Ethical Perspectives on Changing Agricultural Technology in the United States

by

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ARTICLES

ETHICAL PERSPECTIVES ON CHANGING AGRICULTURAL TECHNOLOGY IN THE UNITED STATES*

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INTRODUCTION

In this paper we consider the ethical implications of the development and transfer of agricultural technology in the United States. Technology has contributed to a number of changes in American agriculture. We think three types of changes are especially important: first, increases in agricultural productivity; second, changes in farm structure and in the character of rural life; and third, impacts on the environment, especially as they relate to our interest in establishing regenerative agriculture.[1] After a brief, general discussion of agricultural technology, we will examine the impact of such change on farmers, consumers and our society as a whole.

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1. Regenerative agriculture is characterized as a farming system in which an abundance of safe and nutritious food and fiber is produced using farming methods that are ecologically harmless, sustainable, and profitable. To the maximum extent feasible, following a transitional phase, chemical insecticides and other toxins are replaced by reliance on natural biological controls, and renewable sources of soil nutrients are largely or totally substituted for chemical fertilizers. See J. MADDEN, REGENERATIVE AGRICULTURE: BEYOND ORGANIC AND SUSTAINABLE FOOD PRODUCTION (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA-Extension, Michigan State University Cooperative Extension Service No. 33, 1984); and Rodale, *Breaking New Ground: The Search for a Sustainable Agriculture,* THE FUTURIST, Feb. 1983, at 15.

We will give special attention to the ethical justifications offered for the effects of changing technology. Finally, we will offer a few speculative and prescriptive comments regarding the future.

I. Agricultural Technology in the United States

A. *Technology and Abundance*

The industrialization and rapid growth of the United States economy has been supported in an important way by agricultural abundance. Plentiful food supplies have enabled an ever increasing proportion of the population to be employed in non-agricultural pursuits of manufacturing, services and other sectors.[2]

Until the early years of the twentieth century, the nation's agricultural output increased primarily as a result of the cultivation of previously untilled land.[3] With the closing of the land frontier, however, further increases in agricultural production occurred primarily through the development and appropriate utilization of science and technology. Many of the early technological innovations were labor-saving mechanization.[4] Later innovations included agricultural chemicals, particularly fertilizers, pesticides, and feed additives. Modification of biological systems, particularly the development of improved crop varieties and animal breeds, has been responsible for further increases in productivity.[5]

It is important to distinguish between "*production*" and "*productivity*" as related to agricultural technology. Agricultural *production* can increase through expansion in the use of resources, such as occurred during the cultivation of the land frontier in this nation, or it can result from the appropriate

2. Between 1918 and the mid-1970s, the person-hours of farm labor used in the U.S. declined from 24 billion hours to less than 5 billion hours. U.S. Department of Agriculture, Structure Issues of American Agriculture 31, (Economics, Statistics, and Cooperatives Service, Agricultural Economic Report 438, 1979).

3. *Land Use in the 1920's*, 3 Agriculture in the United States: A Documentary History 2016-2021 (W. Rasmussen, 1975).

4. For example, adoption of self-propelled mechanical harvesters reduced labor requirements for producing cotton from 150 hours to 25 hours per acre. Meanwhile, cotton yields per acre doubled. W. Cochrane, The Development of American Agriculture 126-129 (1981).

5. W. Sundquist, Technology and Productivity Policies for the Future 1 (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA—Extension, Michigan State University, Cooperative Extension Service No.4, 1983).

utilization of improved technology, or improvement in the quality of various resources other than technology, such as managerial ability, labor, and land.

The term *productivity* refers to a ratio of output to input. Total productivity of agriculture is the ratio of total output to total input, with both numerator and denominator usually measured in terms of current market value. Total productivity is often used to measure efficiency. Partial productivity, on the other hand, measures the output attributable to a selected input or group of inputs. The common example is land productivity, such as yield of wheat per acre harvested. Livestock productivity is often measured in terms such as milk production per cow, or eggs laid per hen. The concept of productivity is implicit in the following economic definition of technology:

> [A] specific state of art and science which is used to transform a set of inputs (resources) into a set of outputs (goods or services). . . .
>
> The significance of technical change is that it permits the substitution of knowledge for resources, or of inexpensive and abundant resources for scarce and expensive resources, or that it releases constraints on growth imposed by inelastic resource supplies. In the process this change generally provides some economic benefit by a cost-reducing productivity dividend.[6]

B. *Who Benefits from New Technology?*

Much of the early mechanical technology was developed in the private sector and transferred to farmers through firms selling agricultural supplies and implements. Other scientific and technological innovations, particularly those related to biological systems and chemicals, were initially pioneered in the public sector and transmitted to farmers through the extension system.[7]

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6. *Id.* at 2.

7. Rasmussen, *Advances in American Agriculture: The Mechanical Tomato Harvester as a Case Study*, 9 TECHNOLOGY AND CULTURE 531-543 (1968); *cf.* I. FELLER, L. KALTREIDER, P. MADDEN, D. MOORE AND L. SIMS, THE AGRICULTURAL TECHNOLOGY DELIVERY SYSTEM (1984). (In a recent study by the Institute for Policy Research and Evaluation, The Pennsylvania State University documents the roles of the public and private sectors of the agricultural delivery system in the United States.)

The received wisdom of neoclassical economic theory postulates that the initial beneficiaries of new technology are the businesses or institutions receiving royalties or profits from supplying the technology to users. The employees of these organizations also are direct beneficiaries. Other beneficiaries are the early adopting firms or innovators who enjoy lower average cost of production per unit of output while the prices are still keyed to the older (higher cost) technology. Consequently, early adopters earn increased profits.

The secondary impact of most new technologies is to increase production of the agricultural commodities. Particularly in commodities facing an inelastic demand, the increase in output ordinarily is translated into a more than proportionate decline in prices, and, therefore, a lower total income for the producing sector of the industry after the adoption of the technology has reached an advanced stage. Conversely, the marketing sector, whose income is keyed to the volume of output, would tend to receive higher income as a result of reduced commodity prices at the farm level. Consumers ultimately become the beneficiaries of newly adopted technologies as they pay commodity prices lower than they would have had to pay if the new technology had not been adopted.

Moreover, a community, state, or region (not necessarily a farming area) benefits from successful adoption of new technology when it increases its share of the industry sales, and when local employment in the manufacture, sales, and service of the technology increases. When local farmers capture an increased share of the production of the commodity affected by that technology, employment and income benefits accrue to firms and employees involved in the processing, transportation, and sales of the commodity and of secondary products manufactured from that commodity. The national economy also benefits through real income gains (increased purchasing power) and sometimes through increased exports of the farm commodity.[8]

The ultimate beneficiaries of the technology, then, are consumers (through lower commodity prices), the national

8. The relationship between the "technology treadmill" and commodity policy is explored by Cochrane, *A New Sheet of Music,* 1 CHOICES 11-15 (1986); the subject is related to science and technology research activity by V. RUTTAN, AGRICULTURAL RESEARCH POLICY 17-44, 332-340 (1982). The role of technology in shaping U.S. agriculture is documented in the report, GENERAL ACCOUNTING OFFICE, CHANGING CHARACTER AND STRUCTURE OF AMERICAN AGRICULTURE: AN OVERVIEW (1978). The benefits and costs of new technology are further explored in SUNDQUIST, *supra* note 5, at 5-6.

economy (through improved balance of international trade), early adopting firms (through an initial surge of profits and increased share of industry sales), and the firms or institutions providing the technology to users (through royalties and profits).

In some instances the direct economic benefits of a successful agricultural innovation are more than offset by externalities or negative impacts. A case in point is the proposed half-million acre irrigation project that would cause a massive expansion of agricultural productivity in the State of Washington through diversion of a large portion of the Columbia River. This diversion would reduce the water available for inexpensive hydroelectric power, thus requiring consumers and businesses to pay higher electricity costs. Studies have predicted that the state's economy would incur huge increases in energy costs and capital expenditures, far in excess of the economic benefits of the project.[9] Another example of an agricultural innovation leading to economic costs is the pollution of drinking water supplies by agricultural chemicals, causing consumers and businesses to pay high costs for purification equipment or for alternative sources of water.[10] Drinking water pollution also imposes additional health care costs and suffering that defies quantification.[11]

Adoption of new technology also can accelerate changes in the structure of agriculture and rural communities. These changes may include the failure of many less efficient farm operators and the demise of agribusiness firms purveying obsolete technology. Other results could include geographic shifts in production and a further concentration of production into fewer and larger farms.[12]

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9. *Cf.* N. WHITTLESEY, J. BUTEAU, W. BUTCHER & D. WALKER, ENERGY TRADEOFFS AND ECONOMIC FEASIBILITY OF IRRIGATION DEVELOPMENT IN THE PACIFIC NORTHWEST (Washington State University, College of Agriculture Research Center Bulletin No. 896, 1981); also J. FINDEIS & N. WHITTLESEY, COMPETITION BETWEEN IRRIGATION AND HYDRO POWER WATER USE IN WASHINGTON STATE (State of Washington Water Research Center, Report No. 44, 1982).

10. For example, in areas where nitrate fertilizers and pesticides have contaminated drinking water, households are obliged to purchase bottled water to avoid toxic effects. COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY, REP. NO. 103, AGRICULTURE AND GROUNDWATER QUALITY 29, 46-48 (1985).

11. *See*, Hoar, Blair, Holmes, Boysen, Robel, Hoover & Fraumeni, *Agricultural Herbicide Use and Risk of Lymphoma and Soft-Tissue Sarcoma*, 256 J. AM. MED. A. 1141-1147 (1986).

12. The number of farms in the U.S. reached a maximum in 1935,

Different combinations of benefit streams from technology can occur. The increase in local farm profits tends to be capitalized into higher land values and rents; land owners reap a monetary benefit.[13] For example, in some instances a local firm or institution may benefit from developing new technology, but that technology may be more effectively adopted in competing locations. Local producers could then find themselves at a competitive disadvantage as a result of the locally produced technology adopted elsewhere. Alternatively, technology developed elsewhere could be adapted and adopted in local production. Extension personnel and industry farm supply sales personnel routinely draw upon technology developed outside their local areas.

Typically, adaptive or applied research is necessary to select or modify technology appropriate to local climatic, soil, and market conditions. This adaptive work has been a significant contribution of public sector extension and applied research efforts, but it is increasingly the role of the private sector—primarily by agribusiness firms. Roughly two-thirds of the total research and development expenditures for the farm and food system in the United States are now made by the private sector.[14] An even higher percentage of the agricultural technology transfer is provided by private sector sales personnel and consulting firms.

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with a total of about 6.8 million farms. The number of farms declined steadily until 1974, leveling off at about 2.4 million farms. However, the structure of agriculture has continued to shift toward fewer middle-size farms and more small, part-time farms producing a tiny fraction of the nation's agricultural output, plus an expanding sector of large-scale farms producing most of the output. This trend is caused by the interaction of many economic, social, and technological forces, ranging from international trade to high-capacity farm machinery. Improved crop varieties, pesticides, and irrigation have greatly increased output per man-hour. Some technologies tend to encourage farm expansion, while others have enabled smaller scale farms to prosper; mechanization, chemical fertilizers, pesticides, medication for livestock, and other technologies have made it possible for part-time farmers to hold off-farm jobs while operating their farms evenings and weekends. N. DOROW, THE FARM STRUCTURE OF THE FUTURE: TRENDS AND ISSUES 1-3 (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA—Extension, Michigan State University Cooperative Extension Service No. 17, 1984).

13. Cochrane, *supra* note 8, at 12.

14. W. SUNDQUIST, *supra* note 5, at 3.

C. *Biotechnology*

Biotechnology is widely heralded as the cutting edge of advanced agricultural technology. Biotechnology is not a single academic discipline, but rather the application of ideas and methods from many disciplines to provide new and improved biological materials for commercial applications. Not all biotechnology is targeted for use in agriculture; industrial enzymes, vaccines, antibiotics and other kinds of products have benefitted from biotechnology. Agricultural uses that are being considered include the development of biological insecticides in the form of highly selective pathogens (bacteria, viruses, etc.) as well as the development of plants that generate their own insecticides, make their own nitrogen fertilizer, or simply produce higher yields or higher quality products. These technological developments form the special category of biotechnology known as "genetic engineering."

Lloyd D. Teigen *et al.* describe biotechnology as follows:

> Biotechnology alters life forms. It includes: transfer of genes from one plant to another, from one animal to another, and from animal species to plants, or vice versa; gene manipulation; embryo transfers; and sex determination in semen and eggs. Biotechnology alters the processes internal to the organism, in contrast with technology which alter elements in its nutrition or environment (such as nutrients, moisture, fertility, pests, and shelter) or improve materials handling by farmers (mechanization).[15]

At the present time, relatively few commercially successful innovations have resulted from genetic engineering. An example of a highly successful biotechnology is high fructose corn sweetener, produced with a bacterially grown enzyme. This product can be substituted for cane and beet sugar in many processed foods such as candy and soft drinks. In 1985, for the first time, corn sweetener consumption in the U.S. exceeded refined sugar consumption.[16] However, it may take several more years before a stream of genetically engineered

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15. Teigen, Spinelli, Harrington, Barry, Farnsworth & Edwards, *The Implication of Emerging Technologies for Farm Programs,* AGRICULTURAL FOOD POLICY REVIEW: COMMODITY PROGRAM PERSPECTIVES 59 (ERS/USDA Agricultural Economic Report No. 530, 1985) [hereinafter cited as ERS/USDA Report].

16. U.S. Department of Agriculture, AGRICULTURAL OUTLOOK, Jan.-Feb. 1986, at 13.

crop varieties and livestock breeds come on line in commercial channels.[17]

Several dozen biotechnology firms have emerged in recent years. The potential effect of biotechnology on the structure of American agriculture, its employment, income, and competitiveness, is unknown at the present time. If the nation's technology delivery system, both the public sector (primarily extension) and private sector (sales and service organizations), quickly and effectively helps farmers and agribusiness firms to adopt appropriate technologies, the competitive edge of the nation's agricultural industries vis-à-vis foreign competitors can be strengthened. Effective technology delivery need not depend upon the location of firms producing advanced technology.[18] Obviously, however, those nations, states and communities where successful advanced technology firms are located will benefit directly in terms of income, employment, and prestige.

A case in point is the *in vitro* production of bovine growth hormone (bGH) by genetically altered bacteria. Cornell University scientists have estimated that this hormone, when correctly administered to lactating dairy cows, can increase their annual milk production by about 25 percent. Pending FDA approval, Monsanto Company anticipates bGH will be commercially available by 1988. Early adopters of this technology will reap extraordinary profits, to the extent that the costs of the enzyme and the additional feed consumed are less than the increase in value of milk produced. However, experts predict that as adoption of the enzyme technology becomes wide-spread, the surplus of dairy products will expand very significantly, thereby increasing pressure on fed-

17. For example, Donald N. Duvick, research vice president for Pioneer Hi-Bred International, has said the genetics of many plant traits are so complex and poorly understood, and scientists know so little about the gene locations of key genes and how they control important traits, that the recombinant DNA techniques "are currently of little practical use." *Report on Plant Breeding Research Forum,* AGRICULTURAL BIOTECHNOLOGY NEWS, May-June, 1985, at 9. *See also* F. BUTTEL, BIOTECHNOLOGY AND AGRICULTURAL RESEARCH POLICY: EMERGENT ISSUES, (Cornell University Department of Rural Sociology Bulletin No. 140, 1984); L. BUTLER & A. SCHMID, *Genetic Engineering and the Future of the Farm and Food System in the U.S.,* (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy USDA Extension, Michigan State University, Cooperative Extension Service No. 15, 1984); Hansen, Busch, Burkhardt, Lacy, and Lacy, *Plant Breeding and Biotechnology,* 36 BIOSCIENCE 29-39 (1986).

18. M. KENNEY, BIOTECHNOLOGY: THE UNIVERSITY-INDUSTRIAL COMPLEX (1986); Kenney & Buttel, *Biotechnology: Prospects and Dilemmas for Third World Development,* 16 DEVELOPMENT AND CHANGE 61-91 (1985).

eral price support programs and ultimately causing lower prices for dairy products and a reduced number of dairy farmers.[19] Teigen *et al.* estimate that if output would increase as much as 15 percent, given the inelastic demand for dairy products (-0.3), the market price of milk would have a tendency to drop to less than half its present level, from $12.10 to $5.50 per hundredweight.[20] Without massive governmental price support subsidies, dairy farm bankruptcies could become endemic. Farms supplying hay and other feeds, plus hired workers and various agribusiness firms would receive no relief from dairy farm buy-outs and other such federal programs. Teigen *et al.* observe:

> Price changes of this magnitude are so great that under no circumstances would the adoption of bGH be profitable for the industry as a whole. However, it is probable that before price levels would reach even into the $8.50-$9.00 range, structural adjustments (herd reductions and farmers switching from dairy to other enterprises or other lines of work) would negate some of the supply increases and thus moderate the downward price pressure.[21]

The structural adjustment would be particularly painful for those farmers forced to leave the industry who do not have profitable alternatives. States where farmers lag behind in adoption of the bGH technology could be most severely affected.

D. *Technology Treadmill*

Other commercially successful uses of biotechnology appear imminent. However, farmers will find themselves on a more rapidly turning "technology treadmill." They will have to run faster to stay in the same place. Farmers who fail to innovate will find themselves at a disadvantage, since they incur the higher cost associated with the older technology but receive lower prices for the commodities they produce. Feeling this pressure, some of these farmers will adopt the new

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19. Kalter, *The New Biotech Agriculture: Unforeseen Economic Consequences*, 2 ISSUES IN SCIENCE AND TECHNOLOGY 125-133 (Fall 1985); R. KALTER, D. BAUMAN, R. MILLIGAN, W. LESSER, & W. MAGRATH, BIOTECHNOLOGY AND THE DAIRY INDUSTRY: PRODUCTION COSTS AND COMMERCIAL POTENTIAL OF THE BOVINE GROWTH HORMONE 3-4 (Cornell University Department of Agricultural Economics, A. E. Research No. 84-22, 1984).

20. ERS/USDA Report, *supra* Note 15, at 60-61.

21. *Id.* at 61.

technology as part of the widespread adoption pattern; but their profits often will decline in spite of this late adoption, unless they can expand the size of the farm sufficiently to compensate for the loss.

Early adopters are more likely to be able to finance expansion out of the temporarily high profits. Farmers who do not adopt the new technology may continue to incur costs above the falling commodity prices; ultimately they will either go out of commercial farming entirely, become part-time operators, or shift to production of other agricultural commodities in which they may have a comparative advantage. Meanwhile, the early adopters, who had the skill and capital to appropriately apply the new technology, typically will have captured a larger share of the market, and some may now operate larger farms; but they may or may not have higher profits than before the new technology was introduced.

Notable exceptions occur, of course. For example, in many instances farmers may profitably produce specialty crops, fresh fruits and vegetables, and other perishable commodities, often highly labor-intensive enterprises. These are often sold by direct marketing to consumers, or to specialized markets ("health food" stores, restaurants, etc.). However, these specialty markets are often very limited. Another exception to the general trend is the "bargain basement syndrome:" as new technology such as high-capacity machinery becomes available, farmers who are debt-free or have high equity and a favorable cash flow may have the opportunity to upgrade their capital stock with used equipment that can help them to produce more efficiently and with less labor input—thereby reducing their production costs and freeing up more time for off-farm jobs, custom-hired services such as harvesting, or other businesses. These arrangements tend to enhance the financial stability and sustainability of many small or moderate-scale part-time farms that do not invest in the latest machinery.

II. Non-Technological Influences On U.S. Agriculture

Although technology represents a strong influence upon the direction of changes in U.S. agriculture, it is important not to overstate its effects. The climatic and natural resource endowments of competing regions always have affected change in agriculture and can be expected to do so for the foreseeable future. The Central Valley of California contains

millions of acres of highly productive cropland plus a long growing season and (thanks to federal subsidies) ample irrigation water at low prices. As a result, California has captured the lion's share (49 percent) of the total vegetable market (fresh and processed vegetables), and an even higher percentage of the market for many fruits.[22]

Agriculture is also shaped by competition. Beyond competition with each other, American farmers face tough competition from abroad. Particularly as a result of the "strong dollar" in recent years, U.S. agriculture exports have been steadily declining, while imports of foreign-produced foods have increased significantly. Major factors supporting the strength of the dollar include the desire of foreign investors for a safe and stable currency, and massive deficit spending by the federal government which has artificially and temporarily sustained prosperity and economic growth in the United States.

Macroeconomic trends, such as the strength of the U.S. dollar, are beyond local control, leaving the American farmer subject to volatile factors. For example, a decline in the exchange rate would strengthen the competitive position of U.S. farm commodities in international markets.[23] However, too rapid a decline could trigger a rapid and massive flight of foreign capital from the U.S. financial markets, possibly undermining the stability of the U.S. economy, and ultimately the world economy.[24] Economic predictions are speculative at best in this situation because present circumstances are unprecedented.

The picture becomes even more complicated when the trade policies of other nations are taken into consideration. For example, by subsidizing farmers, the European Economic

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22. California produced $2.0 billion worth of vegetables compared with a U.S. total of $4.1 billion in 1984. U.S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL STATISTICS 1985, at 148. California's share of U.S. fruit production in 1984 was $2.4 billion of $5.5 billion total (44 percent) including 90 percent of the nation's grape production, for example. *Id.* at 206; U.S. DEPARTMENT OF AGRICULTURE, FRUIT OUTLOOK AND SITUATION YEARBOOK 46 (1985).

23. FEDERAL RESERVE BANK OF KANSAS CITY, COMPETING IN THE WORLD MARKETPLACE: THE CHALLENGE FOR AMERICAN AGRICULTURE (1985); THE CURRY FOUNDATION, AGRICULTURE, STABILITY AND GROWTH: TOWARD A COOPERATIVE APPROACH (1984).

24. H. LEVER & C. HUHNE, DEBT AND DANGER: THE WORLD FINANCIAL CRISIS (1986); S. MARRIS, DEFICITS AND THE DOLLAR: THE WORLD ECONOMY AT RISK (Institute for International Economics, Policy Analyses in International Economics #14, 1985).

Community (EEC) has made a major financial commitment to becoming a strong exporter of wheat and other agricultural commodities. In 1979, the wheat subsidy of the EEC averaged $2.42 per bushel. By mid-September of 1984, the real subsidy had dropped to only $.05 per bushel due to the strong dollar.[25] A similar trend occurred in other commodities. As a result of these subsidies, farmers produce more of these commodities than they would produce with lower prices. In addition, European crop yields have increased because of the widespread adoption of improved technologies, particularly in the form of higher yielding crop varieties.[26] U.S. agricultural exports have dropped precipitously in recent years, from $43.8 billion in 1981 to $31.2 billion in 1985, a decline of 29 percent.[27] Meanwhile, agricultural imports have increased from $17.2 billion in 1981 to a forecasted $19.5 billion in 1985, a 13 percent increase. As a result, the nation's agricultural exports, a mainstay of our balance of trade for many decades, are seriously eroded.[28]

Changes in the regulations and laws governing the production practices used in agriculture can be regarded as exogenous to the process of technological development to the extent that they represent responses to new information and to shifts in public opinions. At the same time, it must be recognized that these institutional changes may themselves be reactions to changes brought about by technology.[29] In order to evaluate the appropriateness and legitimacy of such reactions, it will be necessary to establish some basis for the evaluation of the technological changes themselves.

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25. *C.f.* U.S. Department of Agriculture, *EEC Grain Policies Hurt U.S. Exports,* AGRICULTURAL OUTLOOK, July 1985, at 22-23.

26. For example, wheat yields increased 3.1 percent annually from 1960-62 to 1982-84. *Id.*

27. *Cf.* U.S. Department of Agriculture, AGRICULTURAL OUTLOOK, Oct. 1986, at 37.

28. Economists are expressing concern that this trend may be irreversible, perhaps continuing at least until the turn of the century unless there is a sharp reduction in competitor exchange rates (the price of the U.S. dollar in currencies of nations competing in production of U.S. agricultural products) plus major changes in agricultural policy and a significant increase in the efficiency of our agricultural industries.

29. Interestingly, recent reports have shown U.S. imported goods to be frequently contaminated with chemicals banned in the United States. *Cf.* S. HEARNE, HARVEST OF UNKNOWN: PESTICIDE RESIDUES IN IMPORTED FOOD (1985). Federal action to prohibit chemical-contaminated foods would (1) increase food prices, (2) increase U.S. farm income, (3) reduce income of foreign producers and agribusiness firms, and (4) possibly improve consumer health.

III. Evaluating Agricultural Technology

As outlined above, agricultural technology has had a variety of effects: food production and agricultural productivity have been increased; farm structure in the United States has changed from many moderate sized farms to a few very large farms which produce the vast majority of food; and new environmental questions are raised concerning farm technology, especially pesticide contamination of water and goods. Each of these three major areas of impact calls for a somewhat different basis for normative evaluation. Productivity increases lend themselves to evaluation in terms of utility or wealth maximization criteria. Farm structure questions are most frequently analyzed in terms of influences on the development of individual moral character. Environmental concerns have given rise to a novel set of philosophical issues with new forms of argument proposed to address them.

A. *Productivity and Utility Maximization*

Increases in total food production and in productivity are frequently cited as results of technological change in agriculture, and as justification for the institutions, laws and policies that bring it about. The argument is that the development of mechanical and biological technologies has made more of the food and fiber that people want available at a lower cost. By any reading of the utilitarian maxim,[30] this must be counted as a good outcome. To the extent that people are able to divert that portion of their income previously needed for basic food and fiber consumption to other goods, technological development in agriculture can contribute generally to economic growth. To the extent that lower prices are achieved through genuine increases in productivity, there is no *a priori* reason to suppose that food producers in the aggregate suffer ill effects that would outweigh the benefits to the consuming public at large.[31] Furthermore, since declining food prices are, in relative terms, of greater benefit to the poor than to the rich, increases in food and fiber produc-

30. The utilitarian maxim is that the *summum bonum* is the attainment of the "greatest happiness of the greatest number" of persons. J. Mill, Utilitarianism, Liberty, and Representative Government 5-24 (1910).

31. Some people, especially low-income producers with no viable alternative employment, could experience a disproportionate loss of income; but as long as we confine ourselves to a general welfare maximization ethic, these effects must be weighed against proportionately smaller benefits that are multiplied by the millions of food consumers who receive them.

tion levels serve the further goal of economic growth with equity.[32] These considerations would count in favor of agricultural technology which increases farm production and productivity. At first appearance, then, increasing agricultural productivity is consistent with the injunction to promote the greatest good for the greatest number.

Modern utilitarianism comes in several varieties,[33] however, and some versions will support a stronger argument in favor of increased productivity than will others. Recent interpretation of John Stuart Mill's utilitarianism, for example, stresses a fairly complex notion of happiness as the basic criterion for evaluation of utility. An action advances utility only to the extent that it contributes to the well-rounded "happiness" of the individual. Happiness is a notion that includes not only pleasure and pain, but also freedom, personal rights, and the individual's growth in moral and intellectual character.[34] On this view the productive effects of agricultural technology would need to be weighed with other effects (if any) that technology has upon human well-being.

A more common strategy for utilitarian argument is to stress not happiness but the satisfaction of preferences. Peter Singer has proposed a form of utilitarianism based upon equal consideration of interests, where interests are determined by personal goals, plus the institutional endowment required for an individual's opportunity to pursue such goals.[35] A simplistic interpretation of the utilitarian maxim might appear to support policies that provide maximum social benefit even when this is achieved at the expense of a minority group. Singer's theory provides a basis for avoiding this result. In his view, a policy that systematically precludes any subgroup of individuals from enjoying benefits has violated

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32. L. TWEETEN, FOOD FOR PEOPLE AND PROFIT: ETHICS AND CAPITALISM, (The Food and Farm System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA—Extension, Michigan State University Cooperative Extension Service No. 5, 1983).

33. Griffin, *Modern Utilitarianism*, 36 REVUE INTERNATIONALE DE PHILOSOPHIE 331-375 (1982).

34. Hoag, *Happiness and Freedom: Recent Work on John Stuart Mill*, 15 PHIL. & PUB. AFF. 188-196 (1986).

35. If the schools, courts, and businesses of a society systematically preclude an individual's opportunity to pursue goals (because of racial or religious bias, for example), the individual would be said to lack the institutional endowment required. Note that institutional endowments need not (indeed, cannot) be guaranteed *carte blanche*; some goals may be simply unattainable. Singer's point is that the opportunity to pursue goals must be fairly distributed before maximizing criteria are relevant.

the preliminary assumption that all interests will be considered equally. The injunction to maximize utility can only be applied when this preliminary condition is satisfied. Institutional (or distributional) states of affairs that preempt the individual's opportunity to satisfy interests fail to weigh the interests of all parties equally, so there can be a basis to reject actions that appear to maximize utility, if they have failed to treat all persons' interests on an equal basis.[36] In other words, a decision maker attempting to maximize the satisfaction of preferences across society might, nevertheless, choose against agricultural technology in cases where it could be shown that productivity increases entirely foreclose an individual's opportunity to pursue his or her own interests.

An argument of this sort has been advanced on behalf of California tomato pickers whose jobs were displaced by the introduction of a mechanical tomato picker.[37] It should be noted however, that Singer's own use of this restriction more typically has to do with the loss of life or of basic political liberties than with the loss of a *particular* type of employment.[38] The tomato pickers' case might be more compelling according to Singer's form of utilitarianism if it could be shown that displaced workers would be forced into severe economic deprivation, rather than simply into another job. Nonetheless, increasing food production should, under the right conditions, relieve hunger; in Singer's view, the alleviation of hunger counts heavily in the interests of those who have been historically deprived. Thus, it is reasonable to expect that Singer's utilitarianism would make an even stronger case for improved technology than Mill's.

A narrower view of preference utilitarianism equates satisfaction of preference with rational economic choice, so that an individual's market behavior can be taken as evidence of individual utility. When this view is augmented with some of the received dicta of neoclassical economics (individual preferences are purely subjective; interpersonal comparisons of utility are impossible; no social utility is derivable from indi-

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36. P. SINGER, PRACTICAL ETHICS 18-23 (1979).

37. Schmitz & Seckler, *Mechanized Agriculture and Social Welfare: The Case of the Mechanical Tomato Harvester*, 52 AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 569-577 (1970); Brandt & French, *Mechanical Harvesting and the California Tomato Industry*, 65 AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 265-272 (1983); Martin & Olmstead, *The Agricultural Mechanization Controversy*, 227 SCIENCE 601-606 (1985).

38. P. SINGER, *supra* Note 36, at 162-168.

vidual preferences)[39] it becomes possible to argue that social welfare is always maximized when individuals control resources and expend them rationally under free market conditions. Only instances of market failure (due primarily to externalities or to government interference) could upset the efficient achievement of maximum utility.[40] Although government is deeply involved in the development of agricultural technology, the investment of resources into activities that increase production and improve productive efficiency is so thoroughly in the spirit of market utilitarianism that it is hard to imagine any advocate of this view who would not come out strongly in its favor.

The same general argument could be used to justify agricultural technology according to Posner's wealth maximization ethic.[41] When used to justify individual action, wealth maximization requires an individual to maximize his or her own satisfaction, and requires social institutions to interfere as little as possible. The theory finds a basis for moral value in exchanges (i.e. what one is willing to give up in order to acquire something else) an individual makes in pursuit of maximal satisfaction (or wealth). It is assumed that interpersonal comparisons of subjective enjoyment is impossible. Hence, moral action is definable only in the extreme individualistic sense of personal choice.

Wealth maximization places an even stronger emphasis upon the satisfaction of preferences through the market mechanism than does neoclassical utilitarianism, though strictly speaking it is not utilitarian, but egoistic in its maximizing calculation.[42] By converting the mandate to promote the general welfare into an injunction to maximize personal wealth, wealth maximization would appear to make the strongest possible case for new agricultural technology. These new technologies increase the relative ability of con-

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39. J. GOULD & C. FERGUSON, MICROECONOMIC THEORY 11-33 (5th ed. 1980); READINGS IN WELFARE ECONOMICS (K. Arrow & T. Scitovsky, ed. 1969); L. ROBBINS, AN ESSAY ON THE NATURE AND SIGNIFICANCE OF ECONOMIC SCIENCE (2nd ed. 1935).

40. *Cf.* A. BUCHANAN, ETHICS, EFFICIENCY AND THE MARKET (1985) for an exhaustive discussion of such views; this would appear to be the position of L. TWEETEN, *supra* Note 32.

41. Posner, *Wealth Maximization Revisited,* 2 NOTRE DAME J. L. ETHICS & PUB. POL'Y 85 (1985); *see also* R. POSNER, THE ECONOMICS OF JUSTICE (1981).

42. A utilitarian acts to promote the general welfare; an egoist acts to promote personal welfare. *Cf.* P. TAYLOR, PRINCIPLES OF ETHICS 31-80 (1975) for a discussion of basic approaches in ethical theory.

sumers to command resources, and can improve the economic position of shrewd managers, as well. The general conclusion that can be drawn is that an approach to ethical evaluation that stresses maximization of preference satisfaction will lead to a strongly positive evaluation of agricultural technology, and this evaluation will be stronger still the closer one moves to market preferences as the indicators for satisfaction or happiness. This general approach to ethics has been criticized,[43] but one must admit that, other things being equal, increases in productivity will support a strong presumptive case in favor of the development and application of new agricultural technologies.

B. *Farm Structure and Agrarianism*

The question, of course, is whether all other things are equal. As we have seen, technology is related to farm structure. Among the effects of changing agricultural technology is the virtual elimination of the moderate-sized production unit generally identified as the family farm.[44]

Although many larger farm operations are family run, the prototypical family farm portrayed throughout American literature and in films such as 1984's *Country* are, in fact, those moderate sized farms that are most stressed not only by technological change, but by exogenous factors such as exchange rates, regulation, and macroeconomic trends. There is extensive literature supporting the notion that these family farms ought to be shielded from events that threaten their continued existence, and that new technologies favoring large scale production ought to be opposed. Jim Hightower describes farm families as "the last bastion of free competition that exists in the food economy, if not in the entire economy."[45] He goes on to state:

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43. Sagoff, *Values and Preferences*, 96 ETHICS 301 (1986).

44. N. DOROW, *supra* note 12, at 1; U.S. DEPARTMENT OF AGRICULTURE, FINANCIAL CHARACTERISTICS OF U.S. FARMS, JAN. 1, 1986, (Economic Research Service, Agricultural Information Bulletin No. 500, 1986).

45. J. HIGHTOWER, EAT YOUR HEART OUT 157 (1975). In addition to Hightower and Wendell Berry (perhaps the most vocal of recent agrarians), see H. BREIMYER, INDIVIDUAL FREEDOM AND THE ECONOMIC ORGANIZATION OF AGRICULTURE 78-79 (1965); Berardi, *Socioeconomic Consequences of Agricultural Mechanization in the United States: Needed Redirections for Mechanization Research* in THE SOCIAL CONSEQUENCES AND CHALLENGES OF NEW AGRICULTURAL TECHNOLOGIES 9-22 (Berardi & Geisler eds. 1984); Goldschmidt, *Agricultural Production and the American Ethos*, in AGRICULTURE, CHANGE AND HUMAN VALUES 406-422 (Haynes & Lanier eds. 1982); Lem-

> People farm because they like it. It is *both* their business and their life. It is what they want to do. Chief among the likes is the sense of independence, the freedom to call most of your own shots on your own place. Another is a sense of accomplishment - putting yourself up against the weather, the bugs and the market place, and producing a crop that sometimes brings you out ahead.[46]

Hightower argues that the market power of large corporations cuts the profit margins for farmers and places this admirable way of life at risk. He also argues that the technology emerging from public and private research has tended to support corporate interests against the family farm.

It is Wendell Berry, however, who has offered the most eloquent defense of the family farm in his book *The Unsettling of America: Culture & Agriculture.* In Berry's view, the family farm is the best environment for developing a healthy union of body and soul, of recognizing the relative importance of human endeavor in the greater scheme of things. Berry's sensibilities can only be captured by quoting him at length:

> The soul, in its loneliness, hopes only for "salvation." And yet what is the burden of the Bible if not a sense of the mutuality of influence, rising out of an essential unity, among soul and body and community and world? These are all the works of God, and it is therefore the work of virtue to make or restore harmony among them. The world is certainly thought of as a place of spiritual trial, but it is also the confluence of soul and body, word and flesh, where thoughts must become deeds, where goodness is to be enacted. This is the great meeting place, the narrow passage where spirit and flesh, word and world, pass into each other. The Bible's aim, as I read it, is not the freeing of the spirit from the world. It is the handbook of their interaction. It says that they cannot be divided; that their mutuality, their unity, is inescapable; that they are not reconciled in division, but in harmony. What else can be meant by the resurrection of the body? The body should be "filled with light," perfected in understanding. And so everywhere there is the sense of consequence, fear and desire, grief and joy. What is desirable is repeatedly defined in the tensions of the sense of consequence. False prophets are to be

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ons, *Structural Trends in Agriculture and Preservation of Family Farms*, 10 ENVIRONMENTAL MANAGEMENT 75-88 (1986).

46. J. HIGHTOWER, *supra* note 45, at 160.

known "by their fruits." We are to treat others as we would be treated; thought is thus barred from any easy escape into aspiration or ideal, is turned around and forced into action. The following verses from *Proverbs* are not very likely the original work of a philosopher-king; they are overheard from generations of agrarian grandparents whose experience taught them that spiritual qualities become earthly events:

> *I went by the field of the slothful, and by the vineyard of the man void of understanding;*
>
> *And, lo, it was all grown over with thorns, and nettles had covered the face thereof, and the stone wall thereof was broken down.*
>
> *Then I saw, and considered it well. I looked upon it, and received instruction.*
>
> *Yet a little sleep, a little slumber, a little folding of the hands to sleep:*
>
> *So shall thy poverty come as one that traveleth; and thy want as an armed man.*[47]

Berry's view clearly supports the notion that changes in U.S. farm structure are not good. On modern agricultural technology he writes, "And there comes a point, as we know, when *more* begins to imply *worse*. The mechanization of farming passed that point long ago . . ."[48]

It is difficult to support such views on strictly utilitarian or libertarian grounds. First, it is important to recall that technology and corporate power represent only two components in the myriad forces shaping farm structure. Consumer demand, farm finance, and international trade may have effects that exceed those of new technology.[49] As we have also noted, dislocation associated with new technology may be associated not with the scale or type of technology, but with the rapidity with which a farmer is able to adopt it. Early adopters reap profits, but as many adopt and prices go down, adoption becomes a necessity in order to remain competitive, and many who cannot afford to adopt the technology are forced out of farming. These farm failures can, therefore, be seen as

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47. W. BERRY, THE UNSETTLING OF AMERICA: CULTURE & AGRICULTURE 109 (1977). Berry quotes *Proverbs* 24:30-34 (King James).

48. W. BERRY, THE GIFT OF GOOD LAND 105 (1981).

49. B. STANTON, WHAT FORCES SHAPE THE FARM AND FOOD SYSTEM? (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA—Extension, Michigan State University, Cooperative Extension Service No. 2 1983).

the result of wholly impersonal changes in the economic environment for which no person or public agency could be held morally responsible. The farmer's failure to make an astute business decision is, under this view, taken to be at least as important as changes in agricultural technology in contributing to farm failure. If this picture is correct, farmers themselves may be the agents with greatest causal responsibility for changing farm structure.

If the change in farm structure and the demise of the family farm is something done *by* farmers, rather than *to* them, the element of the agrarian argument that portrays farmers as innocent victims is seriously weakened. The misery experienced by farm families is less the outcome of specific policies than it is the confluence of many private decisions, farmers themselves among the primary actors. Furthermore, the benefits to consumers that are associated with changes in agricultural technology would almost certainly outweigh harms to farm families, when distributive issues are ignored. Agricultural economist Vernon W. Ruttan has assembled extensive evidence that supports the claim of net societal benefits for research and application of agricultural science and technology.[50]

Neither can one claim that the rights of farm families are being violated in the process of changing farm structure, since farm failures are the result of business decisions made willingly and with awareness of the possible consequences (if, admittedly, under economic conditions unfavorable to success). If there are no utilitarian or libertarian grounds for saving the family restaurant or the independent gas station, there can be no such justification for giving family farmers special consideration.

Spokesmen for the agrarian tradition, such as Hightower and Berry, have attempted to articulate reasons for treating agriculture as a special case. These efforts attempt to establish special considerations for family farms on some view of agriculture's moral superiority. Berry's arguments, for example, stress the purity of agricultural work, the farmer's closeness with nature; Hightower's arguments stress the character traits of self-reliance and community values that are alleged to develop more fully in the farm life. More sophisticated agrarian arguments stress the idea that equal access to land is as fundamental a right as access to air and water.[51]

50. V. RUTTAN, *supra* Note 8, at 26-43, 56-64.

51. Montmarquet, *Philosophical Foundations for Agrarianism*, AGRICUL-

Agrarian arguments share two fundamental weaknesses, however. First, though they can cite Thomas Jefferson as their intellectual fountainhead,[52] agrarian themes have not figured prominently in any modern philosophical tradition of ethical thought. It is difficult to imagine how the moral superiority of any particular occupation could be established on the basis of ethical theories that stress either general welfare considerations or rights and liberties as the basis of normative evaluation. Second, even if a novel philosophical defense of agrarianism could be achieved, it is hard to see how the agrarian vision could support the continued existence of the modern commercial family farm, a production unit that, as Berry himself admits, has gone far beyond the agrarian vision of purity and unity with the soil.

Despite the lack of a solid philosophical base on which to found their support, family farms appear to enjoy a special place in the American imagination. Celebrated in film, story and song, the family farmstead seems to be a symbol of national values and traditions. Advertisers continue to rely upon farm images to promote products ranging from automobiles to soft drinks. Children's books continue to dwell upon farm scenes in orienting young minds to the world around them. These considerations may be merely a nostalgia for a time irretrievably past, but they may also indicate national values, or, perhaps, even a wisdom that lies so deeply buried in our culture that it has resisted philosophical analysis. Writing on environmental values, Mark Sagoff has argued that emblematic celebrations ought to be regarded as evidence that there are fundamental national values at stake.[53] One might argue that for reasons which are difficult to articulate, family farms represent values that we as a people have decided to protect and preserve. If indeed the family farm is crucial to Americans' self conception of nationhood, there may be grounds for favoring this class of producers, and for

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TURE AND HUMAN VALUES, Spring 1985, at 5, 9.

52. Two of the most frequently cited passages are found in *Notes on the State of Virginia* and in the *1785 Letter From Thomas Jefferson to John Jay*, T. JEFFERSON, WRITINGS, at 290 & 818 respectively (1984). *See also* Montmarquet, *supra* at note 51; P. THOMPSON, THE GOALS OF AGRICULTURE FROM THOMAS JEFFERSON TO THE 21ST CENTURY (Department of Agricultural Economics, Texas A&M University, Faculty Papers Series FP 86-3, 1986), forthcoming in AGRICULTURE AND HUMAN VALUES.

53. Sagoff, *We Have Met the Enemy and He Is Us or Conflict and Contradiction in Environmental Law*, 12 ENVTL. L. 283 (1982).

opposing the technology that threatens their means of promotion.

Concerns about the character and quality of agricultural technology also may provide some basis for caution in accepting the rosy picture portrayed by a utilitarian analysis of production. The mechanical, chemical and biological technologies currently being used on American farms are, in obvious ways, different in character than those used a century or more ago. Their impacts are more far-reaching both in time and in space. Their development depends upon a sophisticated system of institutional support that incorporates the very latest developments in agricultural and biological science in a network of dissemination that insures widespread and quick adoption of promising techniques. In contrast, the agricultural technology of one hundred years ago was frequently developed by individual farmers for their own use; it had limited impact beyond the specific fields and seasons of application, and it was slow to spread from farm to farm. The question that arises is whether these changes in the character of agricultural technology are of any ethical significance.

One answer is grounded in the same agrarian tradition that is cited to support the family farm. Wes Jackson, for example, has argued that these changes in the character of agricultural technology have so altered the activity of farming as to rob it of its special moral significance, and have transformed it into a corrupt enterprise.[54] As such, these transformations in agricultural technology may be seen as intrinsically wrong, as deviations from the spiritual path indicated by an agriculture of smaller place and scale. The same general argument on a narrower scale is sometimes made against biotechnology applications to agriculture. It is argued that, over and above any environmental risks associated with recombinant DNA research, the application of these discoveries to our agriculture fosters an attitude toward nature that is morally wrong. Jeremy Rifkin, for example, has argued that biotechnological programs in agriculture bring an ethic of self-interest and control to the conduct of agriculture, and that it is thinking and acting from this attitude of superiority that is most destructive of the moral values that must guide human life.[55] A similar argument has been made by David Ehrenfeld, who finds in the manipulations of biological technology an

54. W. JACKSON, NEW ROOTS FOR AGRICULTURE (1984).
55. J. RIFKIN, DECLARATION OF A HERETIC 53, 94-95 (1985).

extension of human arrogance that prevents a balanced and moral outlook on life and nature.[56]

Jackson, Rifkin and Ehrenfeld base their assessments of agricultural technology upon particular visions of human character and purpose. Their arguments turn upon the claim that these technologies are morally wrong because they tend to corrupt their users and to create character flaws not only among agricultural producers but throughout society as well. Any analysis of these arguments would have to draw upon religious and philosophical considerations of the broadest possible kind.

It is impossible to conduct an adequate philosophical review of these moral claims without going into some detail on the metaphysical positions they presuppose. However, it may be noted that any effort to extend these views to matters of law and regulatory policy must overcome two philosophical difficulties. First, there is the problem of whether law and regulatory policy ought to be employed so as to encourage the fulfillment of any particular character traits or virtues. Libertarians have consistently argued that they should not. This is, of course, a continuing question in the philosophy of law, and there are advocates for either position;[57] but it is important to note that, as concerns the *regulation* of agricultural technology, agrarian arguments would need to be supplemented with some defense of the general principle of enforcement of morality. Second, even if one accepts the view that enforcement of moral virtue is an appropriate focus for the law, one would still have the difficult philosophical task of establishing that the exploitation of nature through chemical and biological technologies is, in fact, a violation of the basic moral role for human beings established in valid and generally recognized moral principles. It is certainly the case that the majority of the farm population, who (justifiably) consider themselves to be basically moral people, would need to be convinced that the use of these technologies is, in and of itself, morally wrong.

C. *Regenerative Agriculture and Environmental Ethics*

A readier case against the emerging technologies of agriculture can be made when one can demonstrate that un-

56. D. EHRENFELD, THE ARROGANCE OF HUMANISM (1978).

57. C.f. P. DEVLIN, THE ENFORCEMENT OF MORALS (1975) for the conservative view, and H. HART, ESSAYS IN JURISPRUDENCE AND PHILOSOPHY (1984) for the libertarian response. Relevant arguments from Devlin and Hart are excerpted and discussed in T. BEAUCHAMP & T. PICKARD, ETHICS AND PUBLIC POLICY: INTRODUCTION TO ETHICS (1983).

wanted and undesirable side effects may be associated with their use. Here the philosophical principle is to object not to the use of technology *per se*, but to the harmful consequences of its otherwise legitimate applications. This sound and generally recognized principle is, of course, the basis of most current environmental law. There is extensive technical and legal literature for many environmental consequences of agricultural technologies such as pesticide effects,[58] soil and water consumption,[59] and the environmental risks of biotechnology.[60] Although there are many familiar problems with assessing and adequately representing the relative importance of these consequences, the philosophical basis for addressing them would seem to be necessarily consequential, if not always utilitarian in the narrow sense. That is, these harmful consequences must be weighed against any beneficial consequences associated with greater productivity. There may be some consequences that are totally unacceptable because they violate individual rights to clean air and water, or impose involuntary risks of cancer or other diseases. If so, then harmful consequences may not be simply traded against beneficial ones in monetary terms; such a trade-off would vitiate the legitimacy of benefit-cost analysis, as well as the standard welfare maximizing calculations that inform classical utilitarian ethical theory. Nevertheless, the ethics of developing or transferring agricultural technology will consist in finding a procedure to weigh beneficial income and productivity consequences against unintended harmful consequences; the philosophical problems in effecting such a comparative judgment

58. *See* F. GRAHAM, JR., SINCE SILENT SPRING (1970) for a readable and not entirely outdated survey; *see also* Shrader - Frechette, *Ethical Issues and Pesticide Policy,* in AGRICULTURE, CHANGE AND HUMAN VALUES 549 (1984); Hill, *Controlling Pests Ecologically,* Q. REV.—THE SOIL A., Mar., 1984, at 13.

59. S. BATIE, SOIL CONSERVATION POLICY FOR THE FUTURE (The Farm and Food System in Transition—Emerging Policy Issues, Extension Committee on Policy, USDA-Extension, Michigan State University, Cooperative Extension Service No. 23, 1984); Schultz, *The Dynamics of Soil Erosion in the United States,* THE VANISHING FARMLAND CRISIS 45-57 (1984).

60. Brill, *Safety Concerns and Genetic Engineering in Agriculture,* 227 SCI., Jan. 25, 1985 at 381-384; *but see* especially the exchange between Brill and Colwell *et al.,* responding to Brill's paper in 229 SCI., Jul. 12, 1985, at 111-117; *see also* Tangley, *Releasing Engineered Organisms in the Environment,* 35 BIOSCIENCE 470-473 (1985); Alexander, *Ecological Consequences: Reducing the Uncertainties,* ISSUES IN SCI. & TECH., Spring 1985, at 57-68; and J. DOYLE, ALTERED HARVEST (1985).

are significant, but they are not different in kind for agriculture than they are for other areas of environmental law.

A related consideration that does appear to be unique to agricultural technology is the sustainability of a production technique or procedure. Unlike virtually any other productive industry, the resource base for agriculture (including forestry and fisheries) is potentially renewable. With proper soil, water and seed management practices, solar energy can be combined with human and animal labor to produce food and fiber in a way that leaves the resource base thoroughly intact after a variable, but relatively short, regenerative period. Of course, few farmers in history have practiced truly sustainable agriculture; contemporary agricultural technologies require the input of nonrenewable fuels, chemicals, and nitrogen fertilizer, as well as creating permanent loss in topsoil and groundwater. The concept of sustainable or regenerative agriculture should not be seen as an absolute criterion for agricultural production, however, for different technology mixes and different cultural practices result in widely varying degrees of consumption for the resource base.[61] The philosophical question here is whether achieving relatively more sustainable production practices ought to be a moral goal for agriculture, or whether agriculture ought to be treated just like any other industry, that is, by allowing cost and profit considerations to determine its use of resources.

Perhaps the issue can be framed best by considering reasons why emphasis upon permanence, sustainability, and regeneration should in some cases supersede the utilitarian rationale for increased productivity, and for the increases in economic efficiency that the subsequent reallocation of income would bring. E.F. Schumacher criticized a number of value assumptions underlying the economic analysis of productivity and efficiency in his 1973 book, *Small is Beautiful*. In the process of analyzing how a firm could maximize its profits or minimize costs, for example, the economist typically ignores the distinction between renewable and non-renewable resources; the current market value of each resource is simply entered into the calculus with no regard for the permanence of production processes and consumption patterns. Recommendations made on the basis of such analysis have the effect of encouraging and rewarding greed, ecological irresponsibility, and indifference to future generations. Schumacher quotes John Maynard Keynes, the great 1930s advocate of federal deficit spending, as saying:

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61. J. MADDEN, *supra* note 1.

> For at least another hundred years we must pretend to ourselves and to everyone that fair is foul and foul is fair; for foul is useful and fair is not. Avarice and usury and precaution must be our gods for a little longer still. For only they can lead us out of the tunnel of economic necessity into daylight.[62]

Rejecting totally this philosophy, Schumacher claims the assertion that "foul is useful and fair is not" is the antithesis of wisdom.

> The hope that the pursuit of goodness and virtue can be postponed until we have attained universal prosperity and that by the single-minded pursuit of wealth, without bothering our heads about spiritual and moral questions, we could establish peace on earth, is an unrealistic, unscientific and irrational hope. The exclusion of wisdom from economics, science, and technology was something that we could perhaps get away with for a little while, as long as we were relatively unsuccessful; but now that we have become very successful, the problem of spiritual and moral truth moves into the central position.
>
> From an economic point of view, the central concept of wisdom is permanence. We must study the economics of permanence. Nothing makes economic sense unless its continuance for a long time can be projected without running into absurdities.[63]

Quoting Gandhi as saying, "Earth provides enough to satisfy every man's need, but not for every man's greed," Schumacher contends that permanence is incompatible with value assumptions that encourage conspicuous consumption at the expense of irreplaceable resources and the environment.[64] At the same time, he contends the economic-political system is destroying opportunities for man to live a meaningful and satisfying existence, something that combines a satisfying work experience with spiritually enriching leisure activity. He advocates a norm called "Buddhist economics," whose principal goal is to maximize human satisfaction by the optimal pattern of consumption, whereas modern economics seeks to maximize consumption by the optimal pattern of productive effort, including where possible the substitution of

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62. E. SCHUMACHER, SMALL IS BEAUTIFUL 22 (1973).
63. *Id.* at 30-31.
64. *Id.* at 33.

cheaper for more expensive resources. Where irreplaceable natural resources and unspoiled environment are not priced dearly, they tend to be depleted and damaged in the human's quest for profits. Thus, Schumacher contrasts the value assumptions of conventional economic analysis with those of a philosophy emphasizing permanence rather than immediate enjoyment, inner satisfaction rather than outer materialism.

Aldo Leopold was another critic of productivity and efficiency as moral goals. His statement of the land ethic in *A Sand County Almanac* bases its argument for sustainable environmental practices on an understanding of the natural ecology.[65] Our new knowledge of ecology entails an expansion of our moral duties that is fully consistent with the history of moral awareness and obligation. Leopold describes an "ethical sequence" in which freedoms have been restricted down through history, as human civilization has come to understand more clearly the distinction between social and anti-social conduct. He cites the abolition of slavery as a great example of moral progress. The key to this advance, in Leopold's eyes, was to dispense with the notion that human beings could stand as property. The disposal of property he writes, ". . . is a matter of expediency, not of right and wrong."[66] Leopold thought that the next stage in humanity's moral development was to move beyond the notion of land as property.

> Land, like Odysseus' slave-girls, is still property. The land-man relation is still strictly economic, entailing privileges but not obligation. The extension of ethics to [land] is, if I read the evidence correctly, an evolutionary possibility and an ecological necessity. . . . All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. His instincts prompt him to compete for his place in that community, but his ethics prompt him also to cooperate (perhaps in order that there be a place to compete for).[67]

Leopold and Schumacher share an interest in environmental values; but unlike Schumacher, Leopold centers his argument on the place of community as the central organizing value for any system of ethics. For Leopold as for the agrarians, community is a value and a goal that brings into

65. A. LEOPOLD, A SAND COUNTY ALMANAC (1949).
66. *Id.* at 237.
67. *Id.* at 238-239.

focus the sense in which we are dependent upon each other even for the independence or liberty that is the overarching purpose of society.

Leopold and Schumacher are representatives of a recent turn in philosophical ethics that stresses a need to expand the scope of moral concern beyond its traditional boundaries. Recent work in environmental ethics has found the central deficiency of theories such as utilitarianism or Kantian ethics (i.e. ethical theories that, like the Golden Rule, justify action according to a principle of universality) to reside in their anthropocentrism, an exclusive emphasis upon the interests of human beings.[68] William Aiken has reviewed several non-anthropocentric approaches to agriculture and has proposed a philosophy of "eco-humanistic" agriculture that would balance the goal of ecological stability against human welfare. Aiken distinguishes his view from traditional ethics by denying the link that founds the value of the environment upon human interests. He argues that even if science provided substitutes for all natural resources required to promote human interests, we would still have an obligation to preserve nature. Aiken tempers this view, however, with the dictum that "human welfare will be given priority . . . when there is an irreconcilable conflict with environmental integrity."[69] As such, Aiken's eco-humanism provides a philosophical basis for regenerative agriculture that simply would not be recognized by utilitarian, libertarian, or Kantian approaches to the evaluation of agricultural technology.

IV. Some Speculative and Prescriptive Comments

One crucial lesson of the preceding discussion is that narrow economic goals need to be moderated by a host of other considerations, not the least of which are moral values that state clearly our society's dependence upon natural systems. There is a sense in which the search for economic efficiency serves quite adequately to express our dependence upon natural systems, for as natural resources become scarce or our use of them becomes in any way imperiled, prices go up and (effective) demand goes down. In the case of foodstuffs, however, demand goes down only when consumption goes down, and this, as Malthus wrote, is achieved only through human

68. *Cf.* P. Taylor, *supra* note 42 for a discussion of basic approaches to ethical theory.

69. Aiken, *Ethical Issues in Agriculture,* Earthbound 274 (1984).

misery and vice. A main purpose of society, then, in minimizing human misery, is to establish a food system with margins of safety. This margin of safety is, in the static economic sense, an inefficiency. It is a waste of productive resources that might be put to another use, and indeed would be put to another use if falling market prices were allowed to drive down production. In the dynamic economic sense, however, it is efficient in that it reduces risk; it also reduces misery, thus securing a vital social good.

On the other hand, at the same time that our margin of safety isolates us from the tragedy of starvation, it isolates us from the feedback mechanisms that inform us when we are increasing our vulnerability to a breakdown in the environmental system that supports agricultural practice. Those of us outside the system of agriculture may become oblivious to our dependence upon nature and upon the people within agriculture who cultivate nature to fulfill our needs. Our agriculture must continuously find ways to provide feedback on our use and abuse of natural resources well before the Malthusian controls of famine and warfare occur. This goal for agriculture, which is a creation of agriculture's success in achieving productivity and efficiency goals, is, as Leopold thought, a modification of the old agrarian goals. We must become cognizant of our community, not only our community of fellow citizens, but also that of the biosphere, the natural environment. We must become more aware of and responsible for the externalities stemming from our use of economic and natural resources. We must adopt a *conscious process of self-control.*

University of California's recently retired Vice President, Jim Kendrick, has argued that all of agriculture, large and small farms, should be "regenerative," meaning that it should be biologically sustainable rather than depleting or ruining the resource base upon which it depends. He admits that regenerative agriculture must be profitable if it is to be truly sustainable.[70]

A corollary of Kendrick's argument is that profitable agriculture must be made more regenerative. We need more research and education directed toward farming methods that do not depend on chemicals which may pose a threat to people and the environment. We need practical, profitable, and ecologically harmless ways to manage insects, weeds, and

70. Kendrick, *Regenerative Agriculture Must be Profitable,* CAL. AGRIC., Jul.-Aug. 1985, at 2.

other pests, while maintaining the fertility of our soils for generations to come. And we must help farmers find ways to make the transition from chemical-intensive to regenerative farming systems, without going deeply into debt or becoming bankrupt in the process.[71] All of agriculture, including its science, technology, and practice must become more ethical as it seeks greater efficiency. Economics and ethics must be viewed not as antagonistic and mutually incompatible views of the world, but as mutually supportive guides to the betterment of human well-being.[72]

If our analysis is correct, the traditions of American agrarianism and of conventional economic utilitarianism are both conceptually inadequate. To the extent that Americans adopt increasingly urban values, agrarian arguments for preserving family farms or resisting technological change will seem increasingly archaic. Signs indicate that already the farm population is beginning to be perceived not as the source of traditional American moral vision, but as yet another special interest group, looking to feed at the public trough.[73] Agrarian celebrations of agriculture's moral superiority can still attain verisimilitude when they become the subject matter of artistic masterworks such as John Steinbeck's *The Grapes of Wrath* or Robert Benton's *Places in the Heart*, but agrarian themes cannot be accepted at face value.[74] Con-

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71. Madden, *Debt Free Farming is Possible,* FARM ECON., Mar.-April, 1986.

72. Madden, *Beyond Conventional Economics: An Explanation of the Values Implicit in the Neoclassical Paradigm as Applied to the Evaluation of Agricultural Research and Productivity,* NEW DIRECTION FOR AGRIC. AND AGRIC. RES. 221-258 (1986).

73. *See* Easterbrook, *Making Sense of Agriculture,* THE ATLANTIC MONTHLY, Jul. 1985, at 63-78; Hulbert, *Rural Chic,* THE NEW REPUBLIC, Sept. 2, 1985, at 25-30. *See also* Sinclair, *Loophole Allows Extra Farm Subsidies,* WASHINGTON POST, Jan. 20, 1987, at A3, col. 1.

74. The agrarian vision of American agriculture is subjected to intense critical scrutiny by Easterbrook, *supra* note 73, at 63. Easterbrook concludes a perceptive review of changes in farm technology and economy with the claim that, "Eventually Congress will have to face the fact that there are too many farmers" at 78. For him, farmers are an interest group special only in "the statistical lock" that they place on farm district representatives. An equally critical attack on recent film and literary efforts to revive agrarian themes was launched by Hulbert, *supra* note 73, at 25. Here, agrarian themes are dismissed as romantic populism; Hulbert notes that artistically successful treatments of rural life portray it in terms of complexities more commonly associated with urban settings. Two works (not mentioned by Hulbert) that successfully articulate the ambiguity of agrarian themes are E. KELTON, THE TIME IT NEVER RAINED, (1973) and J.

ventional economic considerations will generally be more persuasive when reasoned argument comes into play.

On the other hand, there are important economic and philosophical reasons for resisting the narrow utilitarian or libertarian decisions that favor productivity and efficiency. The experience of regulatory restrictions on food additives and agricultural chemicals indicates that pursuit of market efficiencies becomes politically (if not morally) indefensible when human health and safety consequences are at stake. Unlike agrarian themes, however, free market justifications appear to be attaining more, rather than less, credibility, despite serious deficiencies. In fact, one might speculate that the somewhat contrary tendencies of agrarian and free market ideologies may have served to counterbalance one another over the last hundred years of change in agricultural technology and farm policy. If this is the case, then one would expect the declining influence of agrarian sentiments to be accompanied by a growing tendency to err in favor of short-term productivity growth and efficiency, at the expense of long-term, sustainable abundance. A persistent trend of such errors could have disastrous effects on the long-term outlook for environmental quality and, ultimately, for the competitiveness of United States agriculture.

Many factors influence competitiveness, but two keys to comparitive advantage for agricultural commodities are soil fertility and water availability. We may speculate that permanent effects on these production factors (through erosion, mineral depletion, pumping nonrenewable aquifers for irrigation, or contamination of groundwater) will weaken U.S. comparitive advantage in the future.[75] An indirect impact on

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GRAVES, HARD SCRABBLE (1973). A more positive assessment of agrarianism was made by Adams, *American Gothic: Country, The River, Places in the Heart*, 43 THE ANTIOCH REVIEW, Spring 1985, at 217-224, but even he finds the politics of the three films "at once seductive and regressive" at 222.

75. We feel that there is *prima facie* justification for linking a decline in environmental quality with one in competitiveness, but repeat that these comments are offered in a speculative vein. A probabilistic correspondence between the two has not, to our knowledge, been measured quantitatively. What is more, the attempt to quantify such a link would appear tortuous. For example, one study notes little expected decline in productivity due to loss of soil fertility, even if current soil erosion rates were to continue for fifty years, but the same study notes that silt carried by streams could shorten the life of reservoirs, and this could, in turn, affect overall productivity by affecting water supplies. Crosson, *Future Economic and Environmental Costs of Agricultural Land*, THE CROPLAND CRISIS: MYTH OR REALITY 165-191 (1982); Crosson, *Agricultural Land: A Question of Values*, AGRICULTURE

competitiveness also arises from excessive regulatory costs: a failure to provide enough effective regulation can lead to too much regulation. Public confidence in agriculture can be shaken by "horror stories." A loss of public confidence may result in laws that either raise the cost of technology available to U.S. farmers by requiring unnecessary scientific testing and documentation, or make technology unavailable altogether, through direct bans or through regulatory procedures that make it impossible for manufacturers to recoup the costs of registering a new technology for commercial use.[76] Foreign producers can gain an artificial advantage over U.S. producers when safe and effective new technologies are restricted by an overzealous regulatory process. In an ironic twist of fate, the philosophy of unrestricted productivity growth can create a backlash, an over restriction of productivity potential, in the form of a depleted natural environment and a reactionary political environment.

Rather than relying on an uncertain and tenuous balance of fundamentally unsound philosophies to guide agricultural law and policy, we would prefer to see an evolving statement of agriculture's role and function begin to guide decisions on the development, implementation and regulation of agricultural technology. Although a great deal is known about agricultural production, we have not, as a society, pondered the larger questions of what kind of agriculture we would most like to have. Schumacher and Leopold identify two of the key philosophical concepts that will have to undergo significant development if such a statement is to become a reality. Schumacher raises the question of time: how do we formulate an effective concept of agriculture that takes us beyond this year's crisis? Leopold raises the question of land: how do we formulate an effective concept of agriculture that transcends the legal and economic definitions of land as property? Responsible philosophies of agriculture will have to attempt answers to these questions that go beyond conventional economics, as well as traditional agrarianism. Such philosophies will be difficult to achieve; but they *must* be attempted. For that, the moral imperative is clear.

AND HUMAN VALUES, Fall 1985, at 6-13.

76. For an example of this phenomenon involving pesticides, *see* F. GRAHAM, *supra* note 58; *see also* J. PERKINS, INSECTS, EXPERTS, AND THE INSECTICIDE CRISIS (1982).