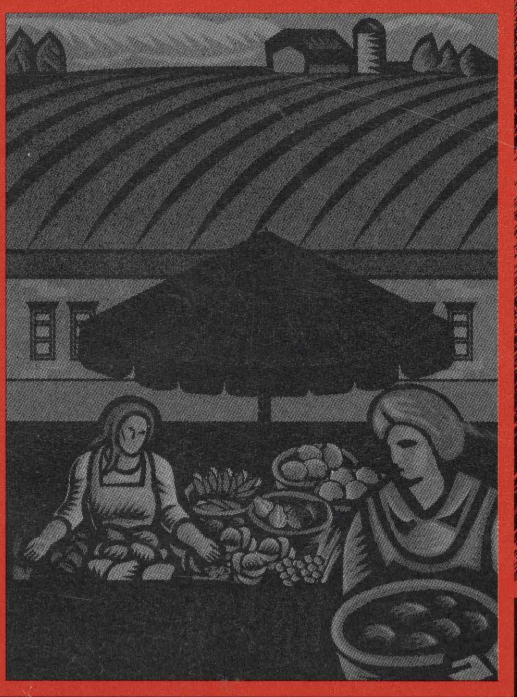
From a Trail to a Path to Sustainable Agriculture



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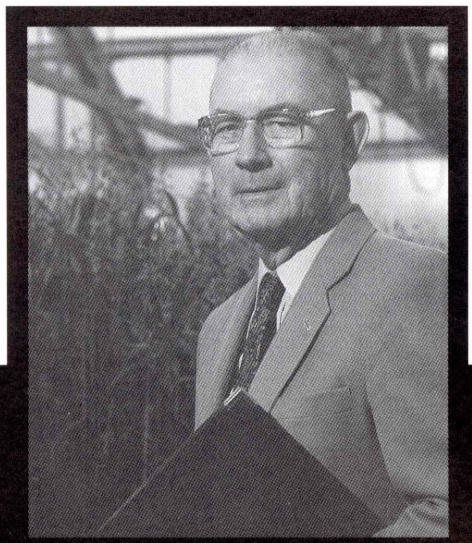
THE SPEAKER

DR. JOHN PESEK, IOWA STATE UNIVERSITY EMERITUS PROFESSOR OF AGRONOMY

Dr. John Pesek, Iowa State University Emeritus Professor of Agronomy, has had a long and distinguished professional career. He has made nationally recognized research contributions in agronomy in the areas of soil fertility, crop production, and the economics of soil fertilizer use. His work has led scientists to a better understanding of the effects of management practices on the environment and their combined influence on yields.

In the 1980s, Dr. Pesek chaired a National Research Council committee under the National Academy of Sciences Board of Agriculture that was directed to study alternative methods of soil management. The book resulting from their case studies, *Alternative Agriculture*, was a groundbreaking report that



documented how farming systems that used lesser amounts of pesticides, fertilizers, antibiotics, and fuel can be productive and profitable. Its publication generated worldwide attention and brought Dr. Pesek to Washington, D.C., to testify before the Joint Economic Committee of the House and Senate.

Dr. Pesek has been named a fellow of the American Society of Agronomy, the Soil Science Society of America, Crop Science Society of America, the Iowa Academy of Science, and the American Association for the Advancement of Science. He has served as president of both the American Society of Agronomy and the Soil Science Society of America and he helped establish the nation's first National Soil Tilth Center. Dr. Pesek has authored or co-authored more than 75 publications and has been active in international programs in Brazil, Mexico, Egypt, Morocco, Uruguay, Tunisia, and Russia. He was named a Charles F. Curtiss Distinguished Professor of Agriculture in 1981 and received the Agronomic Service Award in 1989.

LECTURE

From a Trail to a Path to Sustainable Agriculture

01 MARCH 2001
JOHN PESEK • IOWA STATE UNIVERSITY

Agriculture may be narrowly defined as the art, practice or science of crop and livestock production on organized farm units. It emerged as a directed human activity roughly 10 to 12 thousand years ago and its appearance is generally recognized as one of the foundations of civilization. Agriculture is a major industry for the United States and worldwide. It is indispensable because it provides almost all the food and much of the fiber we use. In addition, most of the fresh water, another essential human need, first falls on privately controlled farmland in this country. When the definition is expanded to include off-farm inputs and marketing and processing for eventual consumption, agriculture constitutes a vast business enterprise.

"Agriculture...is generally recognized as one of the foundations of civilization."

This is why I believe that sustainability of an agriculture that is environmentally benign in relation to world resources, population, and the environment is a serious issue—perhaps the central issue for the human race. Until relatively recently, we could move to new locations to produce our food if our land resources were destroyed. But a burgeoning global population assures that if we have not already exhausted new places to produce our food and fiber, we soon will. R. B. Lee and I. DeVore in 1968 (quoted by J. R. Harlan) estimated that of the 80 billion humans who have lived on earth during the last 2 million years, 90 percent lived as hunter-gatherers and only 10 percent under agriculture. They pointed out that this makes hunting the most successful adaptation of humans and, to me, this underscores the need for a successful, sustainable agriculture. Put another way, agriculture has been practiced for less than one percent of the time that humans have walked the earth.

And what is sustainable agriculture? The Iowa Groundwater Protection Act of 1987 specifies what we want it to be for us in Iowa: "[Sustainable agriculture] is the appropriate use of crop and livestock systems and agricultural inputs supporting those activities which maintain economic and social viability while preserving the high productivity and quality of Iowa's land." This "definition" is more of a statement of the goals or aspirations that emphasize the maintenance of people (social viability) and high quality of land (natural resources, in the context of the Act). From my disciplinary background, I have come to visualize sustainable agriculture as a broad goal of agricultural production that is dynamic and emphasizes the full use of biological (renewable and recyclable) resources. I think it also is destined to vary its production and other practices depending upon individual preferences, location, era, incentives and technology evolution, acceptability and appropriateness. Of course, emergence of new technologies depends upon time and so does the evaluation of acceptability and appropriateness—that they benefit people equitably, are safe and useful. Many other

definitions have been proposed and contain greater or lesser constraints than in the ones stated above, and apply to domains ranging in size from the farm through regional and national up to global.

Farming, the basic production activity in agriculture, represents a unique relationship of food and fiber producers to the rest of society and is central to sustainable agriculture. Farmers, by producing the food and fiber needed, freed society to pursue other activities of civilization. In return for use of its sovereign territory, society has high expectations of the farming community. Because the food supply is so critical, the greater society has long supported agriculture and farming in ways that might even escape our attention. Even before Iowa became a state, the territorial government provided funding for county agricultural fairs at which experiences were exchanged, knowledge was disseminated, and animal and plant germplasm were traded. And Iowa established the State Fair for similar reasons in 1854. Later the federal government created the land–grant colleges that were directed as much to farm dwellers as to industrial laborers. Congress created the office of commissioner for agriculture during the Civil War, and 25 years later this position was elevated to cabinet rank. Society has created and maintains the transportation, communications and market infrastructures for agriculture, promotes international trade, has rescued farmers and protected them from natural disasters and economic catastrophe. At the same time, society has been inclined to exert demands upon agriculture that appear to have been more for everyone's protection and interests than for

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their value to farming, e. g., clean water, food safety, set aside programs for the future, etc.

Early agriculturists arose from the landscape and were kept closely attuned to their environment. We can only surmise the conditions under which they lived, but we know that their ability to alter their living conditions and environment was limited, their numbers were relatively small, and the land space per capita was large. Whenever their numbers exceeded the carrying capacity of the locale, they moved elsewhere, or it is certain that the natural order of environmental dominance asserted itself to reduce the numbers. We have historical examples of such "natural corrections" (agricultural failures) prior to the modern era.

The Mesopotamian fields under irrigation had seriously "salted out" by about 4000 years ago. Evidence in tax records shows that during the previous 1800 years both the area planted in wheat and the yield declined. In 3500 B. C. about half of the grain produced was wheat, but by 1700 B. C. the proportion of wheat dwindled to 2 percent. Fewer taxes were paid on wheat and more on barley until near the end of the period, when almost all the taxed grain was barley. The key is that barley tolerates salt better than wheat. Some believe that when invaders from central Asia came, the Mesopotamian population had essentially disappeared and many of the cities had been covered with salty desert. Severe soil erosion in ancient Greece and Rome caused reductions in food- producing capacity and grain production in North Africa declined. Even in Central America, some city-states collapsed before Cortez arrived, and certain elements of Pueblo culture in the southwestern United States also perished by the sixteenth century.

The Central American and the Pueblo declines are not fully understood, but the conclusion in Mesopotamia was that the small amount of salt in the irrigation water led to a slow accumulation of salt in soils. The presence of salt in the water

might not have been known and the effect of residual salt was not understood. The farmers may not have been aware that providing drainage and periodic flushing of soils with excess water would have moderated the problem. The food supply lines for Rome eventually became so long that the empire's food supply became vulnerable to attack by enemies, while the food basket of North Africa became desertified. Though we exert more control over our environment, it would be presumptuous to consider ourselves exempt from the realities of nature and soils.

It is interesting to note that, through no conscious human intervention, the same misfortune did not befall the Nile River Valley of ancient Egypt, possibly because it was regularly flooded and the salts removed. But irrigation of deserts is not the only cause of salinization; even the simple wheat-fallow system of farming in the northern Great Plains has caused salt seeps on parts of the landscape. Rice culture in parts of China has flourished for several thousand years with intensive human input, and the land is still producing.

The history leading to the establishment of our country and of over two centuries following has been primarily one of exploitative behavior by our citizens and our government. Natural resources have been plundered and were more often spoiled than used. Expanses of forests were cleared to make room for farming; others were cut, consumed wastefully, and not reestablished. We have allowed our soils to erode and millions of acres of formerly cultivated land have had to be abandoned due to either wind

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or water erosion, or both. Even today, we lose billions of tons of soil to erosion annually, and in addition to silt, plant nutrients and other agricultural chemicals are finding their way into surface- and ground-water.

We cannot fault our forebears entirely because they, like the people of Mesopotamia, often were not aware of the consequences of their actions and their immediate personal survival was paramount. Besides, the land, timber, water, and game supply must have seemed inexhaustible when viewed by the signers of our Declaration of Independence and Constitution as recently as the late eighteenth century. But the fleeting high productivity of many soils east of the Appalachians was recognized. People estimated the useful life of soils for farming by the type of native vegetation initially present. Except for the presence of silt or toxic saltiness, the quality of water could not be assessed.

But circumstances have changed, and our ability to understand as well as to see what was happening has rapidly expanded in the two centuries since. It is not surprising therefore that those outside of agriculture, as well as some of those in it, have become concerned about our stewardship as well as about farm workers' welfare and the safety of the food we deliver. Some people feel very strongly that they are unnecessarily exposed to unknown or unacknowledged hazards and wonder why we in agriculture have had a tendency to turn to the "technological fix" rather than working within the biological system first.

Jim Davidson, Dean of Research at the University of Florida, expressed some thoughts on this matter at the American Society of Agronomy Administrators' Roundtable in 1989. He observed that we in the land-grant colleges are confronted with the dilemma that nonagricultural groups interested in food quality and safety, natural resources, environmental quality and human resource issues simply do not trust us.

He went on to say:

"The distrust on the part of nonagricultural groups is well justified. With the publication of Rachel Carlson's book entitled '*Silent Spring*' we, in agriculture, loudly and in unison stated that pesticides did not contaminate the environment—we now admit that they do. When confronted with the presence of nitrates in groundwater we responded that it was not possible for nitrates from commercial fertilizer to reach groundwater in excess of 10 parts per million under normal productive agricultural systems—we now admit they do. When questioned about the presence of pesticides in food and food quality, we assured the public that if a pesticide was applied in compliance with the label, agricultural products would be free of pesticides—we now admit they are not. Certainly, the availability of new instrumentation and ability to detect trace amounts of pesticides in water and food have changed the meaning of absolute zero. Although this may be used as an excuse for our belief that agriculture was not a contributor to environmental degradation, the truth is, we are not conducting the research and/or making the appropriate measurements to insure that this was the case."

This is a very strong indictment by one of us in professional agriculture!

Today, we might well add more concerns to that list. For one, we are learning that many surface water bodies have levels of phosphorus high enough to promote excessive growth of

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blue-green algae (Cyanobacteria) leading to eutrophication. Often these raised levels of phosphorus are associated with the presence of concentrated livestock operations. What is more, we do not know whether optimal levels of soil phosphorus and nitrogen applications for crop production pose serious hazards to water bodies, and if they do, when, under what conditions, and to which ones. Another situation concerns the growing hypoxic volume in the Gulf of Mexico near the mouth of the Mississippi River. Finally, recent evidence suggests that transgenic corn producing some *Bacillus thuringensis* proteins is harmful to certain non-target insects. We must ask ourselves whether and how far we can trust present methods of testing to assure the public that we will not have to change previous conclusions.

Yet, we cannot eschew any technologies (whether indigenous, old or new), methods of production, and potential crops to grow before they are tested and either found appropriate or discarded after trial. Much of the productivity we enjoy in Iowa and worldwide traces back to improvements in production technology, management, and superior crop cultivars. Without these, it is certain that global pressure on food supplies would be even more common, more profound and affect larger areas and more people. Industrialized countries tended to promote the selection of their own successful (and ultimately dominant) technologies abroad because these were the ones they knew best, and because of the trade opportunities their adoption would present. We are encouraged by those that succeeded, but it is clear failures to understand the cultures and promoting adoption of inappropriate technologies, whatever the source, has led to some failures in developing food and fiber production in developing nations.

We have not always been as confident of feeding and clothing an expanding global population as we are now. Especially following World War II, we were concerned about our ability to "set the fifth plate" at the dinner table of the world. In fact, scientists

working on a productive capacity study for the United States, published in 1952 by the United States Department of Agriculture (USDA) and the land-grant colleges, struggled to gauge the potential effect of emerging technologies in arriving at estimates of our productive capacity. These new technologies included the use of synthetic chemical fertilizers and pesticides, high-yielding crop hybrids and cultivars, and improved planting and harvesting machinery. Their use has been enhanced by improved management skills and better information accompanying and following their adoption.

Thanks, in part, to the fertilizer, seed and agricultural chemical industries, farm machinery manufacturers, farmers and the educational and extension system, these technologies became part of the conventional agriculture practices of the last half of the past century and have produced dramatic increases in production. Yields of U.S. crops are among the highest in the world, with fewer farmers potentially feeding more people than ever before, but localized shortages of food continue to occur at various places on the globe. Our food prices to consumers are the lowest in the world representing only about ten percent of "take-home pay".

The conventional agriculture, stemming from adoption of the mid-century new alternative technologies during the last 50 years, was accompanied by consolidation of land holdings into fewer hands, the use of high-capacity machinery and employment of large amounts of other off-farm production inputs. It also permitted the concentration of some livestock operations into

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large production units and the vertical integration of production (under single corporate ownership) of other species from conception of the animals to eventual food products for distribution. These new configurations required a large infusion of capital from non-farm sources. All of these changes resulted in fewer different crops and fewer animal species being found on each farm, and fewer and fewer farms having both crop and livestock enterprises. These changes also led to reduction in numbers of primary farm families accompanied with severe declines in the vitality and economies of small cities and towns; unintended but real and often traumatic consequences.

On the heels of the adoption of some of the new technologies, concerns emerged about environmental, health and food quality problems attributed to these recently developed and embraced technologies. Agriculture also was labeled as one of the nation's major polluters, particularly with silt deposits and plant nutrients that led to physical, chemical, and biological degradation of water bodies. A farm debt crisis coincided with rapidly plummeting land prices during the 1980s and many farming operations could not survive. Other farmers were looking for ways to reduce input costs and increase efficiency in order to stabilize their debt loads, and still others were searching for safer farming practices.

In addition, monitoring records of wells and springs in Iowa showed increasing amounts of nitrate and the presence of pesticides previously not observed in groundwater, we had come close to losing the bald eagle and placed other birds of prey and wildlife in jeopardy. The fact that analytical methods have become more sensitive and that nitrate often is not at hazardous levels is not an adequate defense as long as too much is being used. Nor is the fact that nitrate is a naturally occurring component of natural uncontaminated water sources—after all, even rainwater usually contains nitrate.

The national stage was set for a general reassessment of different ways to farm by the late 1970s and early 1980s.

Several organizations were formed during the last century and made individual attempts to address various agricultural issues of interest to them. Rodale Press, in Pennsylvania, was among the oldest and emphasized production of wholesome and safe food through organic gardening and farming. The Wallace Genetic Foundation established in 1959 also was among the early ones. The Center for Rural Affairs in Nebraska was reformed as a non-governmental body when a federally supported plan to help the rural poor seemed likely to be discontinued in 1972. The Land Stewardship Project in Minnesota was created to respond to the continued high soil erosion losses and has tried to do something about the problem since 1973. The Land Institute in Kansas started in 1976 because there was a perceived need to work on sustainable alternatives for farming. The Northwest Area Foundation (renamed during the 1970s) began to explore ways to increase the economic vitality in the border states from Minnesota westward, plus Iowa, Oregon and South Dakota, while making agriculture a more effective economic base for the vast rural parts of the region. The Nebraska Sustainable Agriculture Society was formed in the early 1980s to help farmers to do research and share information, and the Practical Farmers of Iowa was organized in 1985 and focused on generating and disseminating farming information to achieve ends later to be specified by the Iowa General Assembly. There were others summarized by Adam Davis, a graduate student, and these are found across the nation.

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Whatever the reason for formation, all of these have since embraced the general desirability of the several aspects of agricultural sustainability. *The American Journal of Alternative Agriculture*, supported by the Wallace Genetic Foundation, is different. From the time it was established in 1983, it was dedicated solely to sustainable agriculture.

At much the same time that some of the above groups sprang up, the federal government had made note of the need to protect the natural resource base in farming. When the nation was beset with excessive soil erosion in the 1930s, the Soil Conservation Service (SCS) was established in the USDA. (The SCS is now called the NRCS, Natural Resources Conservation Service.) NRCS has a presence in every county in the country much as the Cooperative Extension Service in the land-grant colleges working in cooperation with the USDA. It is a source of technical help and information especially for maintaining the integrity of natural resources used in farming. In 1959 Congress adopted Senate Document 59 that laid a bold plan for a system of national laboratories to work on agricultural problems of nation-wide interest, many of them related to natural resources and the environment. The National Soil Tilth Laboratory in Ames, completed in 1989, is one of these. Later the Environmental Protection Agency (EPA) was created in the Department of the Interior with important natural resource protection roles for clean water and air, largely in the general public's interest. More recent relevant federal and state program initiatives include Integrated Pest Management (IPM), Integrated Crop Management (ICM), Integrated Farm Management Demonstration (IFMD) and Integrated Resource Management (IRM), all addressing very fundamental facets in sustainable agriculture. These latter four are all interrelated and share the common trait of being broad interdisciplinary approaches to solving and teaching about system problems in agricultural production.

In Iowa, The State Soil Conservation Committee was established in 1939 and became the Department of Soil Conservation in 1970. The Iowa General Assembly first appropriated funds for the Department to disburse in support of soil conserving practices in 1973, and has continued ever since.

Other groups addressed some of the same farming issues on one-time or less extensive practice bases. The USDA published a study of organic farming in 1980, as did the Council for Agricultural Science and Technology (CAST). The American Society of Agronomy sponsored a symposium on organic agriculture in 1983 and published the results the following year. Even I discussed the issues of prudent and environmentally friendly farming practices in my presidential address to the Agronomy Society in 1979 with fuel shortages of the 1970s freshly in mind. Early in the 1980s, concerns about nitrate finding its way into groundwater in rural areas resulted in forming the so-called "Big Spring Project" in northeast Iowa. This study of a natural underground "watershed" was conceived in the Iowa Geologic Survey of the Iowa Department of Natural Resources with Iowa State University joining in this EPA funded effort. The Soil Conservation Society of America sponsored a conference at Luther College entitled, "Groundwater Quality in Northeast Iowa" in 1984, and CAST published a report called "Agriculture and Groundwater Quality" in 1985. At the same time, prompted by concerns about nitrate levels in surface- and ground-water, the Iowa Fertilizer and Chemical Association also took action. It arranged with the Secretary of the Iowa

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Department of Agriculture to assess fees against fertilizer tonnage sold in order to support research at Iowa State University on the most effective use of nitrogen for corn production. Iowa State was asked to develop a proposal for "a new center to coordinate research and education programs dealing with improving the management of fertilizers and ag chemicals" in 1986, and it did.

If the agricultural science community had been more prompt in taking time for a good hard look at the "flip side" of the technologies we were studying and developing, we might have avoided some of the mistakes we made and some we seemed to have made. In fairness, however, this could not all have been done effectively nor conclusively in all cases because public agencies had no control over the emergence and deployment of many new technologies and methods, if they ever did. Also, some problems are slow in manifesting themselves, and most rewards to public servants went to new ideas, not for warnings. Besides, agriculture became obsessed with the need to be as efficient as possible in crop and animal production to maintain a competitive edge and succeeded admirably in total food and fiber production. Much of the competitive edge depended upon increasing yields with externally supplied inputs. But we have ignored the real cost of our applied technology at the farm level because we have not had to pay for the consequences, and society at large has not fully determined nor assessed this cost, nor has been willing to pay more for alternatives. After all, the upland farmer does not directly pay for the cost of dredging the Mississippi River or reimburse the loss of Gulf of Mexico fisheries, nor does the farmer in north central Iowa have to worry about nitrate removal from river water used for drinking in Des Moines. Neither do users of sub-therapeutic doses of antibiotics in animal production compensate for losses in the effectiveness of similar products in human or veterinary medicine. In bearing these added costs in other ways, parts of society are paying the "hidden" costs of inexpensive food.

Why, then, had we come to this kind of a situation?

The Report on Alternative Agriculture, commissioned in 1985 by the Board on Agriculture and published in 1989 by the National Research Council (NRC) of the National Academy of Science, summarized the work of a committee on the role of alternative agricultural methods in modern production agriculture. The late William Brown, president of Pioneer Hi-bred International, Inc., was chair of the Board, and Paul Johnson, a farmer and member of the Iowa General Assembly, was also a Board member. The dominant conclusion was that laws and policies governing agriculture, especially commodity policies, are among the major obstacles to "alternative" agriculture. These commodity policies came to dominate agricultural producer behavior at the farm level in ways that acted against achieving the goal of sustainability.

According to the CAST publication, "*Sustainable Agriculture and the 1995 Farm Bill*", programmatic provisions supporting a sustainable agriculture, as we understand it now, were addressed as early as the Food and Agricultural Act of 1977. But the expression did not appear until the Food Security Act of 1985 that authorized funding for a Low Input Sustainable Agriculture (LISA) initiative. This act also provided for the Conservation Reserve Program, Sodbuster and Swampbuster provisions and the Conservation Compliance Program. The Food, Agriculture, Conservation and Trade Act of 1990 further enhanced sustainable agriculture by providing for Sustainable Agriculture Research and Education (SARE) programs and other closely related activities.

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The modest original funding has grown to $13 million with research receiving the major part. The 1996 Freedom to Farm Act continued the conservation compliance and other environmentally friendly programs, including SARE, found in previous acts.

About 70 percent of the nation's cropland acres were in crops covered by federal commodity programs and some 88 percent of eligible production were enrolled at the time of the NRC Report. Since then, the 1996 Farm Bill provided for phasing out the acreage limitations of the 1990 program over a period of years (the scheduled phase-out is not complete). It also added soybeans to the commodity crop list, thus, greatly expanding the commodity cropland; provided for loan deficiency payments (LDPs) on what is actually produced; and discontinued wool and honey supports. The amount of subsidy a farmer received under previous recent farm bills was calculated, in part, on the base acreage and on the base yield of land in program crops. The farmer, therefore, has been encouraged to strive for maximum yields and to keep the highest acreage of land in program crops. There is evidence that this has led to over-application of fertilizers and other chemicals, and the cultivation of fragile land to grow more program crops.

Just how pervasive government commodity policies are in farming was described at an early Leopold Center Conference by John Miller, a farmer from Cedar Falls, Iowa. He said, "A farmer is always making decisions ... often ... decisions on ... decisions. Government may have more influence on these ... than either research or education. Research and education are optional when compared to ... policy. I can choose to respond to research by adopting it as an ... innovator, or I can ignore it altogether ... education is ... effective if I choose to be receptive. But failure to pay heed to policy can cause me financial hardship, it might even break me, or it could put me in jail."

A most dramatic illustration of long-term national agricultural policy may be seen in a Landsat 3 photograph published by J. F. Dormaar and S. Smoliak in the *Journal of Range Management*.

It shows the border between southeastern Alberta and Montana clearly reflecting the difference in landscapes resulting from national policies to produce wheat south of the 49th parallel and allow reversion to rangeland and its maintenance and production to the north. The Canadian government allowed this reversion soon after World War I.

Both policy and technological developments led to profound changes in acreage allotment to the four major crops by Iowa farmers. Oats declined from about 6 million acres in mid-century to less than a million today, in part, because mechanical power replaced animal power and also because oat was not designated as a program crop and was no longer necessary for the traditional establishment of meadows. Meadow acreage declined as a result of the growth in nitrogen fertilizer use, replacing the nitrogen-supplying function of leguminous meadows for grain crops in rotations. In addition, hay consumption declined because much of the beef-fattening activity moved out of the state. Soybeans emerged as a profitable new crop occupying fewer than a million acres 60 years ago to an acreage equivalent to that in corn. The 1996 addition of soybeans to the list of "program" crops made them even more desirable because they are now eligible for LDPs. Today the two crops occupy about two-thirds of the total land area of the state.

One must not overlook the effect that personal preference and skills of the farmers, and of those whose farms they tilled, had on these changes. The chemical and antibiotic technologies were

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relatively easy to apply, readily available, simple, quite dependable and the effects were easily observed and demonstrated. In addition, each of these off-farm input technologies had at least two persons who would benefit from their adoption and effective use. The first was the farmer who expected to gain more income from higher crop yields or healthier livestock, hoped to save on some costs previously incurred, or might escape part of the inconvenience and hard work of some traditional practices. The second was the person producing and selling the products. Therefore, there was much incentive for both to try to adopt them, and information was readily available and freely given. Another dimension was the relative simplicity of growing only one or two crops using essentially the same machinery and land, as compared to producing more crops requiring additional lines of machinery, and more varied production and management skills. Add to that the further management skills and facilities demanded for one or more animal enterprises, and one can understand why many chose an easier way, especially when the agricultural commodity programs made it profitable to do so and few incentives for stewardship of natural resources were provided.

Early in the 1950s, Iowa State's Joe Bohlen and George Beal presented a simplified model on how new methods, products and technologies were adopted by farmers. They developed a diffusion sequence for adoption that went something like this: innovators, early, majority, and late adopters, laggards, and non-adopters. Supported by economic studies, they showed that the earlier adopters had the most to gain from utilizing a new technology, and those whom others followed were mostly in this group. Believing this, favorably inclined farmers started to look for opportunities to be the earliest adopters, and promoters looked for these farmers. Since then, Peter Nowak divided non adopters into two classes: one included those who had intractable impediments to change, such as lack of financing, or being too close to retirement to capitalize on the new methods: and the second was those who declined adoption for some deeply held

convictions about their use. Using hybrid seed corn as an example, Zvi Griliches previously had described the characteristics of a new technology that would allow it rapidly to capture essentially all of the market. Relatively early in the 1950s, the power of "leveraging" to borrow capital for adopting new technologies and expanding operations was realized and frequently was used for consolidation of land holdings by neighbor-to-neighbor buy-outs.

Commodity program crops were not the only ones affected by the new thinking. Federal policies also dealt with the cosmetic standards of fruits and vegetables—standards that have little or no bearing on their safety or nutritive value. Often these standards are achieved with additional and possibly unnecessary applications of pesticides. In addition, the rules governing the licensing of new compounds that may be safer and more effective are difficult and costly to comply with, so it is frequently easier to continue using a product that had been approved in the past. Even after some products and practices have been found to be unsafe or harmful, it has been difficult to remove these undesirable materials and discontinue the practices. An added food safety problem is that some of these products and practices also had been adopted off shore, with the potential to return on imported produce sold here.

State and federal extension, research and teaching agencies have also been identified as sometimes having a negative influence on adoption of alternative sustainable methods. These entities have failed agriculture partly because of what they have left undone, e. g., not looking at the "flip-side" previously mentioned, rather

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than by not being competent in what they did. As the last century progressed after World War II, the purchasing power of their appropriations declined after 50 years of enhancement. So these groups now had limited resources to fulfill their responsibilities. But they also may have been in error in the selection of the instruction and studies they conducted with their available resources.

One consequence of inadequate appropriations was that rather than to be partially idle, faculty members and scientists, especially at the land-grant colleges, sought funding from other sources to keep busy and to help train new scientists. A relatively ready source sprang from industries that were developing and producing the external input products of potential use to farmers. Thus, a company could leverage a productive scientist's efforts and take advantage of public laboratories and experimental fields with what might be relatively small grants. This meant that the new technologies and products were tested by the colleges and were granted an early credibility they might not have otherwise enjoyed. While the scientific community applied the same rigor to evaluating publication of these tests, the fact remains that it was doing someone else's work rather than the research its members might have chosen if completely independent of private financial help. The extension and teaching sectors could not avail themselves of as much of this type of potential support so their activities became more and more restricted.

The funding for agricultural research also became available from public granting agencies such as the National Science Foundation and, later, the USDA. Even though these were public monies to be spent for public research, the projects of greatest local interest were hardly ever funded. This procedure also resulted in some agency outside of the state capturing local scientists and resources to conduct studies the agency deemed important rather than addressing pressing local problems. The most serious outcome of these two external funding options was to take the decisions for

research out of the hands of local citizens and appointed administrators. This resulted in very low priority being placed on finding approaches to crop production not involving off-farm inputs, continued disregard for the non-renewable resources consumed, and failure fully to provide the knowledge for protecting renewable resources.

The reward and recognition structure in the university community during the last half of the century became more and more generous to those doing research rather than to those teaching and conducting extension programs. For researchers, the rewards came to those who demonstrably conducted original research of high quality. This was easiest to achieve by scientists working alone on narrowly defined, single-disciplinary projects, and especially in basic science. Even though most problems on farms deal with developing and operating complex production systems, these problems were not addressed because there were few if any remunerative "strokes" for the cooperative work with several contributing specialists that such investigations require. Besides, applied extended multiple-year systems research could be funded only with shrinking directly appropriated public funds. Industry mostly supported short-term work and public funding agencies supported more basic research but usually on a short-term basis with planning horizons hardly ever exceeding three years. Thus, studies and instruction that were most relevant to farmers and for society more fully to understand environmental issues were left partially or mostly undone.

"These cases indicated that alternative agricultural systems do work, that they are environmentally beneficial and can be highly profitable when efficiently managed."

The Report on Alternative Agriculture drew much attention. The first printing was rapidly exhausted. It was reprinted, and translated into other languages. The fourteen case studies that comprised about half of the total were perhaps the most important part of the report. These cases indicated that alternative agricultural systems do work, that they are environmentally beneficial and can be highly profitable when efficiently managed. Ironically, the case studies to show feasibility of alternatives in some farmers' hands were criticized because they were not scientific. They were conducted and published to show that some producers could apply alternative methods, with the implication that others could do so, too. From the start, it was acknowledged that the distribution of case studies was inadequate because there were no examples from the Great Plains, the Southern Piedmont and Atlantic Coastal Plain, and New England, nor from the Pacific Northwest, Alaska and Hawaii. Some important crops also were not significantly represented or not mentioned at all.

These case studies led to the conclusion that not all the farm and ranch operators applied all the technologies that were available and often used by their contemporaries in conventional agriculture at the time. Yet the farmers studied apparently were successful in their production operations and most of them had been farming for extended periods. They were not uniformly consistent in their approaches, but generally had one or more of the following characteristics:

- diversification rather than continuous planting of fields to a single or only a few annual crops,

- biological pest control and other innovative methods to reduce pesticide use,

- disease prevention in livestock rather than routine use of sub-therapeutic doses of antibiotics, and

- genetic improvements in crops to resist pests, diseases and drought, and to use nutrients more efficiently.

Alternative agriculture encompasses, but is not limited to, farming systems known as biological, biodynamic, low external input, organic and sustainable. In reality, I believe that it represents a trail toward the way to the sustainable agriculture as visualized in the legislation establishing the Leopold Center for Sustainable Agriculture. Dennis Keeney, the first director of the Leopold Center, restated the vision in the following "day-to-day" definition: "[Sustainable agriculture is] farming systems that are environmentally sound, profitable, productive, and maintain the social fabric of the rural community."

Neil D. Hamilton, Distinguished Professor of Law and Director of the Agricultural Law Center at Drake University, wrote: "The theory of sustainable agriculture is fairly simple—the development of policies and practices that ensure our nation's ability to produce the food and fiber we need without degrading our natural resources, while preserving the economic health of farmers and agricultural businesses and the social values contributed by the agricultural community to U.S. society. The potential of the concept to serve as a new way of looking at agriculture and analyzing the impact and value of decision-making is significant."

So, what has changed since NRC's Alternative Agriculture?

Essentially concurrent with the study of alternative agriculture that began in 1985, the 1987 Iowa Groundwater Protection Act established the Leopold Center for Sustainable Agriculture at Iowa State, before the NRC report was published. But there was a connection between these two events making them part of the

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same awakening because Paul Johnson would have been aware of what was happening at NRC after the committee was appointed. So, he and his colleagues in the Iowa General Assembly, David Osterberg, a professor from Mt. Vernon, and Ralph Rosenberg, an attorney from Ames, maybe had a good idea of the direction of the study as the Leopold Center was conceived and created. This was the time a proposal for a center addressing the narrower objective of more rational nitrogen fertilizer use had been prepared at Iowa State.

Much progress already has been made accepting sustainability as a desirable measure of the agriculture of the future, nationally and internationally. While not yet a household expression, the ideas of sustainable agriculture, as well as the words, regularly have appeared in the technical and popular media, and the 1992 First International Crop Science Congress, chiefly planned and held in Ames, prominently devoted its first section to "Sustainable Agriculture." This acknowledgment has continued in the Second Congress, and has shown up regularly in themes for annual national and international meetings of numerous scientific agricultural societies, and in local and state initiatives of public, private and non-governmental organizations. Based on modest searches by Adam Davis and me, at least a dozen books and scores of technical and popular papers have been printed. Further attesting to the international thrust of this concept, lending and development institutions such as the World Bank and the International Monetary Fund have included sustainable development, sustainable agriculture and environmental quality among support activities to support in developing countries.

This academic interest on the part of scientists in state, federal and other organizations has led to the establishment of numerous college courses dealing with principles and practices applicable to sustainable agriculture in Iowa and in most other states. Terry Loecke, a graduate student at Iowa State, recently concluded that all major land-grant universities have courses related to sustainable

agriculture. Iowa's other two state universities and several private colleges and universities have followed suit. Among the latter, the earliest may have been Dordt College and state universities elsewhere. Loecke also identified numerous additional colleges and universities with curricula directed toward preparing graduates with competence in subject matter central to sustainable goals in agriculture.

There have been at least three singular high points of achievement in Iowa. First was the recent establishment of one of the earliest interdisciplinary graduate curricula leading to the M.S. and the Ph.D. degrees at Iowa State University. The second was creation of the Henry A. Wallace Endowed Chair for Sustainable Agriculture in 1997 endowed by the Wallace Genetic Foundation and the W. K. Kellogg Foundation, and supported by the Leopold Center and the College of Agriculture. The third was organization of the Wallace Learning Center in southwest Iowa, housing the extension field specialist staff for the area, the Armstrong Research and Demonstration Farm, and the Precision Beef Alliance, and with the Neely-Kinyon Research and Demonstration Farm, and the Lauren Christian Swine Research and Demonstration Farm as satellites.

Several scientists were recruited to the Iowa State faculty and professional staff specifically for the purpose of studying and teaching about sustainable agriculture in the curriculum and other programs on- and off-campus. One of these was employed to devote full time to organic farming and agriculture, joining an

"More and more research scientists and extension specialists have undertaken on-farm systems research and demonstrations needed to solve problems found on farms."

extension field specialist previously appointed. At least fifty faculty and staff members are contributing participants in the new curricula.

The concept of sustainable agriculture, and the funding made available to it, has encouraged the state and federal academic and scientific communities to undertake scores of controlled and demonstration studies to generate an information base for interested farmers looking for answers to their production problems. They, too, have risen to the challenge of systems research demanding interdisciplinary cooperation. This applies to issues specifically related to sustainability and the employment of some new technologies such as the Ground Positioning System (GPS) and the Geographic Information System (GIS), both of which, along with farm machinery modifications and computer programs, provide for site specific management of farms and fields. Such site specificity permits more precise application of management and production inputs so important for practices on farms as well as on watersheds and the larger landscape. Investigators are quickly drawn to new opportunities to solve problems whenever the financial resources are available.

More and more research scientists and extension specialists have undertaken on-farm systems research and demonstrations needed to solve problems found on farms. In the process, they have enlisted the help and involvement of farmers and other local people to make available the land, labor, and machinery needed to conduct field trials. In many cases farmers have been full partners in identifying problems for study, siting the experiments, installing them and collecting much of the data. While many of the contacts for such joint efforts were made through organizations such as Practical Farmers of Iowa, many more have been achieved by way of other organizations, individual local farmers and business and professional people. We have become quite proficient in this approach, and our skills are still improving.

The Iowa General Assembly has placed its bet on informed farm and agribusiness populations—I believe others should also. Through the Leopold Center, Iowa has provided for new research, demonstration and extension efforts in order to learn and carry out selection and use of enlightened technology that is friendlier to the environment and strengthens the economic fabric and social viability of families and communities. The Agricultural Water Quality Incentive Act of 1990 and the Freedom to Farm Act of 1996 suggest that the Congress will continue to provide some incentives for groundwater protection in targeted areas. A number of private foundations now provide significant support for sustainable agriculture initiatives or execute their own programs. Some of these are foundations of long standing and international in scope and have identified sustainable agriculture as a new opportunity to be of service and others have recently moved into this arena.

As a result of these efforts, and by utilizing the newly available external resources, we are discovering and demonstrating that precise soil testing and fertilizer applications reduce potential contamination of both surface and groundwater and, at the same time, their use leads to greater profits. Also, scouting the pests and carefully managing their control provides savings in farm operations, should lead to improvements in water quality, and also lessen the potential of unwanted residues in food crops. In partnership with the Practical Farmers of Iowa, organic farming and other organizations, we multiply our efforts in demonstrations and the dissemination of information.

"There is a limit to what individual states and local and national organizations can do in the face of a well funded federal policy emphasizing production that also rewards exploitation of natural resources–a policy that provides only indirect incentives to protect the environment and landscape."

It is already evident that farmers and others will respond positively to these kinds of initiatives, but the incentive and market systems must permit them to make a living. And, in doing so, our agriculture will become more efficient, thanks to better information for more precise and careful use of technological inputs. Our ability to compete with farmers in other parts of the world will be maintained. Agriculture also would become more environmentally sound, and natural resources would be spared.

David Masumoto, a California farmer and writer, believes that agriculture has been estranged from the rest of the population. Whether or not this was universally true, in the early 1990s, he wrote: "A courtship has blossomed between farmers and environmental concerns. If given time it can lead to marriage. But we need to start thinking of farmers as part of our ecological landscape." Again, the degree to which this is the universal case is not known, but the rest of the population has repeatedly provided farming with resources and support to continue.

There is a limit to what individual states and local and national organizations can do in the face of a well funded federal policy emphasizing production that also rewards exploitation of natural resources—a policy that provides only indirect incentives to protect the environment and landscape. We know much more than we ever have about environmentally friendly practices of crop and livestock production and how they may be adapted to real situations. We also have the commitment of many farmers and professionals to advance sustainable practices once exploitative but profitable commodity programs are modified. This modification needs to provide incentives for protecting the many elements of the natural resources, environment and landscape. It must also provide for assessing the external (downstream) costs of technologies and a way of redressing damage by those causing the harm. Because some damage may not be reparable in the short or intermediate terms it has to be controlled by policy.

What has not happened since NRC's Alternative Agriculture?

Modern agriculture functions largely as it does because of the laws and policies we have established to govern it, as well as the economic and geographic forces that determine feasibility. If we had different rules, even with similar natural resources, our agriculture and our allocation of production resources would be different. Consider the change in basketball that permitted the three-point score. It has changed the strategy of the game and placed emphasis on different skills, even though the only other change was the addition of two lines on the court. Or, compare Canadian Football with that played in the National Football League. The participants, their deployment, the field and the ball are very similar, but the rules make these two very different games in strategies, tactics and resulting action.

The NRC report urged that Congress restructure federal commodity programs to remove disincentives for the adoption of alternative agricultural techniques. It specifically recommended that if the existing commodity programs are retained, they should be reviewed to remove penalties for adopting crop rotations or planting alternate crops. And it argued that farmers should be free to decide for themselves how best to produce or deliver an allotted amount of a commodity for a given production period. This means the de-coupling of farm support from production of only selected commodities. Some of these notions surfaced in the 1990 Farm Bill as the "triple base" provision to offer more flexibility, but it did not meet with total approval. The 1996 Farm Bill is phasing

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out acreage allotments, but remnants of the 1990 Farm Bill remain until the phase-out is completed and the full force of "Freedom to Farm" prevails. In the meantime, the reduced farm subsidies provided in the 1996 Farm Bill still depend on the old bases.

Thus, the major redirection of farm legislation targeting funds toward incentives more in harmony with sustainable agriculture and the public goals of maintaining land quality, and cleaner water and air has not occurred. A new round of discussions leading to passage of the 2002 farm bill would present the next opportunity for promoting these incentives. The amounts of funds historically dedicated to the maintenance of dependable agricultural producers have been significant. The effect of even part of them to achieving environmental, natural resource and landscape protection could be great, and could be lasting. In failing to restructure the commodity programs, we have failed to address the natural resource management recommendations made by the Report. The CRP, Conservation Compliance Program, and the Swampbuster and Sodbuster provisions have remained in the legislation, but funding for restoration of wetlands and establishment of riparian filter strips to improve water quality has been woefully inadequate. These funds could well come from savings generated by restructuring the commodity programs.

The regulatory changes recommended by the Report have not been fully addressed. These deal with procedures for review, approval and determining safety of new chemicals, safer working conditions, lower residues of chemicals in foods and water and improved environmental quality. Included are providing public information on the relation of appearance of foods to their safety, along with modification in cosmetic and grading standards. Emphasis should be on safety and less on appearance. Finally, in this general set of recommendations was one to assess the full societal cost of new technologies, and provide information on their effectiveness compared to the next best alternative weighing health and environmental costs against the benefits.

Even with such changes to commodity programs, however, sustainable farming will not be an immediate panacea for all our problems. Sustainable farming typically requires more information, more and differently trained labor, and more diverse management skills per unit of production than conventional farming. This is because diversification required for each additional crop and additional animal species calls for more and different skills to be successful. It takes better production management and different kinds of labor resources to operate a diversified farm (such as those that may have beef cows, finishing cattle, swine, corn, oats, soybeans and hay) than it does to operate a similar-sized farm growing only wheat and hay or only corn and soybeans. Marketing skills and capital deployment also need to be more extensive and diverse. Diversified farming cannot be done from "a tractor seat" as Clark BreDahl, an Iowa farmer, was reported to have said.

The NRC report also recommended the appropriation of at least $40 million to provide for research thrusts directed toward study of problems unique to "alternative agriculture." While SARE was created and appropriations made, they fall far short of what was recommended and is necessary. The $13 million in the budget is very small compared to the total appropriated to USDA research agencies and to the USDA Cooperative State Research, Education and Extension Service (CSREES). Some reallocation of CSREES funds and state appropriations has been made at the land-grant university level, but is still inadequate to offset almost a half century of funding for emerging chemical, biological and mechanical technologies leading mostly to use of off-farm production inputs.

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Some USDA units like the National Soil Tilth Laboratory in Ames have directed significant efforts to research applicable specifically to sustainable agriculture.

Can we meet continuing and emerging challenges?

I see four major challenges to Iowa's farming and non-farming citizens in meeting the goals of sustainability as envisioned by the Iowa General Assembly in 1987, assuming that more drastic changes in farming will not happen.

- The first is to make the common alternating corn and soybean production sequence now occupying almost two- thirds of Iowa fully environmentally friendly and enhance the quality of the "land" or find profitable and sustainable alternate uses of farmland.

- The second challenge is correctly to utilize, or otherwise dispose of, manure and other wastes of all livestock enterprises so these do not further degrade all bodies of water for uses other than drainage.

- The third is to make assessments of the many emerging molecular biological and related technologies and assess their value in meeting the promise and goals of sustainable agriculture.

- The final challenge is to assure that rural residents may continue to have a means of earning a living, and for all citizens to be able to enjoy the physical and spiritual invigoration that comes with immersion in environments and landscapes pleasing to the senses.

Gains made toward the first two challenges, that should be responsive to directed appropriate incentives, would contribute to achieving the fourth. As suggested earlier, Iowa alone cannot provide all the incentives probably needed, but it should continue to provide those it has already undertaken. Only time will tell how much incentive is enough, and if, indeed, the necessary incentives will be put in place by society.

Addressing the third challenge will require national and global involvement as well as local applied evaluations. The reason is that so much of our commodity production, of all kinds, enters bulk export trade and is subject to federal regulations, treaties and agreements. We have to assure not only our own consumers and citizens about the safety and appropriateness of each of these technological products but assure that our commodities will continue to be internationally accepted, as well.

We are not likely quickly to abandon all of the practices and technologies with which we already feel comfortable. Nor did the NRC Committee suggest that we do. Yet, more and more people are seriously exploring the possibilities of adopting more sustainable agricultural systems. They need encouragement. If the rules of the game are gradually rewritten to do this, then there may be as much emphasis on making these changes as there was for adopting technologies emerging after World War II to become the norm for conventional agriculture in the past half-century. Sustainable agriculture does have a future—it is either that or we humans have no future.

Neil Hamilton, who was quoted earlier, wrote: "The relation of sustainable agriculture to the multitude of environmental, social, and economic issues associated with modern farming practices makes the debate over the issue one of the most significant in the history of U. S. farm policy." Earlier I expressed the conviction that a sustainable agriculture is critical to the survival of humankind in its present lifestyles.

"We are overdue in adopting new policies–replacing the old with those that are better and safer for farmers, healthier for consumers, kinder to the environment, and ultimately sustainable."

Hamilton continued, "Sustainable agriculture may provide the nation with a mechanism for protecting our environment from pollution by agricultural practices in a method that minimizes regulation and emphasizes research, education and sound economic decisions to promote alternative production practices. The concept has great potential for our nation. Sustainable agriculture may remove the tension from the debate between the farm sector and environmentalists, it may restore and protect consumer confidence in the quality of the nation's food supply, it may justify continued federal spending on the farm sector at a time when federal price support expenditures are under fire, and most importantly, it may provide farmers with the opportunity to rightfully claim the title of land steward to which they aspire."

I do not think that the general public will let us forget our responsibility for environmentally safe farming practices, the security, wholesomeness, and safety of its food supply and the importance of preserving the environment and the landscape. We are overdue in adopting new policies—replacing the old with those that are better and safer for farmers, healthier for consumers, kinder to the environment, and ultimately sustainable. After all, we will depend on agriculture for food forever—that is a long time. Even if we do not look forward any farther than we look back to the beginning of agriculture, we are speaking not of decades or centuries but of thousands of years. And our population continues to grow.

Will our agriculture last?

It must. If it does not, remember the conclusion of Lee and DeVore that 90 percent of all humans until 1968 have lived as hunter-gatherers, and that has been the most successful (longest lasting) adaptation of "cultural man." Very few with whom I have talked are willing to go down that road, except for a few days each year. Slipping back to hunting and gathering would be a harsh "default" consequence of frittering away our resources, especially our collective intellect.

THE CO-SPONSORS:

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The Iowa State University Agronomy Graduate Student Club serves three primary purposes. First, the club provides a forum for agronomy students to share ideas and concerns and to socialize. Second, the club facilitates two-way communication between the large, diverse agronomy graduate student body and the Agronomy Department and the College of Agriculture administration. Finally, the club encourages participation in community outreach activities such as presentations at the Ames Children's Museum and the Roosevelt Science Night.

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Extension is the educational outreach arm of Iowa State University and directly serves Iowans in all 99 counties. Extension is a partnership of local, state and federal resources and meets the daily needs of citizens in agriculture and natural resources, families, communities, youth and 4-H, and business and industry.

A deep appreciation and sincere thanks go to those known and unknown students, faculty, staff and other friends who have made this Colloquium possible.

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The objectives of the club are to acquaint present and potential members with opportunities in soil and water conservation fields, to develop leadership and create a spirit of fellowship among members, to foster the development of professional attitudes and to encourage recognition of the need for continued professional and intellectual improvement; and to promote the interests of students in soil and water conservation fields as these interests relate to professional advancement and to the Soil and Water Conservation Society.

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Founded in 1985, Practical Farmers of Iowa is a non-profit sustainable agriculture network of producers and consumers. Its mission is to promote farming systems that are profitable, ecologically sound, and good for families and communities.

VISION 2020

Vision 2020, funded by the Kellogg Foundation and Iowa State University, supports Iowa's educational system, promotes sustainable agriculture and fosters healthy communities.

The author acknowledges the help of the following in providing information, verifying facts, editing or suggesting improvements in this manuscript; Mary Adams, Alfred Blackmer, Lorna Michael Butler, Adam Davis, Brian DeVore, Jerry Dewitt, Michael Duffy, Charles Frances, Elizabeth Granberg (for Wes Jackson), Elaine Elvess (for Jim Gulliford),Fred Kirschenmann, Matt Liebman, Terry Loecke, Don Ralston, Ricardo Salvador, Karl Stauber and Gretchen Zdorkowski; and he accepts full responsibility for any information that was used incorrectly, and apologizes for any persons overlooked.