agronomy

Review

Agriculture's Moral Dilemmas and the Need for Agroecology

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Abstract: Those engaged in agriculture possess a definite but unexamined moral confidence or certainty about the correctness of what they do. The basis of the moral confidence is not obvious to those who have it, or to the public. In fact, the moral confidence that pervades agriculture is potentially harmful because it is unexamined. It is necessary that those engaged in agriculture analyze what it is about agriculture in society that favors, inhibits, or limits agriculture. All should strive to nourish and strengthen the aspects of agriculture that are beneficial and change those that are not. To do this all must be confident to study ourselves, our institutions, and be dedicated to the task of modifying the values and goals of both.

Keywords: agriculture; ethics; moral dilemmas; moral confidence

1. Introduction

Norman Borlaug [1] cautioned "that agricultural scientists have a moral obligation to warn the political, educational, and religious leaders about the magnitude and seriousness of the arable land, food, population, and environmental problems that lie ahead". Unless these problems "are addressed in a forthright manner future solutions will be more difficult to achieve" [2]. Agricultural scientists pride themselves on the achievements of the green revolution, but they have not addressed the existing moral problems and study of agroecology is in its infancy.

Having worked toward the obligation to feed a growing world population, the agricultural community has essentially ignored the moral challenges created by its technology. The rationale for ignoring them was that the costs associated with pollution, environmental damage, and harm to human health were justified by the production benefits. Atreya et al. [3] argue that the soil, water, and air pollution, pest resistance and resurgence, bio-magnification, and loss of bio-diversity and ecosystem resilience caused by the use of pesticides were unintentional developmental problems. If these costs are accounted for, the benefits from the use of pesticides could be outweighed by the cost of pollution and human health effects. These represent choices that arise in the course of technical and social transformation. Knowing all the technological ingredients of modern agriculture has done little to create an understanding of how they have affected the texture of modern life.

Since the mid-twentieth century the quality of science in the US has been evaluated almost exclusively in terms of its ability to deliver technological innovations. This is particularly true in agriculture. Agricultural scientists have made great strides to improve crop production. However, when they claim credit for improving production and keeping the cost of food low, they must also accept society's right to hold them responsible for problems they have regarded as externalities (An externality is a cost that is not reflected in price, or more technically, a cost or benefit for which no market mechanism exists. It is a loss or gain in the welfare of one party resulting from an activity of another party, without there being any compensation for the loss. From a self-interested view, an externality is a secondary cost or benefit that does not affect the decision-maker). Internalizing the externalities will lead to understanding of how technological choices have important consequences for the practice and future of agriculture. We have lived through several decades when the advance of technology and the horizon of human progress have seemed to be the same. We want to be prepared to take advantage of the technological advances on the horizon. But we need to ask and be prepared to respond to what we have not asked—what could go wrong?

Agriculture, the essential human activity, is our most widespread interaction with the environment. We live in a post-industrial, information age society. No one will ever live in a post-agricultural society. To assure agriculture's sustainability and continued productive capability the agricultural community must recognize and address the several moral dilemmas agriculture has created. Continuing to justify all of agriculture's activities and technology by the necessity of achieving the moral obligation and the production challenge of feeding, what most agree will be, a growing population [4] has not been and will not be a sufficient defense for agriculture's negative environmental and human effects.

Humans, the world's dominant species, are no longer just a part of nature; we are a force of nature—"that is disturbing and changing the climate and our planet's ecosystems at a pace and scope never seen before in human history" [5] (p. 87). "We cannot rebuild the Greenland ice sheet, the Amazon rain forest, or the Great Barrier reef. When the rhinos, the macaws, the orangutans are gone, no 3D printer will bring them back to life [5] (p. 183). E.O. Wilson [6] strongly suggests that "Soon we must look deep within ourselves and decide what we wish to become." The following is a start of this exploration that must include careful examination and discussion of present and future agricultural practices—both those that enable feeding the world and those that may prevent achieving that desirable goal.

2. Concerns about Agriculture

There are many concerns about agriculture. They include thoughts about the sustainability of the agricultural enterprise, the use and role of pesticides, the place of biotechnology and genetic modification, and agriculture's effects upon the environment. Each is discussed briefly below. Discussion of the present system of animal production in the US has been intentionally omitted. Those opposed suggest it presents an unacceptable level of risk to public health and damage to the environment, as well as unnecessary harm to animals (http://pewtrusts.org/en/research-and-analysis/reports/0001/01/01/putting-meat-on-the-table).

2.1. Sustainability

Everyone involved in agriculture is in favor of sustainability. However, there is little agreement on what is to be sustained. Within the agricultural community to sustain usually means protecting the productive resource (soil, water, and gene pools) and thereby assuring increasing production. It is clear that sustaining the productive resource is important. It is not clear why that legitimate goal always outranks sustaining environmental quality. This debate goes to the heart of what agriculture ought to be. Agriculture has a major responsibility because it is so widespread and has the potential to care for or harm so much land. This is a different view from protecting only the productive ability of land. Because of increasing urbanization, there will be less land to feed the >9 billion. We create places for people to live and simultaneously destroy agricultural land, an essential environmental resource. Concrete is the land's last use. Land is not simply a productive resource. It is the basis of life. Without the land there will be no agriculture. Therefore, land must be regarded as something more than other productive resources (fertilizer, machines, irrigation water, pesticides, or seed). To harm or destroy the land is to destroy something essential to life, and that certainly raises a moral question.

The pursuit of agricultural sustainability is commonly viewed as mainly or wholly a technical problem that simply requires changing farming methods in developed and developing countries and adopting new, alternative technologies [7]. Within the agricultural community it is seen primarily in utilitarian terms, as a means of protecting the productive potential of the land (the soil) and satisfying market demands for healthy, tasty food. But achieving agricultural system sustainability will not be accomplished by tinkering at the fringes with new technology. It will require re-thinking how we practice agriculture and pursuing more than production sustainability. It is a challenging moral, educational, and political task.

Now some tell us that current agricultural practices may threaten future global food security and will have negative effects on global food production [8]. The total agricultural area has decreased since 2000, fertilizer and pesticide consumption have increased, water use efficiency has increased, and available water sources are already being used for irrigation. About 70% of available global water is consumed by the global agricultural sector which uses about 2.5 trillion cubic meters of water each year, >40% of which comes from groundwater (The commonly accepted and most frequently cited value for water use by agriculture is 70%. The value has a lot of underlying assumptions and guesses. For the US, it is more likely around 40% of the total diversion. Energy uses about the same amount of water). In the US, 60% of irrigated crop production depends on groundwater for supplemental or full supply [9]. It is forecast that agriculture's demand for water could rise to 10 to 13 trillion cubic meters by 2050. That is $2\frac{1}{2}$ to $3\frac{1}{2}$ times greater than the total human use of freshwater today [10]. Water use for agriculture peaked in 1980 and has decreased every year since due to improved irrigation system efficiency, in spite of an increasing number of acres irrigated [11]. Population growth and increasing living standards around the world will intensify the risks of a global food crisis in the coming decades. It is crucial that any sustainable agricultural system must increase crop yields and simultaneously decrease the environmental effects of agricultural intensification.

Meljboom and Brom [12] advocate consideration of sustainability as a moral idea. First it would explain the normative component of sustainability. Second, it would lead toward a definition of sustainability—in the sense of what it is that must be sustained. Understanding sustainability as a moral idea would help to open it up for fundamental critical reflection without hampering it as a guide to practice. It might lead to thought about a limit, a self-imposed restraint, on using the earth in the long-term interest of humans to the detriment of other creatures with whom we share the planet. Economic growth has acquired the power and scope of a new religion and it drives agricultural expansion [13] (p. 147). Should there be limits to agricultural expansion?

2.2. Pesticides

The world uses a vast array of synthetic organic chemicals to manage insects, weeds, fungi, and other organisms that sometimes just bother and other times may cause significant yield losses and harm to humans. Pesticides and other agricultural technology have made it possible to feed a growing human population and protect millions of people from malaria and other insect-borne diseases. Of the pesticides used in the world, 80% are used in agriculture: approximately 40% are herbicides—the front line of defense against weeds [14], 33% insecticides, and 10% fungicides. Sales and use have been expanding rapidly throughout the world, although the development of new modes of actions has become rare [15].

There is no question that pesticides increase crop yields and cause harm to the environment, to people, and other creatures. For example, there are 42% fewer species of invertebrates in streams with severe pesticide contamination and 85% fewer new queens in bumblebee hives exposed to pesticides (Science 341:31. Smarter pest control). Pesticides have been aggressively promoted and are generally accepted within the agricultural community, as essential to maintaining yields and feeding a growing world population. There are also legitimate global human rights concerns because of their detrimental effects. The UN General Assembly [16] report denies the claim that pesticides are necessary to feed the world. It regards them as a short-term, but not a sustainable solution that helps achieve adequate food and health for all.

A common view among the general public is that synthetic, organic chemical pesticides are dangerous, overused, are present in food, soil, and water and should not be. It is also widely acknowledged within the agricultural community that they have made our lives easier and more enjoyable by reducing mosquito, ant, and cockroach populations. But among the general public the dominant view is that they pose real threats to human health and the environment [17].

Modern pest management has been highly dependent on the science of pesticides. The challenges of pest management are enormous, and as pointed out by Edwards and Hannah [18] the potential input from the wider plant science community is largely unrecognized. Reddy and James [19] claim that weed science has been slow to "catch up" with progress toward precision agriculture that has been made in irrigation and fertilizer management. It is clear from any current issue of Weed Science and Weed Technology that herbicides continue to dominate weed science research and lead to one of agriculture's moral dilemmas. Young [20] points out that true integrated weed management requires a high level of plant ecological and biological knowledge, technological machinery, and decision-making algorithms that can respond rapidly to changes in weeds and the environment. There are few field scale examples of true integrated weed management due to the lack of suitable technological tools and therefore a need for, in Young's view, a paradigm shift. For example, a symposium held during the 2018 annual meeting of the Weed Science Society of America discussed the present state and potential for weed removal automation which has not received much attention by the greater weed science community. Automated weed removal with selective herbicide application is among the paradigm shifts Young recommends. It employs machines that recognize weeds and use an herbicide, flame, laser, or hot oil to kill/manage them [21].

2.3. Antibiotics

There is great concern about the increasing incidence of poor performance of antibiotics for treatment of human diseases due to bacterial resistance because of their use in livestock enterprises. It is estimated that approximately 80% (a disputed number) of all antibiotics used in the US are fed to farm animals. There is disagreement about the quantity and patterns of antibiotic use in food animals. These very effective, necessary medicinal products originally developed to protect human health, have become less and less useful as resistance to them has become more common due to widespread use in animal/poultry production for disease prevention and growth promotion and over-prescribing them for human problems. Van Boeckel et al. [22] estimated that global antimicrobial use in food animals would increase 67% by 2030. McKenna [23] offered a view of how antibiotics created modern agriculture and changed the way we eat.

2.4. Loss of Biodiversity

There is a well-documented, continuing loss of ecological biodiversity, species, and genetic diversity. Between 0.01% and 0.1% of all known species become extinct every year. If the low estimate is correct, we are losing between 200 and 2000 species every year. If the high estimate is correct, the earth is losing between 10,000 and 100,000. Kolbert [24,25] posed that the earth is undergoing a sixth extinction and global warming and man's activities, including agriculture, are the primary causes. Between 1.4 and 1.8 million species have been identified. We don't know how many more there may be. The low estimate is around two million different species on our planet. The high estimate is 100 million. It is important to know that we don't know how many species the earth has. Therefore, it is hard to know how many are being lost. Scientists estimate that we are losing species at a rate 1000 to 10,000 times higher than the natural extinction rate, the rate that would occur if humans were not involved.

2.5. Biotechnology and GMOs

The first genetically modified crop planted in the United States was canola in 1996. The acreage of GMO crops has increased dramatically since then. Agricultural scientists have been using conventional plant breeding techniques to improve food crops for hundreds of years to create plants that have higher yield and are more responsive to fertilizer. However, an intense debate continues between two sides, both of whom, are convinced they are right and the others are wrong, at least partially misinformed, and don't understand. Partisans on both sides are convinced they are in an all-or-nothing battle characterized by the proponents, who think of themselves as the good guys versus the misinformed guys [25].

The proponents have faith that limitless technological progress will finally solve the problems of limitless contamination. The good guys seem to be quite convinced as the objectors; the other good guys are not that science will solve the problems. Mampuys and Brom [26] deny this and claim that "it is likely that there will be a permanent difference in .... opinion that cannot be solved with more data or new facts." Berry [27] (p. 211) reminds us, as many of those who see only the benefits of biotechnology do not, that nature "requires respect, a kind of reverence, and deference before Nature's ultimately mysterious forms and processes." I suggest this view is correct and reflects the past optimism about human and environmental safety, which was loudly and consistently proclaimed by the agro-chemical industry and, which was ultimately proven to be, if not wrong, at least highly questionable. Mampuys and Brom [26] claim the current strategy is unlikely to solve the problems and the focus should shift to "managing permanent different viewpoints and providing a platform for a broader conversation on agriculture and food production." The debate and tensions between the two groups will not be easily reconciled because they rely on different knowledge and verification claims [28]. Proponents claim that it is not unjust to use GMO's to alleviate hunger and malnutrition and achieve the goal of feeding an expanding population [29], a reasonable argument that is weakened because more than half of the general public (57%) say that GM foods are generally unsafe to eat. It is an enduring gap between the public and scientists and depicts a moral challenge for the agricultural community.

The comment of James Davidson (Emeritus VP for Agriculture and Natural Resources, University of Florida, Gainesville, FL, USA) illustrate the agricultural community's optimism and unwillingness to recognize and respond to past errors [30,31]. Davidson's comments lend support to those who believe that GMO's portend other problems which agriculture's practitioners will have to recognize and eventually apologize for:

"With the publication of Rachel Carson's book entitled Silent Spring, we, in the agricultural community, loudly and in unison stated that pesticides did not contaminate the environment—we now admit they do. When confronted with the presence of nitrates in groundwater, we responded that it was not possible for nitrates from commercial fertilizer to reach groundwater in excess of 10 parts per million under normal productive agricultural systems—we now admit they do. When rk4kquestioned about the presence of pesticides in food and food quality, we reassured the public that if the pesticide was applied in compliance with the label, agricultural products would be free of pesticides—we now admit they are not."

The claim that GM crops will feed growing numbers of people in the third world has great moral appeal. It is responsible, even altruistic. But the claim is deeply misleading because it is based on the incorrect but popular assumption that we don't produce enough food to feed starving people. People are hungry because they do not have enough money to buy food, do not have access to land to grow food, or do not live in a country where the government provides adequate help. Agricultural scientists have essentially said, "Trust us, we know what we're doing." Rollin [32] acknowledges the prevailing illiteracy about science among the general population which when combined with the dominance of positivism within the agricultural scientific community and the capture of ethical discussion by those who hold power and want to maintain it has served to stifle essential ethical discussion.

2.6. The Environment

Some claim that agriculture encroaches on and harms the natural environment [33–35]. Over the last 200 years an estimated 30% of US farmland has been abandoned because of erosion, salinization, and waterlogging. Since the 1960s, one third of the world's arable land has been lost to erosion. Some US cropland loses soil, the essential agricultural resource, at an average rate of 5 tons/acre/year from water and wind erosion [36].

3. Concluding Comment

Within the mainstream agricultural community, feeding the >9 billion is often cited as the primary, if not the only value that justifies technological innovation. The social, environmental, and economic costs of a developed country's capital, energy, and chemically dependent agricultural system, and the challenge of sustaining the environment, small rural communities, and other species are recognized as important, but the necessity of increasing production dominates other reasonable goals. There are very few natural ecosystems where species composition is independent of human involvement. One is tempted to ask if the essential concern of environmental ethics is protecting ecosystems from agriculture.

The world now produces enough food to feed everyone a minimally adequate daily diet (http://www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm). Feeding the >9 billion is undeniably a production problem, but it is also a poverty, distribution, infrastructure, and environmental problem. Western developed country agriculture is a productive marvel that is envied by societies where hunger rather than abundance dominates. However, it is becoming quite obvious to anyone who listens to, reads, or watches the news that citizens of democratic societies are becoming reluctant to entrust their water, their diets, and their natural resources blindly into the hands of farmers, agribusiness firms, and agricultural scientists.

Ethicists and agricultural practitioners must participate in the dialog that leads to social consensus about risks. Agricultural technology has always exposed people to risk. In the past, most of the risk was borne by users of the technology. Now there is widespread concern that the risks and short- and long-term consequences of agricultural technology are borne by others. Agriculturalists must begin to contribute the time and resources needed to understand their positions and those of their fellow citizens. For most non-agricultural segments of society, these are not new demands. For agriculture they are.

Scriven [37] argues that "science is essentially evaluative and it would not be scientific if scientists could not make and thoroughly support a whole range of value judgments." The alternative claim that science is value free is based on the positivist argument that moral/value judgments or ultimate value judgments are disbarred from science. When discussion of values occurs, we assume we are getting down to the most fundamental issues in human experience. The discussion moves toward something more humane, fair, and more difficult. But the discussion seems to disintegrate because the terms are not concrete; they are not factual. Instead of trying to discuss, which may be perceived as questioning someone's values, perhaps we should ask about people's motives, their preferences, or the prevailing norms of a particular group in society and proceed to the difficult question—what is the right thing to do?

Because agriculture is the essential human activity, it is essential that it rest on a firm ethical foundation. Agriculture is not just about results. Principles matter because they determine what values are operative and what truths are sought. Exploration of agriculture's moral dilemmas by ethicists and agriculture's practitioners, will facilitate navigation through complex issues, and serve as a guide to ways to construct common ground for discussion and resolution of agriculture's dilemmas. The prevailing assumption is that technological solutions will continue to reduce and eventually eliminate hunger because the productive progress of the green revolution was proof that the key to agricultural success was faith in scientific savoir faire and technological know-how. As we seek that common ground, we should resist the temptation of presentism—the assumption that what is happening now is going to keep on happening because nothing is going to happen to stop it.

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