APPLYING LISA CONCEPTS ON SOUTHERN FARMS

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The term LISA was coined in 1988 as an acronym to identify a federally funded research and education program designed to address the public issue of agriculture and the environment (USDA-CSRS, p. 2). LISA is made up of two related, but different, concepts: low input and sustainable agriculture. This combination reflects a compromise between two different perspectives of the environmental issues confronting agriculture.

The low input perspective is that farmers must reduce their use of commercial chemical inputs as a means of reducing environmental and ecological risks. The sustainable agriculture perspective is that long-run productivity and utility of agriculture depend ultimately on our ability to keep farms both ecologically sound and economically viable. Reduced reliance on commercial inputs is seen as one means of addressing the ecological risks that could threaten long-run sustainability.

An initial emphasis on the low input half of LISA raised serious concerns among farmers and many others associated with conventional, commercial agriculture. General farm organizations, commodity associations, agribusiness firms, and the public research-extension establishment all seemed to see LISA as a threat. The chemical input technologies developed, implemented, and supported by these groups were being questioned, and in some cases condemned, by people and organizations outside the traditional agricultural mainstream.

Even now, many of the concerns expressed about LISA seem to focus on low inputs and seemingly ignore the sustainable agriculture dimension of the issue. Meanwhile, sustainable agriculture, rather than low inputs, has emerged as the dominant aspect of LISA. For example, the term sustainable agriculture is prominent in the 1990 farm bill, while low input, as a type of agriculture, is largely ignored (U.S. Congress). An emphasis on the long-run sustainability of U.S. agriculture could have far different implications for southern farms than those implied by a simplistic restriction, ban, or even lowering of commercial agricultural inputs.

IMPACTS OF REDUCED CHEMICAL USE ON SOUTHERN COMMODITIES

Any threat by LISA quite logically might seem greater to those who are more dependent on commercial chemical inputs, particularly pesticides and fertilizers. Southern farmers are confronted with a wider variety and greater intensity of insects, diseases, and weeds than are farmers in any other major agricultural region of the country. Warm, humid summers and mild winters provide favorable breeding, multiplying, and growing conditions for many agricultural pests. These same climatic conditions have contributed also to soil erosion, rapid breakdown of soil nutrients, and declining natural productivity of southern soils.

Consequently, many southern farmers have become highly dependent on commercial pesticides and fertilizers. They see no way to eliminate or even significantly reduce commercial inputs without losing their ability to compete with farmers in the Midwest who have more naturally fertile soils and fewer pest problems. Thus, southern farmers might logically feel threatened by any movement that would restrict commercial input use in agriculture.

A research project funded by the Tennessee Valley Authority, the American Farm Bureau Federation, American Soybean Association, and several agribusiness firms was designed to estimate the potential economic impacts of reduced chemical use in agriculture (Knutson, Taylor, Penson, and Smith). The project considered potential impacts of totally eliminating all pesticides; assuming no insecticides, herbicides, or fungicides except for seed treatment—and eliminating all chemicals; assuming no pesticides or inorganic nitrogen fertilizer. These scenarios were assumed to establish the outer bounds, or maximum impacts, within which more realistic changes in input use might be judged.

Leading plant scientists at land-grant universities were asked to provide estimates of yield reductions for each chemical use scenario for the commodities and production regions of their expertise. The scientists were asked to consider potential changes in cultural practices such as crop rotations, green manure, and increased mechanical cultivation and hand

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labor in formulating their responses. Farm management economists at the same universities were asked to provide estimates of changes in costs of production associated with the projected changes in yields.

Macroeconomic models were used to estimate impacts on the agricultural sector and general economy based on projected crop yield and cost impacts. The study showed very modest impacts at the aggregate levels, even assuming elimination of chemicals from use on crops that account for more than 70 percent of total commercial chemical use. Food price inflation was only 4 points higher (8.2 percent) without pesticides or commercial nitrogen than for the base line food inflation rate (3.9 percent) for the 1991-94 transition period. After 1994, total weekly food costs were projected to be only 6.5 percent higher ($4.39/family/week) without pesticides than with continued pesticide use and only 12 percent higher with no chemicals, essentially organic farming. Total Gross National Product was estimated to drop by less than 0.5 percent under either scenario. Aggregate net farm income was projected to increase; but only marginally, for the 1995-98 period — for the no pesticide scenario. Higher net returns for crop producers were largely offset by lower projected net returns for livestock and poultry producers.

The more significant impacts of elimination of agricultural chemicals would be felt at the individual farm and regional levels. Projected crop yield reductions without pesticides ranged from 24 percent for wheat to 78 percent for peanuts. Yield reductions without pesticides or commercial nitrogen ranged from 38 percent for wheat to 62 percent for cotton, 63 percent for rice, and again 78 percent for peanuts. Increases in per unit cost of production ranged from 27 percent for corn to over 300 percent for peanuts. Such yield reductions and cost increases would have obvious negative short run impacts on individual farmers who depend on these commodities for a living. Increases in price to offset reduced yields and increased costs might not occur simultaneously and might not be equally offsetting for all farmers.

Impacts might also be significantly different for farmers in different regions of the U.S. Commodities common on southern farms showed the greatest negative impacts for elimination of pesticides and commercial nitrogen. Peanuts, rice, and cotton lead the lists for production cuts and cost increases. In addition, the study indicated that projected yields dropped more in the South than in other regions for the same crops. For example, soybean yields were projected to drop 51 percent in the Delta compared with a 33 percent drop in the North Central region. Consequently, total costs per bushel of soybeans were projected to rise by 90 percent in the Delta compared with 37 percent in the North Central region.

The chemical reduction report simply verifies common knowledge that conventional, southern agriculture is more dependent on agricultural chemicals than is any other major agricultural region in the U.S. Thus, elimination of chemicals would be expected to have a greater negative impact on yields and costs of commodities produced predominantly in the South and on yields of Southern farms of commodities common in other regions.

However, such conclusions provide little if any information regarding the potential impacts of adopting LISA farming concepts on southern farms. LISA farming is not synonymous with the elimination of commercial pesticides or fertilizers. LISA does not imply organic farming. The low input half of LISA relates to reducing inputs, but not reduced inputs without acceptable alternative means of controlling pests and maintaining soil fertility.

A literature review based study by Pimentel and others, for example, indicates that total pesticide use could be reduced by 50 percent with no decrease in crop yields. They concluded that commercial chemical pesticides could be replaced by integrated pest management, biological pesticides, and mechanical weed control at a total added cost equivalent to only 0.6 percent of total purchased food cost. These results are not necessarily inconsistent with the Knutson study since costs might rise dramatically as pesticide use drops from 50 percent reductions to total elimination.

In addition, the sustainable agriculture half of LISA considers productivity and profitability to be equally as important as environmental protection and resource conservation. The feasibility of applying LISA concepts on southern farms is not a question that can be addressed so simplistically as to ask what would happen to regional crop yields and costs of production if pesticides and commercial fertilizers were banned. The fact that this simplistic assumption is so common, however, implies that any meaningful treatment of this subject should include definitions of relevant terms.

DEFINING THE TERMS

Low(er) input farms may be characterized as operations which rely less on external commercial inputs, particularly commercial pesticides and fertilizers, and consequently must rely more on management of internal resources, such as land and labor. Reducing inputs, in the LISA context, does not necessarily imply reducing the combined use of inputs and resources. In general, lower inputs imply a substitution of internal resources for external inputs (Rodale, p. 3).

Lower input farming methods are important elements of alternative agriculture. Alternative farming, as defined by the National Research Council, includes a range of practices such as integrated pest management; crop rotations designed to reduce pest damage, improve crop health, decrease soil erosion, and fix nitrogen in the soil; and tillage and planting practices that reduce erosion and control weeds (p. 4). Alternative farming systems rely more on management of internal resources and less on external or commercial inputs, and thus may be characterized as low input systems.

The primary goal of alternative agriculture is to improve the ecological soundness of farming through reducing environmental risks and protecting the non-renewable resource base. Productivity and profitability are considered to be essential elements of alternative agriculture, but may be viewed as constraints rather than objectives. Lower input systems, in general, reduce environmental and resource risk and thus are consistent with the goals of alternative agriculture. However, farming systems which fail to utilize all available productivity-enhancing technology may be neither socially nor economically viable over time, and thus may not be sustainable (Ruttan).

Conventional agriculture is distinguished from alternative agriculture primarily by differences in goals and objectives. The primary goal of conventional agriculture has been to increase agricultural productivity as a means of reducing real costs of food, clothing, and shelter. Technology-induced farm profits have been short-run in nature and have gone primarily to the innovators. Environmental protection and resource conservation have been viewed as constraints to achieving greater production efficiency. Conventional farming systems are generally conceded to be more productive and profitable than are most currently available alternative systems. However, conventional farming systems have begun to raise serious questions regarding environmental and resource risks, and thus may not be sustainable.

Sustainable agriculture treats both the ecological and economic objectives of agriculture as essential and equally critical. A sustainable agriculture must be capable of maintaining its productivity and usefulness of society indefinitely (Ikerd). Thus, it must be both ecologically sound and economically viable. The 1990 farm bill defined sustainable agriculture as an integrated system of farming that over the long-term will satisfy human food and fiber needs, enhance environmental quality and the natural resource base, make efficient use of non-renewable and on-farm resources, sustain the economic viability of farming operations, and enhance the quality of life for farmers and society as a whole (U.S. Congress).

Thus, sustainable agriculture represents a balance between conventional and alternative agricultural systems. Sustainable agriculture treats environmental protection, resource conservation, efficient food and fiber production, financial viability of farmers and quality of life in rural communities as multiple objectives in achieving the goal of long-run sustainability. Environmental protection and resource conservation are viewed as investments in long-run productivity and profitability. Productivity and profitability are viewed as prerequisites for resource conservation and environmental protection.

SUSTAINABLE AGRICULTURE: A MATTER OF PHILOSOPHY

The difference between sustainable and conventional agriculture is more a matter of difference in farming philosophy than of farming practices or methods. Differences in philosophy cannot be subjected to scientific analysis. Thus, some scientists have concluded that comparisons of conventional and sustainable systems fall outside the realm of science (Council of Agricultural Science and Technology [CAST], p. 7). However, all scientific inquiry begins with at least two basic value judgments. How does the world work? What is the basic purpose of human activity? Science has yet to provide definitive answers to either of these questions. The fact that one group of scientists assumes one set of answers and another group assumes another set does not imply that one group is made up of scientists and the other is not.

Agroecology provides a philosophical foundation for the sustainable agriculture concept. Agroecology is a synthesis of agriculture and ecology (Altieri). Agriculture, by its very nature, represents an attempt to enhance the productivity of nature in ways that favor humans relative to other species. However, the discipline of ecology views humanity as only one component of an essentially interrelated ecosystem that includes all people as well as the other biological species and physical elements of the biosphere.

The concept of agroecology implies a right of humans to shift the ecological balance in favor of themselves relative to other elements of the ecosystem. However, attempts to shift the balance too far, too fast, in favor of humans relative to other species, in favor of some people relative to others, or in favor of the current generation relative to later generations, may destroy the critical ecological balance upon which the survival of humanity ultimately depends. Quality of human life is a product of relationships among humans and between humans and non-human elements of the biosphere.

Actions taken in any part of the ecosystem have consequences for all other parts of the system, both now and in the future. Agroecologists contend that agricultural technologies ultimately must enhance nature rather than replace nature and must work with nature rather than attempt to conquer nature. The constraints of nature on humankind can be moved but not removed.

A purely humanistic philosophy of agriculture views humans as having dominion over all other species and over the biosphere in general. Quality of human life is a product of bringing this dominion under human control. The purpose of agriculture is to serve humanity. Any constraints to productivity imposed by nature can be removed by future technology and thus are viewed as temporary obstacles to be overcome. The purpose of technological development is to replace limited natural resources and limited natural production processes with technology-based alternatives. The implicit assumption is that technology ultimately can remove all constraints to human progress.

Science has yet to prove which of these philosophies is most correct. However, intelligent people, including scientists, differ with respect to their philosophies regarding the relationships between people, agriculture, nature, and the fundamental purpose of developing new agricultural technologies. Those concerned with the sustainability of agriculture tend to lean more toward an agroecological viewpoint while those who see little relevance of the sustainability issue tend to take a more humanistic view. In the absence of scientific proof that one view is right and the other is wrong, scientists should be willing to pursue knowledge and to develop technologies that are consistent with both.

A SYSTEMS APPROACH TO FARMING

Agroecology implies a systems approach to farming, integrating technology and natural processes to develop productive systems. Consequently, the concept of sustainable agriculture must be applied to farming systems rather than to individual farming methods or practices. The National Research Council defines a farming practice as a way of carrying out a discrete farming task such as preparing a seed bed, applying fertilizer, or spraying pesticides (p. 424). A farming method is defined as a systematic way of accomplishing a basic farming function such as establishing, protecting, or feeding a crop that is achieved by integrating a number of complementary farming practices (p. 423). A farming system is defined as an overall approach to farming derived from a farmer's goals, values, knowledge, available technologies, and opportunities, and is constructed by integrating a number of complementary farming methods (p. 424).

A given set of farming practices or methods is not inherently more or less sustainable than any other set of practices or methods. Sustainability depends on the nature of whole farming systems. The goals and values of long-run sustainability must be reflected in combinations of practices and methods that are consistent with an individual farmer's unique set of resources, including his or her knowledge base, technical know-how and farming opportunities. Sustainable farming systems are very much individual farmer and farm site specific.

Sustainability is determined by the system, considered as a whole, not by its individual components. Thus, farming for sustainability requires a holistic approach to farm planning and management. Whole systems have qualities and characteristics not present in any of their constituent parts, thus one must seek to understand the greater whole in order to understand its parts, not vice versa (Savory, p. 30).

Agricultural economists traditionally have taken a reductionist approach to farm management. Analysis, by nature, implies a separation of the whole into its component parts. Farm enterprise analysis has been an appropriate and effective approach to increasing productivity during the industrialization era in U.S. agriculture. However, the social agenda for agriculture has been expanded beyond productivity to include resource conservation, environmental protection, and social acceptability as well. Farming for long-run sustainability will require a holistic, total systems approach to farm planning and management rather than the reductionistic, enterprise-based approach of the past.

SYNERGISM: THE KEY TO SUSTAINABILITY

LISA implies lower input farming systems that are also sustainable. However, if lower input systems are to be sustainable they must be able to compete in terms of production and profits with conventional, higher input systems of farming. Thus, the primary challenge in successfully applying LISA concepts in any farming region of the country is to reduce reliance on external inputs while maintaining or enhancing productivity and profitability.

Over the past several decades, greater specialization of production on U.S. farms has results in impressive gains in economic productivity. Specialization combined with mechanization has allowed farmers to realize economies of scale associated with farming larger units. Relatively cheap and effective commercial inputs have been another key factor supporting the trend toward fewer, larger, and more specialized farms.

LISA farming systems, however, tend to be more diversified and quite likely smaller than their conventional counterparts. LISA systems rely less on the commercial inputs needed for industrial systems of farming and thus must rely on more intensive management of land and labor. Consequently, synergistic gains resulting from systems integration and intensive management must be found to offset any further potential gains from specialization and economies of scale, if lower input systems are to be commercially competitive.

Government farm programs and publicly funded research have implicitly supported industrialization as a means to improve agricultural productivity. This assertion by the National Research Council went largely unchallenged in the CAST review of the NRC report, *Alternative Agriculture,* by 46 different scientists. Thus, some of the advantages of specialized farming reflect their preferential treatment by the public sector.

The conservation and environmental provisions of the last two farm bills reflect a trend that could eventually remove the past bias favoring short-run economics over long-run ecology. However, the extent to which the current generation will make short-run sacrifices to ensure the welfare of future generations is limited. Sustainable, lower inputs systems will require intensive, systems management to remain commercially competitive under any reasonable policy scenario.

The term synergism means that the total is greater than the sum of the parts. It implies values within whole systems that are not inherent within the individual parts of systems. The value of a good or service in consumption is not an inherent characteristic of the physical product, but reflects the time, place, form and possession characteristics of the product in total. The essence of the whole of something is the arrangement of its parts with respect to time, space, form, and possession. Arrangement is not a characteristic of parts but rather of the whole.

For example, a televised picture is made up of a multitude of colored dots on a screen. There is virtually an infinite number of different patterns, pictures and texts that could be created using a given assortment of red, blue, and green dots. The value of any visual message created on a screen depends first upon the viewer, but then upon the sequence of different spacial arrangements of the dots over time. The value is much more a reflection of the arrangement of dots than of the nature of the individual dots being arranged.

The discipline of economics typically treats time, place, form, and possession as aspects of utility in consumption. However, these principles apply to the various stages of production, as well. The creation of value is not a simple matter of changing the forms of things through the physical processes of production. Value can be produced also by changing the arrangement of various components or parts that make up total production systems. Thus, synergism is the product of the spacial, temporal, physical, and ownership arrangement of resources, inputs, and intermediate products within the whole of a system of production.

A simple example of each general type of gain may serve to illustrate the basic nature of potential synergistic gains from holistic management of farming systems in general. The time, space, form, and possession characteristics of production systems are obviously interrelated and are treated separately here only for purposes of illustration.

A crop rotation represents a temporal sequence of farming methods and practices. A particular sequence of crops may result in increased yields, reduced commercial pesticide and fertilizer requirements, and reduced soil erosion. A cropping sequence may break biological pest cycles, fix nitrogen from the air, and keep the ground covered during periods of heavy rainfall. In other words, crops grown continuously in separate fields may result in higher total costs, greater environmental risks, lower production and less profit than would the same crops grown in a logical rotation or cropping sequence. The added benefits come from the temporal arrangement.

The spacial matching of crops and livestock enterprises to particular climate and soil characteristics is a critical factor in determining both economic and ecologic results. Most crop and livestock species have natural comparative advantages in production in particular regions of the country. Cotton, peanuts, rice, and tobacco, for example, are more common in the South because they historically have had comparative advantages under southern growing conditions. When crops and livestock are grown in regions for which they are not particularly well adapted, the natural environment must be modified.

Relatively cheap and effective commercial pesticides, fertilizer, fossil fuels, and irrigation water have allowed commercially competitive production of many commodities outside their range of previous comparative advantage. However, the increased use of these particular inputs and resources is now a primary source of concern in view of environmental risks and resource depletion. Environmental risks are not an inherent characteristic of a plant or animal, nor even inherent to particular chemicals. Risks and returns, in many cases, are determined by the location of production, or spacial arrangement, among regions of production or even among fields on a farm.

The basic function of agriculture is to convert solar energy into energy forms that will provide human food, clothing, and shelter. This energy conversion process requires an interaction of sunlight with various forms of previously stored energy and matter. Thus, the concept of form is fundamental to production of value. Any point prior to consumption at which we define a production process as being completed is fairly arbitrary. Production processes are, in reality, continuous cycles of change in the forms of energy and matter. The product of one process is an input or resource for a following process.

Over time, U.S. farmers have changed from being basic producers of food and fiber to being primarily converters of purchased inputs into raw materials. However, some farmers now have begun to buck this trend. They are expanding their operations vertically rather than horizontally. They are producing some of their own inputs and substituting resource management for others. They are adding more value to their products by integrating some or all of the traditional processing and marketing functions into their farming operations.

This individualized vertical integration process is typically associated with niche markets. However, producing for niches successfully requires far more than finding a unique marketing opportunity. Successful niche farmers tailor the output of each production process to fit the input requirement of the next process. They choose to supply markets that match their unique human and physical resource bases. In addition, many utilize wastes from one stage of production as inputs in another, in order to reduce costs and environmental risks. Their success may depend more on gains from their unique vertical arrangements of form- changing processes than on either their market niche or the individual processes considered separately.

Ownership Synergism

The utility of possession or ownership is an individualistic concept. Different individuals have different tastes and preferences and different values, skills and abilities. Thus, the value of a given product form at a given place and time will not be the same for any two individuals. Likewise, the opportunities and risks associated with a given production situation will be different for each individual producer.

The fundamental purpose of markets is to facilitate trade among those who value things differently. Economists typically value inputs and products at their market value. For example, a hog enterprise typically would be charged market value for corn produced on a diversified farm to determine the contribution of hogs to profits of the overall operation. Likewise, the corn enterprise would be credited for market value of corn in determining its contribution to farm profits. Such an analysis answers the question of whether hogs, corn, or both individually would be profitable. However, individual enterprise analyses based on market values cannot answer questions concerning the profitability of corn-hogs as a system.

Market values reflect opportunity costs. Thus, the market value of corn to a hog enterprise is not the same as the market value of corn to a corn enterprise. If the farmer bought corn on the open market, he or she would have to pay an explicit or implicit transaction cost associated with the market exchange of ownership. The process of exchange is not cost free, even where differences in time, place, and form are not involved. The fundamental process of matching buyers and sellers involves costs. If the farmer sells corn on the open market, he or she must also bear a transaction cost. Transaction costs increase the accounting cost of corn to the hog enterprise and reduce the accounting returns from corn to the corn enterprise.

No transaction costs are involved in a corn-hog system under one ownership. The sum of the two transaction costs represents a synergistic gain for corn-hog systems. This gain cannot be logically allocated either to the corn or hog enterprises, because it is associated with the combined ownership of both hogs and corn and not with the ownership of either separately. The potential transaction costs savings for a corn-hog system results from the ownership arrangement; not from either hogs or corn.

In reality, the dimensions of time, space, form, and ownership are inseparable. Thus, a holistic approach to farming is a matter of managing the temporal, spacial, physical, and ownership arrangements of interrelated sets of markets, resources, inputs, products, and processes. Holistic management is complex, but within this complexity lies the potential for synergistic gains. And, such gains come from management, the process of choosing arrangements, and not from a given endowment of land, labor, or capital resources.

Risk Synergism

Another important dimension of sustainability is risk. Sustainable farming systems must be able to survive the economic and ecological shocks associated with agricultural production and marketing. Farming systems that are productive and profitable under average growing conditions with average markets, for example, may not be able to withstand adverse changes in weather, markets, pest pressures, or public policies. Avoiding risks is not the solution. The profits needed for long-run sustainability are in fact a return to risks. One key to survival and sustainability is to manage risks.

Crop insurance, forward pricing, and government program participation are common means of managing risks associated with individual enterprises or commodities. However, diversification may replace or complement other risk management strategies. The variance of whole-farm net returns will be less than the sum of the variance of net returns of the individual enterprises, assuming that net returns from the individual enterprises are not perfectly, positively correlated. The larger the number of enterprises and the lower the positive, or higher the negative, correlations among enterprises, the lower the resulting whole-farm variance relative to the sum of individual enterprise variances. The reduction in variance, and reduction in risk for a given whole-farm net return, is a characteristic of the whole system and not an inherent characteristic of the parts.

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How successfully can LISA concepts be applied to southern farms? No one has the answer to this question. However, there is no reason to think that LISA concepts will be any more difficult to apply in the South than in any other region of the country.

Farming With A Sustainable State of Mind

The fear of LISA among southern agriculturalists stems largely from a conventional paradigm or mind-set regarding the difficulty of producing conventional southern crops by conventional farming methods, without conventional pesticides and fertilizers. This conventional farming paradigm is reflected in land grant scientists' projections of yield reductions and cost increases in the Knutson, Taylor, Penson, and Smith study of reduced chemical use. Non-conventional means of controlling pests and feeding crops are fundamentally inconsistent with a conventional farming mind-set.

The first step in applying LISA concepts on southern farms may be a change in the paradigm of southern farming. Recent evidence indicates that southern farmers may be adopting fewer known alternatives to input-intensive farming, in spite of greater pest pressures and fertility problems in the South.

The 1987 Natural Resources Inventory implies that southern farmers rotate their crops less than do farmers in the Midwest. For example, data for 1987 reveal that over 70 percent of southern farmers planned to plant soybeans on land also planted to soybeans for at least two of the three previous years (Monson). This figure was 21 percent for a similarly comprehensive region of the Midwest. Approximately two-thirds of southern soybeans were reported to be double-crop beans. However, continuous double cropping still results in the same crops being in the same fields at the same times year after year. The South Atlanta and Gulf Area land resource area included in this study ranges geographically from eastern Virginia and North Carolina, through the Southeast, and to just inside Texas and Oklahoma.

Continuous cropping systems (defined as three out of four years in the same crop) for the South and Midwest were similar in percentage for corn (43 and 40 percent) and milo (30 and 34 percent), but in continuous small grains were nearly twice as common in the south (26 percent) as in the Midwest (14 percent). Two-thirds (66 percent) of 1987 planting intentions for cotton was reported on land where cotton was grown two or more of the three previous years and 39 percent of tobacco was grown in essentially continuous cropping systems. Peanuts was the only major southern crop reported to be highly dependent on rotations, with less than seven percent of peanuts grown three out of four years on the same land.

Many of the factors considered to be disadvantages for southern farmers in the past are a result of farming in the South with a northern, conventional agriculture mind-set. An agroecological philosophy of farming would view many of the past liabilities of southern farming as potential future assets.

Southern agriculture has some unique natural production advantages that might support successful, sustainable systems of farming with fewer commercial inputs. Moderate climates and long growing seasons offer longer periods for photosynthetic solar energy conversion. Adequate to abundant rainfall provides much of the South with a natural long-run production advantage over regions that currently depend on declining aquifers or publicly subsidized irrigation water.

More rapid energy cycling in southern climates may offer a natural advantage in recycling of agricultural waste and biological regeneration of organic matter. The greater ability of living organisms to survive and multiply in the South could be an advantage as biological means of pest control become more common. Rapid human population growth in the South may offer a natural location advantage for southern farmers in a more energy conscious society of the future. However, turning current liabilities into future assets will require a change in mind-set, a new paradigm.

A farmer with a sustainable state of mind must answer three basic questions regarding his or her farming operation. How would I farm differently if I had to make a living on this farm a hundred years from now, or a thousand years from now? How would I farm differently if I had to live down-wind or down-stream from this farm over the next hundred or thousand years? Finally, among those things I would do differently, which can I afford to do while still earning an acceptable living over the next year or ten years? Sustainability is a matter of balancing long-run necessity against short-run reality. Sometimes, conflicts exist that can be addressed only by society through changes in government programs.

Policies for Sustainability

Past government programs have been designed to stabilize commodity prices and farmers' incomes. These programs have allowed farmers to specialize, mechanize, and adopt production-increasing technologies in a less risky environment. Government commodity programs with target and loan prices, disaster payments, crop insurance, export subsidies, subsidized irrigation water, subsidized farm credit, and regulated commodity markets are all examples of programs that favor specialized, mechanized, technology-based systems of farming.

It is difficult to imagine agricultural policies that are fundamentally different from those of the past. But, fundamentally new policy directions may well emerge as society addresses its new agenda for agriculture. Farming systems that have seemed idealistic or totally unrealistic under past farm programs could become logical and profitable with new directions in farm policy. The Knutson, Taylor, Penson, Smith report indicates that almost any new environmental policy direction, short of mandated organic farming, might be socially acceptable in terms of any potential negative impacts on food costs.

Government program bases and allotments for cotton, peanuts, rice, and tobacco have tended to keep these same commodities on the same farms year after year. Commodity subsidies are based on historic acres, yields, or both. In most cases, the holders of these government subsidy rights have had incentives to pursue input-intensive methods of production. The extent to which such farmers can use crop rotations to control pests, for example, has been limited by the total land available on a given farm.

Farmers without government-subsidized production rights have been unable to economically incorporate program crops into their farming systems, no matter how well those crops may have complemented other aspects of their overall farming systems. Subsidized production of program crops has kept market prices at unprofitable levels for those outside the program. Such programs have also tended to fix total production of program commodities in specific regions of the country, even though comparative advantages in production may have changed over time.

A decoupling of government programs from commodity production could dramatically increase the possibilities for synthesizing more sustainable systems of farming in the South. Such policy changes could increase the risks of specialized systems and make diversified systems more desirable, if not a necessity, on most farms. A recoupling of program benefits to environmental and conservation objectives could reward resource management rather than input intensity and make lower input systems more profitable and sustainable.

There is no reason to believe that southern farms would be any less competitive under policies that emphasize long-run sustainability than under past programs that have emphasized short-run productivity. In fact, midwest farmers may have received a disproportionate share of government subsidies in the past because they have farmed the land thought to have the greatest potential for production. Policies designed to sustain a growing population over time will require continued, ecologically sound production in regions of marginal natural productivity, and just might result in new advantages for farming in the South. A key to success will be the ability of southern farmers to take advantage of these new opportunities by developing and managing integrated, knowledge-based systems of farming.

Knowledge: The Key to Future Productivity

Alvin Toffler, in his book *Power Shifts,* contends that knowledge will be the key to economic and political power in the future. He argues that the smoke-stack era in which power was associated with control of capital and the physical means of production is passing. Toffler suggests that power in the future will belong to those who know how to access and synthesize data and information into value-added knowledge (pp. 18-20).

Toffler summarizes his hypotheses concerning the new system of wealth creation with twelve basic characteristics of future knowledge-based systems (pp. 238-240):

1. The new system for wealth creation is increasingly dependent on data, information and knowledge.
2. The new system of flexible, customized, "de-massified" production will turn out products at costs approaching those of mass production.
3. Conventional factors of production—land, labor, raw materials and capital—become less important as knowledge is substituted for them.
4. Capital becomes extremely fluid and the number of sources of capital multiply.
5. Goods and services are modular and configured into systems.
6. Slow-moving bureaucracies are replaced by "ad-hocratic," free-flowing information systems.
7. The number and variety of organizational units multiply.
8. The most powerful wealth-amplifying tools are inside workers' heads, giving them a critical share of the "means of production."
9. The new heros are the innovators who combine imagination with action.
10. Wealth creation is recognized to be a circular process, with wastes recycled into inputs for the next cycle of production.
11. Producer and consumer, divorced by the industrial revolution, are reunited in cycles of wealth creation.
12. The new wealth creation system is both local and global, doing things economically on a local basis but with functions which spill over geographic boundaries.

These are the same basic characteristics that have been associated with sustainable farming systems. Sustainable farming systems:

1. Are management-intensive and knowledge-dependent.
2. Are individualistic and site-specific.
3. Substitute knowledge and information for inputs.
4. May require capital from non-traditional sources.
5. May produce composite products for specific niche markets.
6. Depend on free-flowing information from multiple sources.
7. Tend to be smaller and more varied in size and character.
8. Combine functions of thinking and doing in family operations.
9. Rely on innovative arrangements of parts within whole systems.
10. Utilize wastes and on-farm inputs in production processes.
11. Connect production with consumption, producing for niches.
12. Rely more on local resources but may produce for global market niches.

Toffler contends that knowledge-based systems will replace the industrial, capital-based systems of the past. Economic and social power will shift from those who possess capital to those who possess knowledge. He contends that the smoke-stack industries lack the necessary flexibility to adapt to accelerated changes in needs and desires of society in the twenty-first century. Power in the future will accrue to those who have the knowledge needed to translate resources, inputs, and raw data into goods, services, and information tailored to narrowly segmented markets. Toffler contends that pursuit of power, not environmental protection or conservation, will be the primary motivation for adopting knowledge-based systems of production.

Many of the economic gains in agriculture have resulted from applying smoke-stack production and business principles to farming. If the smoke-stack era is coming to an end, the process of agricultural industrialization could be nearing an end, as well. Further attempts to apply the industrial model in farming may result in declining economic benefits at increasing economic costs. The era of input-intensive farming may be coming to an end, with or without a new social agenda for agriculture.

Value created on farms in the future may result much more from the application of knowledge than from the possession of either resources, capital, or production technology. Value from knowledge results from the arrangement of things with respect to time, place, form, and ownership. Knowledge is not an inherent characteristic of the components or parts of a system. Knowledge is embodied in arrangements which are characteristics of wholes.

Knowledge-based systems of farming could reduce, if not eliminate, many of the existing resource and capital constraints to future agricultural productivity. Toffler contends that knowledge is the most democratic of all sources of power (pp. 19-20). It is infinitely expandable since there is essentially no limit to how much we can create or use once it is created. The same knowledge can be used by many people at the same time and is more likely to be expanded than expended through simultaneous use. And, knowledge can be created, in principle at least, just as effectively by the weak and poor as by the strong and rich.

Knowledge-based farming, then, could shift the entire balance of power and wealth among types of farms, types of farmers, and regions of the country. Knowledge based farming will favor those farmers who are best able to gain and use knowledge; those farmers most capable of creating value from knowledge and those regions of the country with the most knowledgeable farmers managing knowledge-based farming systems.

LISA farming systems are fundamentally knowledge-based systems of farming. How will farmers in the South fare in applying LISA concepts? It will depend on their ability to gain access to the knowledge needed to develop systems appropriate for their individual resource bases. The inherent quality of their resource base, including their current financial position, will be less critical than their ability to manage those resources. Their access to knowledge may depend to a great extent on the willingness and ability of land-grant universities to provide the necessary data, information, and intellect.

Holistic management of the physical, biological and financial components of farming systems, oriented toward a goal of long-run sustainability, may be a classic example of knowledge-based systems of wealth creation. The ability of farmers to participate successfully in the era of knowledge-based wealth creation may well depend on the ability of the land-grant university system to move from an industrial agriculture paradigm, designed to increase productivity, to a knowledge-based paradigm, designed for long-run agricultural sustainability.

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