The evolution of weed science – an ethical perspective

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Summary Agriculture has evolved through three eras and is now moving into the fourth or biotech era. Weed science, an integral part of agriculture, has evolved its techniques and knowledge but that evolution has not been matched by development of the science's ethical dimension. The ethics of weed science have not evolved because they have largely been implicit, ignored, and unexamined. Acceptance of the fact that ethics and weed science have an undeniable relationship will be an important step toward clarifying the reasons for weed management practices. As weed science moves into the biotech era we again have an opportunity to deal with the ethical dimensions of our technology or ignore them.

A summary response to my topic is that while weed science has evolved its scientific techniques and knowledge, that has not been matched by evolution of the science's ethical dimension. The ethics of weed science have not evolved because they have been implicit, ignored, or unexamined. What follows is an elaboration of that thesis.

DEVELOPMENT OF AGRICULTURE

Agriculture has evolved through three eras and is now moving into the fourth or biotech era. During the first, the blood, sweat, and tears era, famine and fatigue were common and inadequate food supplies occurred frequently. Most people were farmers on small, primarily subsistence, farms. The life of man, as Thomas Hobbes said was, 'solitary, poor, nasty, brutish, and short.'

The mechanical era of agriculture began with the invention of labour-saving machines e.g., the cotton gin, the reaper, and the steel moldboard plough. In 1830, four US farmers supported five non-farmers. In 1910 one farmer fed himself and six others. By 1930, one farmer supported 10 non-farmers and today American agriculture proudly claims that one farmer feeds over 100 Americans and other people. Much of the increase in a farmer's productivity was due to agricultural mechanisation and improved technology

The third era of agriculture, the chemical era, boosted production again. This occurred primarily after 1945, when fertilisers and pesticides became widely available. The increases in crop production and labour productivity over the years are due to improved mechanisation, the use of agricultural chemicals, increased education of farmers, improved crop varieties, and improved farming practices. There are good sources of information on herbicide development and I need not tell that story here.

Herbicide development came at a time when world agriculture was involved in a revolution of labour reduction, increased mechanisation, and new methods to improve crop quality and produce higher yields at reduced cost. The development of herbicides by the agricultural chemical industry and weed scientists contributed to the agricultural revolution. Agriculture was ready for the improved methods of selective weed control created by weed scientists. The results were much better than cultivation; they were amazing. Chemical weed controls were magic in their efficacy and, one assumed, their safety. It was indeed a new era.

Developed country agriculture is now in the chemical era and integrated weed management systems are being developed as we move rapidly into the biotech era. These systems try to integrate all methods of weed management for crops and for sites. It is a difficult task. As these systems are being developed it is wise to recall the advice of Vorley and Keeney: 'integrated approaches to crop production and protection cannot be built on a relationship in which all problems have product solutions, just as a systemic approach to health care cannot be led by pharmacists (1998, p. 27).'

THE CONTRIBUTIONS OF WEED SCIENCE

Weed scientists are justifiably proud of their contributions to the modern agricultural system that produces abundant, high-quality food and fibre that many, but not all in the world, enjoy. While our pride is justified, I suggest that agricultural education did not and does not encourage us to question practices or results. We have not given much time to self-scrutiny even of the value judgment inherent in the term weed. Weed scientists know that they are, as all agricultural scientists are, engaged in the most essential human activity – food and fibre production. This is unquestionably good and all involved in weed science believe it is of undeniable importance. Those who criticise weed science's emphasis on production and short-term economic and technical efficiency have generally been from outside agriculture. Weed scientists have typically responded, if the critique was even acknowledged, with hostility

and defence. The defence argued that weed science was a necessary part of agriculture and that the critics had no expertise in agriculture, a clear *ad hominem* argument.

Weed science, an important part of modern agriculture, is viewed by its critics as a willing contributor to research and policies that have led to several bad things:

- Food and fibre production have increased with a concomitant worsening of the long-term health of soil and the continued supply of groundwater.
- Plant and animal genetic diversity has been reduced.
- The reduced flexibility of agriculture's political and economic system has reduced crop and livestock choice for farmers.
- The developed world's agricultural system is capital, energy, and chemically intensive with a requirement for high production volume and low cost.
- In the developed world there has been a steady decline in the number of small and medium size family farms.

Many weed scientists will claim that their research and teaching didn't cause these things. They may be correct. However, denial of the charges risks the conclusion that whatever they were doing was totally irrelevant to the creation of the modern agricultural system that these five things describe.

ETHICAL REFLECTION

The undeniable and welcome increases in agricultural production have made ethical scrutiny unnecessary. It is not needed if production is its own moral justification. Production cannot always trump other values. But productive success has eclipsed the increasing evidence of unacceptable consequences (e.g., pesticide contamination of water and soil, soil erosion, loss of family farms). Such consequences, in my view, require ethical scrutiny and should be encouraged despite productive success.

Ethical reflection is required because today's students are tomorrow's farmers, business people, agricultural professors, and policy makers. They need to understand the ethical dimension of what they do now and are likely to do in the future. If we fail to consider the ethics of how we practice or recommend agriculture be practised, if we do not include ethical study of agricultural practice and results in the curriculum, and if increasing production is all the moral justification we need, then succeeding generations will continue to be defensive and ineffective when confronted with ethical questions. Future weed scientists will be unable to respond except with appeal to the production paradigm (the correctness of which, although unexamined, their professors taught them).

As weed science evolves, we must teach our students and ourselves to speak in the public arena about the issues that concern a growing number of people. It takes courage and encouragement to examine fundamental assumptions about one's work, i.e. to engage in ethical reflection. Alternatives to careful examination of the ethics of weed science are unacceptable to weed scientists. They include arbitrary or, at a minimum, externally imposed political coercion and social pressure. Ignoring careful ethical analysis of weed science's practices can create social divisiveness, public fear about the safety of our food supply, and scorn for the weed science community. In the long run, acceptance of the fact that ethics and weed science have an undeniable relationship will be an important step toward clarifying the reasons for agricultural practices.

Weed scientists were and are educated, in a series of science courses, to be good scientists, to be problem solvers. They learn uncritically that the most important problems are food production and profit. Production of high yields and abundant food with profit to the grower is accepted and unquestioned as a moral good. The goodness is implicit in all that is taught to students of weed science and other agricultural and food sciences.

What is the problem with this view? In the context of agricultural education the problem is that the production paradigm, and the essentiality of profit, is the only paradigm presented. This paradigm is not examined or is its philosophical foundation explored.

Weed scientists agree that in our modern agricultural system it is important that students know the facts and methods essential to understand and pursue the discipline. Within the wider university professors assert that the educational process must endeavour to teach students how to think critically. Students need to be able to recognise and deal with the complex problems for which there are no accepted solutions that will face them as they begin their careers.

These matters of pedagogical technique seem intuitively obvious. While these approaches to education in general are widely accepted, weed science education seems to have been totally unaffected by their existence. Our education remains 'a dogmatic initiation in a pre-established tradition that the student is not equipped to evaluate' (Kuhn 1977).

When agriculture undergraduates arrive at the university, they usually arrive with the assumption that their studies will engage them in the most ethical activity of all: feeding people, indeed feeding the world. Their professors reinforce this view, and present it as an unexamined article of faith; an instance of

moral certainty. If one is doing what is intrinsically good, ethical justification is a *prima facie* case. It is logically inconsistent however to assume that agriculture pursues the highest moral goal and at the same time claims it is devoid of values. Weed science is not value-free.

PUBLIC CONCERN ABOUT AGRICULTURE

As mentioned, there is increasing public concern about agricultural practices (e.g., animal treatment, pesticide use, water depletion, soil erosion). The public concern means that weed scientists must not adopt a defensive posture based on the value of 'what we do.' We should not presume that those who criticise agriculture and weed science will cease when they hear a defence of the goodness of agricultural practice. Education of the public is often offered as the best solution by the agricultural community. Education is important, but its effect will be enhanced when agriculturists use reasoned responses to criticism, rather than passionate criticism of the critic.

To suggest that the developed world's weed science research system has produced only good seems no more realistic than to say it has not produced any good at all (Aiken 1986). The strongest proponents of modern weed science and its strongest critics agree that not all has been good. Weed science's evolution has integrated new weed control practices while maintaining many old practices. Now the weed science community is moving rapidly toward biotechnology. The primary example is herbicide resistant crops that are rapidly being integrated into weed management systems. But weed management systems are not evolving as the natural world has evolved. 'Natural selection can no longer function as it has functioned in the past. Cultural selection is now a decisive force in determining the future of the biosystems of the earth' (Berry 1999) and it will determine the future of weed science and its technology.

THE EVOLUTION OF WEED SCIENCE

It is plausible to argue that natural selection has played only a minimal role or perhaps no role in the evolution of weed science. Since the great chemical developments after World War II, weed science has been driven by the important task of managing weeds to optimise production. The weed science community has claimed that knowledge has been its primary tool. We claim superior knowledge about weeds, but our knowledge can be characterised as 'an exchange of intramural activity among the knowledgeable. We seek answers, but have missed some of the important questions (Bosso 1987).' We leave the non-specialist (the majority) confused and perhaps believing nothing that we say. These reactions to our scientific pronouncements are perfectly rational to those who have them but frustrate educators. Weed scientists have seen their science evolve from essentially an inability to control weeds without soil-destroying cultivation or hand labour to chemical techniques that are highly effective, meet a pressing public need for safe, effective pest control and increase production in a time of decreasing labour. As Whorton (1974) claims 'they (herbicides) were developed at a time when the danger of epidemic chronic intoxication from environmental contaminants could not be fully appreciated.' When such dangers were known weed scientists quite understandably became defensive and argued that the new chemical technology was safe and necessary when used correctly. The weed science community objected strenuously to the claim their technology was not safe and effective (Whorton 1974). We believed that weed science had evolved to a higher and much better level of weed management and we sought public praise for our success and were upset or angry when it was not forthcoming. We ignored ethical challenges and the enormous literature on the negative environmental effects of our science. We were satisfied that our perception of the public's demand for abundant, inexpensive food (Bosso 1987) was correct and adequate. The weed science community was encouraged because farmers who are concerned with production (yield) and productivity (efficiency), rapidly adopted modern weed science techniques. The farmer's aim has been to optimise production and productivity to achieve economic stability, within existing economic and policy constraints (Thompson *et al.* 1994). Weed science helped farmers achieve their goals.

The public had a different view and offered a moral, rather than an economic, case. The weed science community was surprised at the accusations and totally unprepared to respond. The public reasoned that 'farming practices and systems that … impoverish farm families and rural communities, cause sickness among farm workers or consumers, or harm wildlife do not have to be unsustainable in order to be unacceptable' (Thompson *et al.* 1994, p. 222).

It is clear that public concern and public debate over agricultural practice is conducted largely in moral language: it emphasises rights, duties, equity, and fairness (Thompson *et al.* 1994, p. 103) before it turns to questions of production. It is the latter arena where the agricultural debate usually begins, ends, and loses.

Hollander (1990) cites Ladd (1982) and distinguishes between liability and moral responsibility. Ladd (1982) notes that liability responsibility looks backward and wants to fix blame when something goes wrong. Moral responsibility looks forward and

wants to prevent things from going wrong. Hollander (1990) argues that moral responsibility 'puts each of us on the hook.' Foresight is required because in the moral realm we must look ahead to think about the effects of our actions and the effects of our technology on ourselves, others (society), and our environment. Morally we, individually and collectively, cannot continue to ignore what might happen because of our technology. Unfortunately we have championed the production gains, which are real, and ignored all other effects, including ethical questions.

THE BIOTECH ERA

Weed scientists have not debated or spent much time considering the morality of transfer of our production technology to developing countries, the harmful effects of herbicides, or whether biotechnology in weed science is desirable. Now as weed science moves into the biotech era we again have an opportunity to deal with the ethical dimension of technology or ignore it. Given the prevalence of hunger in the world, it is clear to many that more production is not what is needed to feed people. One can argue that the primary beneficiaries of agricultural research ought to be farmers and the hungry. What seems clear is that biotechnology is not likely to benefit either of these groups (Peters 2000). The technology, to date, is largely controlled by the private sector and its development is dependent on its profitability (Peters 2000). This raises a moral question and the weed science community should consider Rollin's (1995) interpretation of Gresham's Law. A simple statement of Gresham's law is that bad money drives good money out of circulation. The moral equivalent in Rollin's (1995) view is that 'Bad moral thinking tends to drive good moral thinking out of circulation.' A corollary may be that the absence of moral thinking within a scientific discipline leaves the moral field open to criticism by others.

Europe's ambivalent attitudes on biotechnology are portrayed well by Gaskell *et al.* (1997). They note the 'striking mismatch between the traditional concern of regulators with issues of risk and safety, and that of the public, which centres on questions of moral acceptability.' The main lesson of the survey is that 'public confidence in emerging applications of biotechnology cannot be taken for granted.' The weed science community has tended to assume what is needed is more knowledge, but that 'does not necessarily lead to greater public acceptance' (Gaskell *et al.* 1997). Moral doubts are what cause the public to reject new technology in spite of views on use and risk. The finding that risk is less significant to the public than moral acceptability (Will it cause harm? Will it cause unacceptable socioeconomic effects?) strongly suggests that the agricultural community must address the moral dimension. If we do not, others will (Rollin 1995). Consumers cite safety concerns and environmentalists protest the potential for ecological harm (Clarke 2002). The biotechnology industry has been very effective in portraying all opposition to GMOs as part of a radical environmental movement (Clarke 2002). Weed scientists think that our devices and our technology work and the oppositions do not. 'Our beliefs are rational, and theirs are merely emotional, expectant, hopeful (Ehrenfeld 1978). But this is merely a defensive response.

Weed Science ought to evolve toward and publicly proclaim our efforts to develop eco-systemic methods of weed management. Such methods will focus on plant health rather than weed death. Developers of these methods will appreciate, as their corporate counterparts do, that even the best management practices are incapable of 'turning an inherently unsustainable farming system into a sustainable one' (Vorley and Keeney 1998, p. 201). As weed management systems evolve in the biotech era, I encourage weed scientists to recognise the risk of following the pattern established during the chemical era and pursue only the very real advantages of biotechnology and to consider the ethical dimension of the technology developed and rationally examine the issues of social and political acceptability (Vorley and Keeney 1998, p. 124)

The ethical dimension of biotechnology is well characterised by (Smith 1999) who does not cite but clearly agrees with Rollin (1995) who says 'we cannot control technology if we do not understand it, and we cannot understand it without a careful discussion of the moral questions to which it gives rise.' The moral questions of biotechnology devolve to two central issues: is the modified organism harmed, and are there undesirable socioeconomic effects? For weed scientists, because plants are not sentient creatures, the first question is not important. The socioeconomic questions are important. Smith (1999) suggests that the 'rational development of biotechnology may contribute to results that are irrational from a social and ethical perspective.' Smith bases his argument on six points that time and space do not permit me to quote in detail. Each point relates to a structural feature of the global economy and combined they present important ethical issues for weed science. Briefly he notes that biotechnology could lead to further centralisation of economic power in developed countries, a diminution of the position of the poor in value-adding activities, use of intellectual property rights that will exacerbate uneven global development, increasingly disadvantageous terms of trade for poor countries, worsening of the third-world debt crisis, and worsening of

third-world human dislocation and unemployment. Smith's list does not include all ethical dimensions of weed science biotechnology but he raises legitimate ethical issues that weed scientists must address. We can begin by asking what we ought to do, and by so doing we enter the ethical realm.

It is difficult to learn ethical discourse but difficulty should not deter us. Weed science and biotechnology are also difficult. It is even more difficult to integrate an unfamiliar field with one's own discipline. Weed scientists are competent but only reluctantly venture into new fields, especially one as alien as philosophical ethics. I am sure there is both the desire and ability among weed scientists to engage in ethical debate. But we rarely engage in ethical discussion because we do not know how and we thereby ignore or dismiss the challenges and discussions. Thus, unfamiliarity with philosophical ethics discourages a wedding of ethics and what is alleged to be a value-free discipline and science. Until weed scientists venture into the ethical realm, we will not fully understand our discipline. Full understanding is what we must achieve.

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