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COMMENTARY

The Ethics of Modern Agriculture

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To evaluate the ethics of modern agriculture we must first ask, "Compared to what alternative?" Abandoning agriculture entirely — returning to hunting and gathering — is not a viable alternative, nor is it useful to imagine everyone gardening their own food, or buying their own food directly from local farmers, although this vision is fancifully promoted now among some elite circles in the United States. A more useful comparison would be between the conventional modern agriculture of today, incorporating all of the productivity enhancements that modern science can provide, versus a pre-modern antecedent that lacked those enhancements, versus a third method of farming – organic farming — that chooses not to incorporate several of those enhancements (e.g., no synthetic fertilizers, no synthetic pesticides, and no genetically engineered crops). When evaluating the ethics of modern conventional versus pre-modern conventional versus organic farming, we must also draw distinctions between how these differing practices have effected three different objects of value: people, domesticated farm animals, and the natural environment.

Modern Agriculture and People

Using a utilitarian calculus, the productivity enhancements that characterize modern agriculture have been good for farmers and non-farmers alike. Farmers benefit because the higher productivity of their land and labor translates into more material wealth, and the postindustrial affluence enjoyed today by urban and suburban dwellers in both America and Europe rests on a prior adoption, in the middle years of the 20th Century, of highly productive, science-based farming.

Between 1900 and 1940 in the United States, farmers began using power machinery (tractors, drainage pumps, electric poultry equipment), new chemical applications (synthetic nitrogen fertilizers), and new applications of biological science for both crop and animal production (hybrid corn, artificial insemination). Then during the next half century they moved toward full electrification, a wider use of chemicals to control weeds and pests, applications of information and computer science to improve management and marketing efficiencies, and finally new sensor systems such as lasers for the precise leveling of fields and GPS technologies with satellite tracking and onboard computer monitoring to assist in more precise chemical applications. Then most recently in the 1990s came the introduction of crops with enhanced traits introduced through genetic engineering. The productivity gains made possible by these science-based enhancements were dramatic: The index of total output in American farming relative to total input increased by roughly 300% between 1910 and 1990.

A parallel uptake of science-based enhancements in the 20th Century also allowed farming in Europe to become far more productive. In Europe, where the endowment of land relative to labor was less generous, greater emphasis was placed at first on chemical and biological techniques capable of enhancing land productivity, and less on mechanical techniques designed to replace labor, but by the end of the 20th Century European farming had been transformed, no less than American farming, into a technology rich, highly specialized, and highly productive modern industry.

By any utilitarian calculus, the impacts of these changes on people were dramatically positive. For those who remained in farming, incomes rose in relative as well as

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absolute terms. In 1920 in the United States, the average household income of farmers was only 40% of the average for non-farmers. By the 1990s, farm household income was greater on average than that of non-farmers. Those who remained in farming also became better educated. Between 1950 and 1980 the proportion of farm-dwelling American males holding a high-school degree quadrupled, almost catching up with the growing proportion of urban-dwelling graduates. And for those who left farming, of course, living circumstances also improved. Between the late 19th Century and the late 20th Century, the percentage of citizens employed in farming in the United States fell from 50% to just 3%. In Germany from 47% to just 3%, and in Denmark from 48% to just 6%. This dramatic migration of labor out of farming facilitated rapid growth in the industrial sector, where parallel applications of new science were boosting productivity and income to new levels.

This transformation was culturally and emotionally difficult for many who left family homesteads and agrarian traditions behind, but few of those who remark on such difficulties have shown a readiness, themselves, to abandon the urban and suburban affluence and comfort that this modern agricultural revolution has provided. The ethics of proposing a return to a pre-modern style of farming in the United States and Europe today would be dubious, since the only way to accomplish such a return today would be through regulatory diktat or compulsion.

What, then, about the ethics of proposing that developing countries stay away from the modern agricultural model embraced in the 20th Century by both the United States and Europe? From the utilitarian perspective of people in these poor countries, this too would be unacceptable. It would be the equivalent of telling the rural poor in Africa and Asia that it would be just as well for them to remain poor.

Consider the circumstances of a typical smallholder farmer in Africa today, where modern science-based farming techniques have not yet been incorporated. More than 60% of Africans struggle to make their living in farming or grazing animals, most are women (80% of agricultural labor in Africa is provided by women and girls), and on average they earn only one dollar a day, and one third are malnourished. These African farmers are poor and hungry because the productivity of their land and labor has not yet been enhanced by any of the applications of modern science that have, since the Green Revolution of the 1960s and 1970s, helped bring an escape from rural poverty in much of developing Asia. Two thirds of smallholder farmers in Africa do not use scientifically improved seeds, most have no access to veterinary medicine for their animals, only 4% have irrigation, and the vast majority use no chemical fertilizers or pesticides (fertilizer use in Africa, at only 9 kg. per hectare, is less than 1/10 as high as the average in Europe or North America), and mechanization is nearly nonexistent. In the United Kingdom today there are 883 tractors per one thousand agricultural workers, whereas in sub-Saharan Africa there are only two (which is a 50% drop from 1980 level of three).

The ethics of telling these farmers in Africa to stay away from modern agricultural science would be particularly unacceptable if the message came from the same citizens in regions such as Europe or North America that earlier made themselves prosperous by using modern agricultural science, and who show few signs themselves of abandoning irrigation, hybrid seeds, and fertilizers.

Yet this is exactly the message some civil society groups from prosperous countries have recently been sending to poor farmers in Africa. At a 1996 FAO World Food Summit in Rome, 1,200 NGOs from eighty different countries convened a parallel forum to condemn agriculture for its tendency to destroy "traditional farming." At a follow-up UN food summit in Rome in 2002, a reconvened international NGO forum even blamed the Green Revolution for a rise in world hunger, a ludicrous assertion since the largest rise in hunger had been in Africa, which was the one continent where modern science-based farming had least taken hold. In 2004, a coalition of 670 separate NGOs sent a letter to the Director General of FAO describing the Green Revolution as a "tragedy." From a utilitarian perspective valuing the material welfare of people, such campaigns against modern agriculture must be judged unethical.

What of the organic alternative to modern agriculture? Organic farming rejects some but not all of the techniques that transformed conventional agriculture in the 20th Century. Organic farming took its original inspiration from the thinking of pre-modern vitalists who mistrusted products of chemical science such as synthetic nitrogen fertilizers and pesticides. The vitalists believed that living things such as plants could not be nurtured except by the products of other living things (such as animal manure). Today organic farming rejects as well the latest synthetic creation of modern biological science: genetically engineered crops. Are these prohibitions an ethical gain for the material welfare of people?

The income of some farmers can increase following organic certification, but not many. This is why in the United States only four-tenths of 1% of cropland is farmed organically. In Europe only 4% of agricultural land is under organic production, despite EU policies that have delivered cash payments ($559 million in 2001) to farmers willing to convert to organic. Conversions to organic remain the exception rather than the rule in both the United States and Europe because organic methods for replacing soil nutrients, controlling weeds, and protecting against insects are more costly, driving up the price of organic products in the market and keeping the commercial market for organically grown crops relatively small. Organically grown foods become affordable from a utilitarian perspec-

tive only after the income of consumers has increased enough to make food costs a non-salient concern. Without the high productivity and industrial affluence that was originally made possible in both North America and Europe in the 20th Century by a broad uptake of conventional agriculture, consumers would be even less willing than they are today to pay the premiums for organic. It is industrial and post-industrial affluence that stimulates organic farming, rather than the other way around.

If there were a clear consumer health or nutrition benefit from consuming organically grown foods, the higher cost might be more than justified. Yet there is little convincing evidence of such benefits. On the question of nutrition, Claire Williamson from the British Nutrition Foundation concluded last year that, "From a nutritional perspective, there is currently not enough evidence to recommend organic foods over conventionally produced foods." On the question of greater consumer risks from pesticide residues on conventional foods, stronger regulatory standards against such residues in the conventional food chain have now largely eliminated the possible advantage of consuming organic. In the United States the Food and Drug Administration (FDA) has measured the highest average intake of 38 different pesticides in the total diets of various population sub-groups and has found that for all but four of the 38 pesticides, exposures in the U.S. were at less than 1% of the "acceptable daily intake" level set by the United Nations. For the other four, all were below 5% of the ADI value. Carl Winter and Sarah Davis, with the UC Davis Institute of Food Technologists, concluded from this study that "the marginal benefits of reducing human exposure to pesticides in the diet through increased consumption of organic produce appear to be insignificant."

As for the possible risks to human consumers from genetically engineered foods, here again there is no convincing evidence yet that purchasing non-GMO organically grown foods is any safer. Between 2001 and 2004 a number of scientific bodies in Europe, including the Research Directorate of the European Union, the French Academy of Sciences, the French Academy of Medicine, the Royal Society in London, the British Medical Association, and the German Academies of Science and Humanities, all concluded that there was no convincing evidence yet of any new risk to human health from any of the GM varieties of foods that had been placed on the market so far.

For all these reasons, there seems to be little ethical justification — on human welfare grounds — for using either public resources or public authority in the United States or Europe to promote an organic alternative to modern conventional farming. And in poor countries where the productivity of farming is currently low, the promotion of organic techniques is even more dubious on ethical grounds. In Africa, in order to reach the annual production growth goals for 2015 set recently by the New Partnership for Africa's Development (NEPAD), average fertilizer applications will have to rise from the current level of 9 kg. per hectare up to 49 kg. per hectare. If organic farming were imposed on Africa, chemical fertilizer applications would have to move in the other direction and fall to zero. Telling poor and underfed Africans to go to zero use of chemical fertilizers, and to imitate the labor-intensive composting strategies favored by a tiny minority of farmers in rich countries, is ethically dubious. Yet this is the message delivered in Africa today by a number of civil society groups from rich countries, including the International Federation of Organic Agricultural Movements (IFOAM) and Greenpeace. These groups actually claim it is an advantage that so few African farmers use fertilizers, as that means they are already *de facto* organic. Nonproductive and poor, but organic.

Modern Agriculture and Farm Animals

Modern conventional agriculture has been on balance good for people, but it has been an ethical calamity in its treatment of domesticated farm animals. The ethical obligations people have toward domesticated farm animals are widely disputed, yet few ethicists can be comfortable with the approach taken by modern conventional farming, which views the human obligation toward farm animals as only slightly greater than toward domesticated plants. Humane slaughter is provided to farm animals, but the conditions of production now are otherwise inhumane.

In the United States, farm animals are explicitly excluded from most animal welfare legislation. The result has been an ethical nightmare which sees thousands of farm animals – poultry, pigs, and cattle — now treated essentially like farm crops. They are bred and fattened not with their own welfare in mind but only for properties human consumers will value, and since consumers value low cost, market pressures have driven farm animal production in the same direction (highly mechanized, highly-specialized, industrial-scale) that crop production has gone. This means animals are kept confined throughout most or all of their lives inside "concentrated animal feeding operations" (CAFOs) where their existence is reduced entirely to a single commercial function, such as weight gain prior to slaughter, or continuous egg and milk production.

Compared to the treatment of animals in pre-modern farming, animals in CAFOs do enjoy more veterinary services, a higher survival rate after birth, a far more abundant diet, and usually a less painful death, but these gains for the animals are mostly an accidental side-effect of the market efficiencies demanded by cost-conscious human consumers, and they fail to offset the unhealthy and

immoral psychological stress that CAFOs impose on farm animals. It has become a crime in most wealthy countries to impose comparable stresses on domesticated companion animals, yet this same ethical standard is not extended to farm animals, some of which — including pigs — show greater intelligence than many household pets. The only way to enhance the ethical treatment of farm animals in rich countries today will be to construct regulatory standards that take animal welfare explicitly into account (e.g., minimum standards for space to move about, access to sunlight, fresh air, and human contact, and protections against disfiguring practices such as tail docking or extreme beak-trimming). These higher standards might either be self-imposed (for example, by self-certified organic farmers) or state-imposed. Europe is far ahead of the United States at the present time in moving toward such standards, in part because Europe has not traveled so far as the United States down the CAFO road.

Modern Agriculture and the Environment

All agriculture is damaging to the natural environment, without exception. When comparing the damage from modern conventional farming to pre-modern farming, it is useful to separate landscape impacts from chemical pollution impacts. On a per-bushel of production basis, modern farming is actually far less destructive of the landscape than pre-modern farming. In the United States, for example, since 1950 the dollar value of total output has increased more than 100% but thanks to much higher yields (made possible by improved seeds and more fertilizer) the total land area devoted to farming has actually declined by 25%. On a per capita basis, the total land area devoted to farming in America has actually declined by 50% since 1920, thanks to high-input science-intensive farming.

The uptake of modern farming techniques has also brought landscape protection benefits in the developing world. In 1964, India had been producing 12 million tons of wheat on 14 million hectares of land, but then — thanks to the high yields of the Green Revolution — India was able by 1993 to increase its wheat production nearly four-fold while increasing its cropped area by only 60%. To have produced this much wheat before the Green Revolution had increased yields would have required bringing much more land under the plow. In effect, the Green Revolution allowed India to meet its rapidly growing food needs without having to plow an additional 36 million hectares of cropland. M. S. Swaminathan, the Indian plant scientist who led the local effort to develop the new seeds concluded, "Thanks to plant breeding, a tremendous onslaught on fragile lands and forest margins has been avoided."

On the other hand, modern agriculture does entail much heavier chemical use — both fertilizers and pesticides — with damaging consequences to the natural environment. Yet there is a strong argument for reducing this damage by moving even farther down the path of modernization in farming, rather than by reverting to pre-modern approaches. When the environmental risks of farm chemical use first became a salient issue in the 1960s, following the 1962 publication of Rachel Carson's *Silent Spring* (a book that helped create the modern environmental movement), much stronger regulations were placed on pesticide use throughout the developed world, and a first generation of particularly damaging chemicals gave way to less toxic and less persistent alternatives. Also, farmers learned to reduce chemical use (which saved money as well as the environment) by integrating other pest management practices into their operations, by purchasing new crop seeds with greater resistance to insects and disease, and by moving toward far more precise fertilizer application methods (including satellite-based GPS systems that permit what is called "precision farming").

Also, it is important to recognize that levels of chemical use in modern farming could be much lower if crop production were less heavily subsidized. The heaviest users of farm chemicals per bushel of production are the countries — such as Japan, and some of the Alpine countries in Europe — that provide the greatest artificial trade protection and income support to farmers. Much of the environmental harm we associate with modern farming is more accurately understood as a harm caused by the *subsidization* of modern farming.

Compared to modern farming, would a switch to organic farming result in less damage to the natural environment? In landscape terms, the answer is no. Because organically grown field crops have a lower yield per acre, and because they must be fertilized with systems that require more land for animal pasture or for cover crops (to be plowed under as "green manure") organic farming has a larger footprint on the land per unit of production than conventional farming. For example, in Europe the yield in organic systems compared to conventional is 68% lower for cereals and 73% lower for potatoes. Consequently, if Europe tried to feed itself organically it would need an additional 28 million hectares of cropland, equal to all the remaining forest cover of France, Germany, Denmark, and Britain combined. The prohibition in organic farming against use of synthetic herbicides also can have adverse environmental impacts, as it tends to block the modern use of no-till farming practices, rated as superior to organic farming along all environmental criteria.

A strict adoption of organic farming also makes environmentally sustainable agriculture more difficult because it rules out the use of genetically engineered crops. The GMO crops that have been placed on the market so far have brought no new harm to the natural environment and several documented benefits.

On the question of environmental harm from GMOs, a 2003 study conducted by scientists from New Zealand and the Netherlands published in *The Plant Journal* examined data collected worldwide up to that time, and the authors concluded from this data that the GMO crops approved so far had been no more likely to become weeds than conventional crops, no more invasive or persistent, and no more likely to lead to gene transfer. There was no evidence GMO crops had transferred to other organisms (such as weeds) new advantages such as resistance to pests or diseases, or tolerance to environmental stress. Later in 2003 the International Council for Science (ICSU) examined the findings of roughly 50 different scientific studies that had been published in 2002–03 and concluded, "[T]here is no evidence of any deleterious environmental effects having occurred from the trait/species combinations currently available." In May 2004, the United Nations Food and Agriculture Organization (FAO) issued a 106 page report summarizing evidence that, "to date, no verifiable untoward toxic or nutritionally deleterious effects resulting from the consumption of foods derived from genetically modified foods have been discovered anywhere in the world." On the matter of environmental safety, this FAO report found the environmental effects of the GM crops approved so far — including effects such as gene transfer to other crops and wild relatives, weediness, and unintended adverse effects on nontarget species (such as butterflies) — had been similar to those that already existing from conventional agricultural crops. Finally in 2007, a study done for the journal *Advanced Biochemical Engineering/Biotechnology* surveyed 10 years of research published in peer-reviewed scientific journals, scientific books, reports from regions with extensive GM cultivation, and reports from international governmental organizations and found that "The data available so far provide no scientific evidence that the cultivation of the presently commercialized GM crops has caused environmental harm."

Regarding environmental benefits, the advantage of GMO crops is their ability to thrive with reduced sprayings of toxic chemicals, and in some cases reduced soil tillage. Country studies of insect-resistant GMO cotton production in Australia, China, South Africa and the United States have shown reductions in insecticide spraying of 40% to 60% for GMO cotton compared to conventional cotton crops. Reduced spraying of insecticide means less pollution of ground water and surface water and also less damage to non-target species such as the beneficial insects that live in and around the farm field. According to one 2005 calculation by Brookes and Barfoot, the planting of GMO crops up to that point had made possible a global reduction of 15% in the total volume of insecticides applied to cotton since 1996, and a reduction of 4% in the total volume of herbicides used on soybeans. Herbicide tolerant GMO soybeans can be grown not only with fewer, less toxic, and less persistent herbicide sprays, but also with less soil tillage, a factor that reduces erosion and the siltation of water bodies downstream. GMOs even help cut greenhouse gas emissions by reducing the burning of diesel fuel, thanks to lower mechanical tillage requirements and a less frequent need for field applications of herbicides and insecticides. The adoption of "no till" and "reduced till" weed control systems (made possible with herbicide-tolerant GMO crops) has also been an environmental benefit, in the form of less soil erosion and more carbon sequestration. Over the period 1996–2004 a cumulative reduction in fuel use equal to 4.9 billion kg of carbon dioxide was made possible by farmers switching — mostly in North and South America — to GMO crops. In 2004, an additional 9.4 million kg. Of carbon dioxide was sequestered in the soil thanks to reduced tillage made possible by GMO crops.

Summary

In sum, the ethics of modern agriculture are mixed. On a per-unit-of-production basis, modern agriculture is superior to traditional agriculture in its treatment of both people and the environment, but inferior in its treatment of farm animals. On a per-unit-of-production basis modern agriculture is also superior to organic farming in its treatment of people and the agricultural landscape. Regarding chemical pollution of the environment, modern agriculture is not superior either to traditional agriculture or to organic farming, but pollution trends in modern farming are at least down rather than up per-unit-of-production, thanks to recent moves toward precision farming and thanks as well, in some countries, to the adoption of genetically engineered crops that require fewer chemicals.

Why, if this summary is accurate, is modern farming so frequently criticized as somehow less sustainable than either traditional farming or organic farming? The answer to this question requires a much deeper cultural analysis of how attitudes in prosperous countries change, once dietary affluence has been attained (reducing the imperative for still more farm productivity) and once citizens with first hand farming experience shrink in number to constitute less than 5% of the total population. In prosperous modern societies, where few people know farming first hand, citizen misunderstandings regarding the science and economics of agriculture tend to proliferate.

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