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Sustainable Agriculture and Public Policy

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Sustainable agriculture is consistent with the concept of sustainable development, which focuses on economic development as distinct from economic growth. Economic growth requires an increase in output. Economic development can be achieved by increasing the quality of inputs and/or outputs without expanded output. Sustainable agriculture provides adequate food output, although perhaps not increased output, while meeting several societal objectives, such as environmental quality, viable rural communities and enhanced farm family lifestyles. This paper addresses economic development, but not necessarily economic growth, of Maine agriculture.

The idea of sustainable agriculture grew from concerns about the heavy use of non-renewable resources by the agricultural system. Increasing applications of purchased inputs, most petroleum based, by farmers who use conventional practices have been questioned for some time. The concern was heightened by the petroleum shortages of the 1970s, and further emphasized by: increasing evidence of surface and ground water pollution from toxic chemicals applied on fields; by pesticide residues on non-target fields, food, and farm workers; concern about environmental costs from conventional farming practices; and by costs to future generations from heavy uses of nonrenewable resources and the depletion of plant and animal diversity.

Those concerns inspired a search for a more sustainable, less environmentally degrading agricultural system. Sustainable agriculture may be defined as a system "that can indefinitely meet demands for food and fiber at socially acceptable economic and environmental costs" or, in more detail as "an integrated system of plant and animal production practices having a site-specific application that will, over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agricultural economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological systems and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole" (*Agricultural Outlook* 1992). The more detailed definition introduces specific economic and social values to the idea of sustainable agriculture.

Sustainable agriculture and industrialization

It is helpful to think of sustainable agriculture in a detailed context that encompasses, but is not limited to, resource limitation. A starting point is to distinguish the food and agricultural system (which I refer to simply as "the agricultural system") from farming. Farming is only one component of the agricultural system. The other components of the agricultural sector are the input sector, those firms that manufacture and sell goods and services to farmers, and the marketing sector, those firms that operate between farmers and final consumers, which includes processors, transporters, warehousers, wholesalers, retailers and even restaurateurs.

Sustainable agriculture implies maintenance of a viable farming sector; it may be more useful to think of sustainable farming." However, farming activities have steadily declined as a proportion of the agricultural system throughout this century. Although the decline is generally acknowledged, its extent is extraordinary and usually overlooked. At the turn of the century, farming was probably the largest of the three components of the agricultural system. In 1910, farming comprised 41 percent of the agricultural system, but it comprised only nine percent in 1990. On the other hand, during the same period, the input component increased its share from 15 percent to 24 percent and the marketing component from 44 percent to 67 percent. Not only did the share of farming activity decline, the absolute amount decreased after 1945. (See Figures 1 and 2.)

Figure 1: Marketing, Input, and Farm Shares

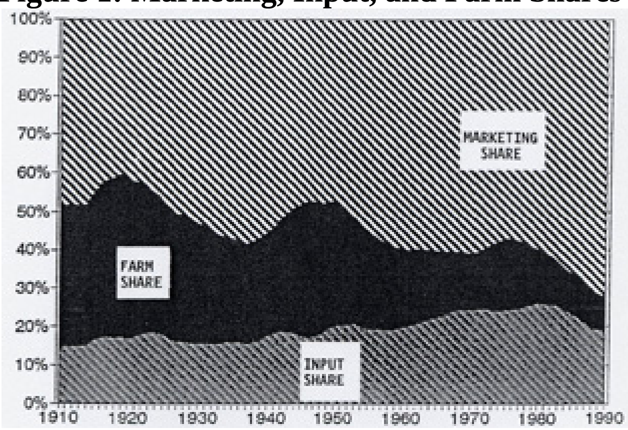
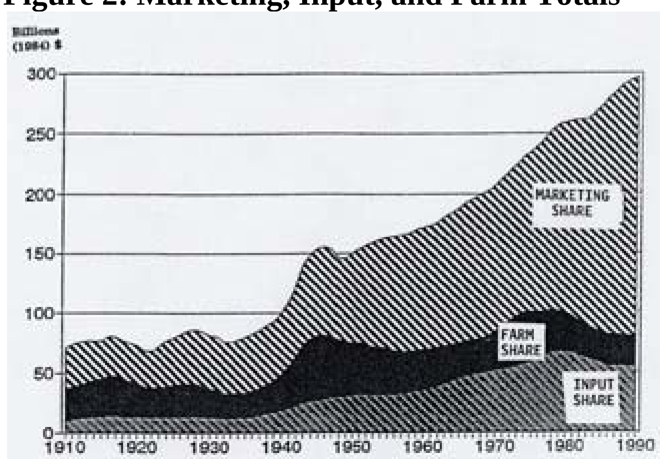


Figure 2: Marketing, Input, and Farm Totals

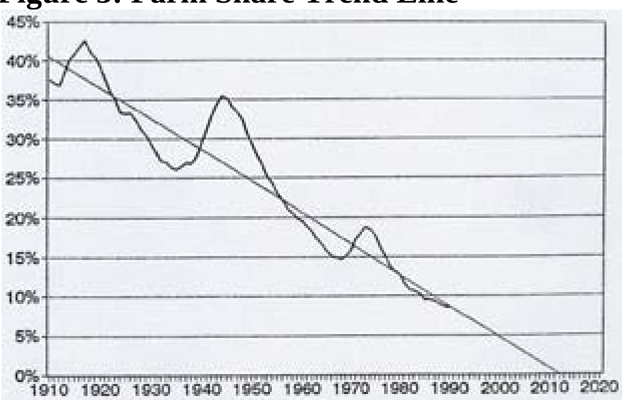


During this time, many of the economic activities that formerly were performed by farmers shifted to nonfarm firms. These estimates are insightful and offer several suggestions for policy development. For example, when we hear that all those farmers moved off the farm because agriculture became more efficient, we get only half the truth. The whole truth was that much activity performed by those exiting farmers was assumed by nonfarm firms.

Those shifts are obvious where tractors replaced animal power or pesticides replaced crop rotations and mechanical tillage, but they apply to practically all technologies adopted by farmers in this century, including most of those grounded in biotechnology. The likely adoption of BST, a bovine growth hormone that, under certain management regimes, will provide substantial increases in milk production per cow, offers a current example. Some analysis suggests that over one-third of the potential loss of dairy farming from adoption of BST will result in an increase of nonfarm activity and costs, rather than an increase in system efficiencies (Marion and Willis 1990).

Another insight can be gained by extending the trend line of farming loss. It suggests an agricultural system with no farming activity around the year 2020, a possibility discussed later (Figure 3).

Figure 3: Farm Share Trend Line



<u>Policy Implication:</u> The industrialization of U.S. agriculture has shifted substantial amounts of economic activity from the farm to the non-farm sectors of the agricultural system. Without substantial policy change, the loss of farming activities and family farms will continue.

The process of farming activity loss

Technology is the linchpin to the process of farming activity loss. Most technologies adopted by farmers result in a shift of activity from the farm to the nonfarm sectors, which results in a reduction in net return per unit of production. This leaves the farmer with excess management capacity. An example of that shift is the replacement of farm activity with purchased inputs. As farmers adopted pesticide protocols during the past forty years, they reduced the need to rotate crops and to till mechanically, which greatly simplified the management requirements of producing the desired cash crop. Commercially purchased fertilizers allowed Maine potato crop farms to spin-off dairy enterprises, since there was no longer need for animal waste for plant food nutrients. This simplified their operations but did not necessarily increase their efficiency.

The marketing side offers similar examples. Maine farmers who once packed their own potatoes, but who now deliver to a central packing shed or food processor, have spun off marketing services to the nonfarm sector. Relieving farmers of these activities allows them to focus more of their capital and management capabilities on producing commodities, but at a reduced margin, since they are compensated less for less activity per unit of production. Farmers who adopt technologies to simplify management, and who want to continue as full-time farmers, expand production to utilize their now-excess management capacity and to offset lost margins.

These farmers do not expand to reduce explicit costs, those costs associated with purchased inputs that show up on the bookkeeping ledger. Rather, they expand to increase income by reducing implicit costs, primarily their own opportunity costs. This reduces the return per unit of production that goes to compensate their own management and labor. Understanding that process helps explain why farm enterprises are constantly pushing beyond the size of lowest explicit production costs. As they strive for greater output, they spin off economic activities, which reduces their returns per unit that cover their opportunity costs. They recapture those returns through expansion, even while explicit costs per unit increase.

The 1990 Northeast Farm Survey (from the Farm Credit Banks of Springfield) demonstrates this phenomenon. In the survey of dairy farms, including some in Maine, the smallest sized herds are the most efficient when considering explicit costs only. The smallest sized farms are more efficient than all others in costs per cow and more efficient than the mid-sized farms in cost per value of output. (See Table 1.)

Table 1: Explicit and Implicit Costs per Cow by Size of Farm
Northeast Dairy Farms, 1990

	Herd Size			
	59 or less	**60-89**	**90 - 119**	**120 or more**
Explicit Costs				
Cash Operating	2053	2275	2333	2481
Depreciation	253	224	233	215
Total Explicit Costs	**2,306**	**2,499**	**2,566**	**2,696**
Implicit Costs				
Return on Equity	274	230	220	194
Family labor/management	745	486	343	180
Total Explicit & Implicit	**3,325**	**3,215**	**3,129**	**3,070**

Source: The Northeast Dairy Farm Summary, 1990, The Farm Credit Bank of Springfield, Springfield, Massachusetts.

However, when opportunity costs are included, the larger farms are more efficient. The 1991 Maine Potato Farm Summary shows the same phenomenon. There are inconsequential differences in the relative efficiencies of large and small farms with regard to explicit costs. (Small farms are five percent more efficient than medium-sized farms and two percent less efficient than large farms.) But small farms face a substantial disadvantage (26 percent with respect to medium sized and 60 percent to large farms) when implicit costs are included. (See Table 2.) In terms of transforming inputs to outputs, society would be better off with the smaller farms, if those farmers could use their excess management capabilities to recover their opportunity costs with activities other than the production of commodities.

Table 2: Explicit and Implicit Costs per Acre by Size of Farm Aroostook Potato Farms, 1991			
	Farm Size by Acres		
	125 or less	**126 to 210**	**211 to 560**
Explicit Costs			
Cash Operating	1,328	1,399	1,364
Depreciation	276	247	212
Total Explicit Costs	**1,604**	**1,646**	**1,576**
Implicit Costs			
Family labor/management	485	266	226
Total Explicit & Implicit	**2,089**	**1,912**	**1,802**
Source: 1991 Potato Farm Summary, Farm Summary, Farm Credit of Aroostook, ACA, 1992.			

The process that reduces farming activity also provides insights into the charge of scale bias often leveled at land grant university research. Since the inception of land grants, and more recently with the publication of *Hard Tomatoes; Hard Times* (Hightower 1973), critics and defenders of land grant research have debated its impact on the farm sector. Critics often charge that land grant research is biased towards larger farms, while defenders argue that their technologies are scale neutral and that larger farms simply have better managers who are more attuned to adoption of that technology. Both sides have the argument wrong. It is not that land grant research is intentionally *scale* biased, but rather it is *sector* biased. Most agricultural research results in more nonfarm activity at the expense of farm activity. That results in a reduction of returns to cover opportunity costs and requires farmers either to increase the number of units produced or to utilize their excess management and labor in endeavors other than commodity production. Indirectly, the technology results in fewer and larger farms (in terms of commodity production) and more part-time farms, but the direct cause is the *sector* bias. The scale bias is an indirect outcome. (Most technologies result in reduction of both implicit and explicit costs since some of the reduced activities represent system efficiencies and some represent a shift to the non-farm sector. The above discussion, which focuses on the shift to the nonfarm sector, does not represent the comprehensive influence of farm technology adoption.)

<u>Policy Implication:</u> *In terms of converting inputs to outputs, smaller farms are as efficient as larger farms.*

Policies that erode farming activities

Because technology is the primary cause of farming activity loss, policies to address farm loss must be directed at the two forces that drive technology adoption: the availability of technologies and the incentives to adopt new technologies.

Technology availability depends on technology development, which is determined by the research system, including both the public component at land grant universities and the private component located in nonfarm agricultural firms. Both public and private research organizations develop similar technologies. With only a few exceptions, technologies developed by both the public and private systems have shifted activities away from farms, an outcome driven by two forces: the source of public research funding and the revolving door of research scientists phenomenon.

Despite a preponderance of public funding, public research is strongly influenced by private funding. As universities feel squeezed by diminished funds from the federal government (and now state governments), they increasingly rely on "soft" monies from the private sector. Many land grant universities are willing to participate with private firms in the development of products and processes that can be privatized by patents and other legal protections. Biotechnology, with its ability to engineer materials that can be protected as private property, is likely to increase the amount of research that is privatized. This will continue to influence the land grant research agenda (Buttell 1986).

The revolving door phenomenon is imbedded in the stronger professional relationship that land grant faculty have with private sector scientists than with farmers. Most private research scientists in agriculture work for nonfarm firms; few are employed by farmers. It is inevitable that faculty professional ties are closer with nonfarm colleagues than with farmers. (Bush and Lacey 1983).

<u>*Policy Implication:*</u> *The current research agenda at land grant universities encourages the shift of activities from the farm to nonfarm sectors, which reduces opportunities for farm families.*

While researchers determine which technologies become available, the private sector does the adoption. Farmers adopt technologies to increase their net returns, which are influenced by a number of factors, including the prices of outputs, prices of inputs, production and market risks, transactions costs and certain tax liabilities, as well as knowledge and information. These influences are affected by public policies, including input subsidies, tax policy, technical and financial assistance, and commodity programs (although the latter have little direct impact in Maine).

Input subsidies encourage farmers to use more purchased inputs than they otherwise would. Subsidies range from assistance to nonfarm firms in developing and testing inputs (e.g., chemicals) to the public absorption of external costs of input use. These are both environmental, like water quality degradation, and social, like dislocation costs of deteriorating rural communities. Tax polices, like deductions for purchased inputs but not for management inputs, or cash accounting, which encourages farmers to purchase more inputs, provide incentives for farmers to increase the size of their operations. Stronger incentives, like accelerated depreciation and investment tax credits, were eliminated in the 1986 tax reforms, but may return under the umbrella of economic stimulus. Technical assistance that provides farmers more information on the use of purchased inputs than on the use of their own resources encourages farmers to use more nonfarm goods and services and less farm-produced goods and services. Commodity programs tend to reduce price risks, and sometimes enhance prices, of specific commodities.

Farmers are provided an incentive to specialize in the production of those commodities and are discouraged from using more integrated farming systems that provide more value added to the farming sector. I do not argue here that these policies are, on balance, socially good or bad. I simply point out that all of these programs provide incentives for farmers to demand and to adopt technologies that shift activities from the farm to the nonfarm sectors, which results in a reduction of farming activities. If another outcome is desired, policy changes have to be made at both the national and state levels.

Policy Implication: *A number of federal and state programs are biased toward larger industrialized farms and discourage family farming.*

Policies for sustainable agricultural development

Decisions to redirect technology development towards increasing farming activity requires a social perspective. The reduction of farming activities that result from technology development and adoption might be socially desirable if those systems were more efficient than alternative systems. There is emerging evidence, however, that this is not the case. Farm case studies conducted by my students recently included a dairy farmer who resisted production expansion as a means of increasing net income. As an alternative, he converted to rotational grazing (a management-intensive system of grazing using a series of paddocks), despite being discouraged (in his view) by the public agencies. He maintained his production and halved his purchase of grain concentrates, which added nearly 25 percent to his net income. In this case, rotational grazing was competitive with concentrate feeding and casual evidence suggests it may represent a general case. There is also evidence that rotational grazing is incompatible with BST. If that is the case, general adoption of BST forecloses the possibility of general adoption of rotational grazing. Adoption of BST will result in substantially less farming activity and more nonfarm activity, whereas a significant shift to rotational grazing could result in more farming with no increase in the price of milk.

Those interested in maintaining farming activity should ask what the outcome would have been had the money spent on BST research been spent instead on rotational grazing research, such as finding legumes and handling systems to make that technology even more efficient. My assessment is that it would be a very competitive system with more farming and more farms. It is no mystery why that alternative research was not conducted. There was no private sector to contribute funds to public research or to conduct its own research. But if there is a societal objective of maintaining farming, farms, and farming communities, we should have devoted public research to that alternative technology. This also suggests that if we want to maintain farming, publicly-funded research directed at applied technologies that enhance farmers' value added activities must be increased.

Although it may seem ludicrous to suggest there will be no farming in the agricultural system after the year 2020 or thereabouts, the idea is not totally farfetched. Biotechnology will likely be the dominant technology in the next decades and can drive activity from the farm to the nonfarm sector at an increased rate. Biotechnology holds the promise of a non-soil based agriculture. The underlying technique would be the economic decomposition of biomass into constituent components for use as inputs to food manufacture. Rogoff and Rawlins (1987) provide the scientific basis for such a system. They visualize a three-step system for which the technology will be available early in this decade. Their system requires the reduction of biomass feedstocks into syrups by enzymes, which are on the verge of availability; the production of major food components *in vitro*, which provides the system efficiency since it produces no wasted plant materials; and the conversion of these components to aesthetically acceptable foods similar to the current biotechnical production of physiologically active peptides and proteins for nonfood use. Their projections suggest this system will reduce farming activities by 88 percent.

Goodman, *et. al.* (1987) conceptualize the economic structure of a similar system where biomass production feeds extraction factories which decompose plant material into component parts that supply food and drug manufacturers. With those manufacturers closely aligned with plant breeders and input suppliers, crops will be engineered for use by specific manufacturers, an arrangement also suggested by Urban (1990). The farming component would require very little activity, primarily reseeding perennial crops occasionally and providing harvesting services if the extraction factory chooses not to do so itself. It would not provide adequate value added activity to support a system of full-time farmers.

Without substantial alteration of an array of agriculture policies, the 80-year trend of reduced farming activities will continue. Biotechnology being developed today with the support of the land grant universities will lead to a more industrialized system, with most farming activity conducted by part-time farmers and with nonfarm firms performing much of the production activity away from the soil. In all likelihood, a more industrialized system will mean more environmental degradation, fewer farmers and farming activities, and weaker rural communities.

Maintaining a system of family farms, including those in Maine, will require a fresh look at how the agricultural system works, and must distinguish between economic growth and economic development. Work being done at the University of Maine is shedding light on the type of farming systems that will most likely succeed in the longer term, and suggesting the state policies needed to support them. Let me identify three general principles to guide state policy:

First, we must be sensitive to current biases that promote the conventional, industrial, non-sustainable agricultural system. Those biases pervade both state and federal policy. For example, a few years ago, the Maine Department of Agriculture offered several programs, albeit small, that promoted the transfer of technologies to support more sustainable agricultural systems. In the budget cuts of the past six years, those programs were abolished, while programs supporting conventional, non-sustainable systems were retained, although some of them received cuts. Longer term development would have mandated retention of the sustainable programs and deeper cuts from the conventional programs.

Second, we must identify and enact programs to support transition to sustainable systems. The transition is the most difficult phase for sustainable farmers. Even if information about sustainable systems is available to farmers, the costs and risks of transition are quite high for early adopters. State programs to share some of this risk are necessary and could be relatively low cost. If no new funds are available, they should be redirected from current programs.

Third, the state should contribute to a redirection of the public agricultural research agenda. The state provides substantial funding to the University system for numerous activities, including agricultural research. The state could encourage the University to prioritize its research to support, rather than diminish, family farms. While most agricultural research is intended to assist Maine farmers, we have seen that the reality can be quite different. At the national level, research administrators are skeptical about, or the research community will probably argue against, such targeting. They will argue that no models can test whether technologies will shift activities to or from the farm. While that may be the case, it is because the question has not been posed, not because it is impossible to construct such models.

<u>Policy Implication:</u> *The state should: (1) remove current biases against sustainable agricultural systems; (2) offer programs to support transition to sustainable farming systems; and (3) negotiate a new public research agenda for agriculture.*

A sustainable economy, including agriculture, will require a new policy paradigm that recognizes the importance of institutional forces in the economic system. It must recognize that markets allocate resources efficiently only within a specific institutional environment and do not always result in the most appropriate, or even most efficient, social solutions. In the case of agriculture, the current institutional relationships that shape technology development and that determine farming practices will surely result in an agricultural system that is neither sustainable, environmentally friendly nor supportive of family farming and rural communities. An alternative system can provide the desired results at no cost in efficiency, if we but overcome the institutional barriers that determine our current fate. The challenge lies in the public policy domain.

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