Southern Illinois University, Carbondale, Illinois 62901, Telephone (618) 536-7733.

Teaching Assistantships (4); 9 months; Fall; 20 hours/week; \$648-680 per month; tuition waiver; April 1; contact same as above.

Microcomputer Lab Assistantships (2); 9-12 months; Summer or Fall; 20 hours/week; \$648-680 per month; tuition waiver; April 1; contact same as above.

The University of Southwestern Louisiana

Graduate Assistantship (1); 10 months; September 1; 20 hours/week; \$400 per month; master's only; private; May 30; Dr. David Drueckhammer; Department of Agricultural Sciences, Technology and Education; P.O. Box 44432, University of Southwestern Louisiana, Lafayette, Louisiana 70504, Telephone (318) 231-6646.

Texas A&I University

Graduate Research Assistantship (1); 9-12 months; September; 20 hours/week; \$550 per month; waive non-resident fees; masters; Funds-Houston Livestock Show and Rodeo; April 15; David E. Lawver, Assistant Professor, Agricultural Education, Texas A&I University, Kingsville, TX 78363, Telephone (512) 595-3711.

Texas A & M University

Assistantships: teaching (3), non-teaching (3), research (2); 9-12 months; generally September 1 or January 15; 20 hours/week; \$800 per month for doctoral, \$500 per month for master's; out-of-state tuition waived for teaching or research assistantships; public (state) and private; April 1 for September appointment; Dr. Don R. Herring, Graduate Coordinator, Department of Agricultural Education, College of Agriculture, Texas A&M University, College Station, TX 77843-2116, Telephone (409) 845-2951.

Fellowships: doctoral (2); master's (2); 12 months; generally September 1 or January 15; 20 hours/week; \$800-1,000 per month for doctoral, \$500 per month for master's; public (state) and private; April 1 for September appointment; contact same as above.

Virginia Polytechnic Institute and State University

Graduate Assistantships (2); 9 months; August 16; 20 hours/week; \$875-950 per month; master's or advanced degree; University; March 1; contact Dr. John Hillison,

Agricultural Education, Room 223 Lane Hall, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, Telephone (703) 961-6836.

University of Wisconsin/Platteville

Graduate Assistantships (3-5); 9 months; September 1; 15-18 hours/week; \$400+/month; limited out-of-state waivers; masters only, in either Agricultural Industries or Education; University of Wisconsin System Grant; March 15; Dr. Ralph Curtis, Director of Graduate Studies, 303

Brigham Hall, UW-Platteville, Platteville, Wisconsin 53818, Telephone (608) 342-1262.

University of Wisconsin-River Falls

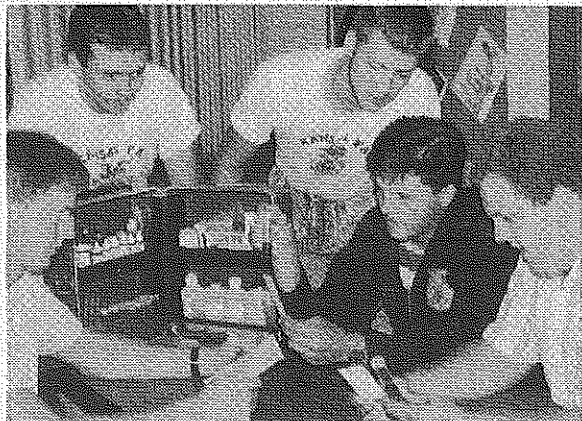
Graduate Assistantships (1-2); 9 months; September; 15-20 hours/week; \$550-580 per month; remission of out-of-state fees; masters; state funding; April 1; Dr. Richard A. Jensen, Chair, Department of Agricultural Education, University of Wisconsin-River Falls, River Falls, Wisconsin 54022, Telephone (715) 425-3555.

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(See instruction on reverse)

Stories in Pictures



Analytical thinking and problem solving skills are used by these students as they compare their soil testing results. (Photo courtesy of Jay Bohnenblust, Clay Center, Kansas)



John Block, President, National American Wholesale Grocers Association discusses *Understanding Agriculture: New Directions for Education*. (Photo courtesy of Andrew Markwart, *The National Future Farmer Magazine*.)



A groundwater flow model is demonstrated during National Conference on Agriscience and Emerging Occupations. (Photo courtesy of Andrew Markwart, *The National Future Farmer Magazine*.)



Horticulture demonstration by employees at the EPCOT Center during National Conference, October 11-15, 1988. (Photo courtesy of Andrew Markwart, *The National Future Farmer Magazine*.)



Innovative Agriscience teachers are recognized for their classroom achievements through the FFA's Agriscience Teacher of the Year Award Program. Lloyal McCabe was the 1987 winner. (Photo courtesy of Susan Forte, Gulf Breeze, FL.)



Students and Instructor study results of a plant tissue culture. (Photo courtesy of Joy Day, *Devils Lake Daily Journal*.)