RURAL CHANGE

The Challenge for Agricultural Economists

PROCEEDINGS

SEVENTEENTH
INTERNATIONAL CONFERENCE
OF AGRICULTURAL ECONOMISTS

Held at Banff, Canada
3rd – 12th SEPTEMBER 1979

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INTERNATIONAL ASSOCIATION OF AGRICULTURAL ECONOMISTS
INSTITUTE OF AGRICULTURAL ECONOMICS
OXFORD

1981

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The Risks of New Technology and their Agricultural Implications

It is a feature of many forms of modern technology that they involve risks to the lives of those who use them and in some instances put the lives of wider sections of the community in jeopardy. It is not that industrial processes long in use, not to mention day-to-day social activities, do not involve inherent risks to human life and limb,[1] but the public in latter days appears to have become peculiarly sensitive to the risks associated with new technology. This concern (together with rising anxiety about technological unemployment) has spawned an increasing volume of literature advocating social control of technology.[2]

The change in public perceptions of certain classes of risks seems to have occurred largely as a result of the recent rising tide of interest in environmental issues. Public controversy about nuclear power generation, about the dispersed effects of insecticides and about the potential carcinogenic properties of foodstuffs have helped to fire what may eventually come to be regarded as an unduly exaggerated concern about safety and environmental protection. Anti-pollution regulations necessarily imply significant costs both in benefits foregone and in costs of administration. Accordingly, because of resource limitations, the more stringent environmental legislation can only be contemplated in more affluent societies. For that reason, an internationally uniform approach to environmental hazards is a Utopian conception.

IMPLICATIONS FOR AGRICULTURE

These shifts in community attitudes have come to have serious repercussions on agricultural policy in that governmental responses to the changing attitudes and the resultant bans and limitations are beginning to constitute significant restraints on rural production potential and technological advances. To date, in most countries, agricultural scientists and administrators have endeavoured to accommodate themselves to changing public sentiment.[3] But, given the important counterproductive effects

* Read by G.J.W. Longworth in the absence of the author.

of latter-day environmental constraints, it is perhaps time that concerned agricultural professionals played a more active role in bringing home to the public the costs to society of excessive controls in the rural arena, however well intentioned those controls may be.

The purpose of this paper is not to outline in detail the nature and extent of the newer constraints on agricultural progress. Suffice it to say that they include, *inter alia*, (1) restrictions on the use of fungicides, insecticides and weedicides, (2) overzealous resort to quarantine controls, (3) prohibitions on the use of feed additives, (4) controls on residues and effluents of agricultural origin, and (5) controls over genetic advances involving recombinant DNA.[4] The paper is concerned rather to discuss some of the issues associated with framing public policy in respect of research and production activities where the community has certain perceptions of the possible dangers to their safety or well-being which may flow from the practice of them. The issues will be illustrated principally by reference to agricultural chemicals, though the observations also apply to a large extent to the other facets of agricultural technology mentioned above.

Though the scientific, engineering and medical professions have given some attention to the social issues involved, they have been relatively neglected by economists and agricultural economists in particular. The overwhelming mass of economic literature in the area of risk is concerned with the production decisions of risk-liable individuals and the degree to which they can mitigate their risks by resort to insurance, futures markets and diversification. This is especially true of the literature in agricultural economics. Such theoretical framework as exists offers few insights as to how governments, whether socialist or capitalist, democratic or authoritarian, can come to grips, in a policy context, with the attitudes about risks formed by the electorate – attitudes which may simultaneously be irrational, inconsistent and inaccurate (in the sense of being out of line with objectively established probabilities) and which may be swayed quite erratically by irresponsible treatment of the subject in newspapers or electronic media. David Hopper has sagely remarked that, in a governmental context, "truth is determined by a majority of voters, not by the test of the laws of proof".[5]

PROBLEMS OF LATENCY AND UNCERTAINTY

It might be well to begin with a catalogue of some of the characteristics of the so-called "toxic" or hazardous substances which find their way into latter-day agricultural research and practice.[6] First, unlike various compounds of arsenic, lead and mercury, as well as nicotine sulphate, which have been used in farming practice for many decades and whose toxicity is well known, it has taken time for the toxic effects of many of the agents used in latter-day pest control to become evident. The latency and the uncertainty about their effects make risk assessment difficult if not

impossible and enhance public apprehension about them and related substances. It may be decades before persons exposed to a particular chemical may show adverse effects. Thus there may be occupational exposure to a chemical without knowledge of its toxic properties – a very different situation to that of voluntary occupational exposure in full knowledge of the attendant risks. There is also the problem of possible exposure of third parties as a result of air or water pollution.

The facts that the carcinogenic, teratogenic and other adverse effects of some agricultural chemicals has been established, coupled with the growing recognition of the environmental causes of cancer, have increased public concern about these and other substances. The problem is exacerbated to the extent that this concern is reflected in statutory form, as in the Delaney clause in the United States which requires the banning of all substances suspected of being carcinogenic.

Testing procedures required by national legislation, such as the US Insecticide, Fungicide and Rodenticide Act, as a prerequisite for the registration of agricultural chemicals, raise all sorts of perplexing scientific questions. First, an insecticide may be deemed suspect by virtue of its chemical structure rather than as a result of tests. Second, in view of the impossibility of tests on human subjects, the required toxicity tests are conducted on animal populations. This raises serious questions as to the validity of inferences made about effects on man from tests on other mammals. The position is further complicated by claims that some lines of laboratory animals are cancer-prone and the fact that progressive refinements in instrumentation are, in effect, changing the criteria used in the tests.

Then there is disagreement about the dosage rates required. It is frequently charged that animals under test are given massive doses far beyond any level that would be liable to occur in real life. Of the same genre is the so-called "threshold controversy". This has to do with the question whether the human organism can tolerate exposure to a hazardous substance up to a certain level without adverse effect; or whether, on the contrary, liability to damage is linearly related to the degree of exposure, even where minute quantities are involved.

Quite understandably, problems connected with the latent and uncertain effects of chemicals give rise to disagreements between scientists, particularly when some are more anxious to attain public notoriety than concerned about following the statistical and other procedures necessary to establish reliable scientific knowledge.[7] Such scientific controversy, whether mischievous or genuine, helps to fire public unrest and apprehension, provides excellent fuel for agitators who revel in scientific uncertainty and represents a very questionable basis for sound governmental regulation. As Paul Portney has observed "it is difficult to legislate that which scientists appear to understand imperfectly. . . ."[8] The stage is set for extreme governmental regulation which takes no account of costs and benefits but bans outright the production or use of substances which may potentially be of great value to the world but are under a cloud

because of scientific uncertainty about the precise extent of their effects on man.

THE PUBLIC ACCEPTABILITY OF RISKS

In recent years, scientists and engineers have devoted considerable attention to the assessment of risks associated with emerging technology and have speculated about the public's willingness to accept such risks.[9] The fundamental philosophical question concerns inconsistencies in the public's willingness to accept risks of differing magnitudes – why people are willing unflinchingly to use automobiles in increasing numbers and accept without question the generation of electricity from coal where the risk of death or incapacitation is relatively high and yet baulk or protest vehemently at new technology when the risks associated with it are significantly less. Doubtless fear of the unknown is partly involved, but that is by no means the sole explanation.

One point to be made is that it is the public's perception of a risk rather than the actual statistical assessment that is important from a policy point of view. The public's perception of a hazard is mainly determined by its severity and to a much more minor extent by its frequency. The 150 people who die each day on United States roads have little or no local or international news value, whereas the plane crash at Chicago on May 26 involving the death of 273 people was flashed to the world's capitals immediately. Propinquity also affects risk perception. A farmer living adjacent to a cotton grower who sprays his crop regularly by plane is likely to be much more concerned about pollution than someone 50 miles away. Furthermore, people are prepared to accept higher risks if they are self-imposed especially if their latency period is likely to be long (e.g. smoking). Such persons are likely to be far less tolerant of some hazard with a statistically lower risk, if they are subjected to it involuntarily.

Attempts have been made to determine the acceptability of various risks by establishing a subjective relationship between the risk and the monetary benefit to be derived from accepting it.[10] It is postulated that the risk of death from an act of God such as a flood or an earthquake (estimated at about one death per year per million people) is of no consequence to the average individual. A risk of one in 100,000 may call for warnings and, where the risk is one in 10,000, the public may be willing to accept limited public expenditure to reduce it. It is asserted that when the risk rises to the order of one in 1,000 per year, the public finds it unacceptable and demands public action to do something really tangible about it.[11] To give perspective, the normal death rate from disease in the United States is about one death per year per 100 people.

Such attempts to establish what might be called thresholds for political action have recently been criticized by Lord Rothschild, partly on the grounds that the duration of the risk is unspecified (which is not altogether true), but more particularly on grounds that the probabilities

cited lack any statistical basis.[12] He argues that in any case both citizens and politicians who may be involved in decision-making have little or no real appreciation of what a statistically defined risk implies whether it be expressed in probability terms or in terms of deaths per year. Rothschild, for his part, arbitrarily suggests that the risk of being killed in a car accident in Great Britain (one in 7,500 in 1974) can be taken as the threshold for people's concern about risks.

IS OBJECTIVE RISK ASSESSMENT OF VALUE IN PUBLIC DECISION-MAKING?

All this raises the more fundamental question of whether attempts to give greater precision to risk liability are going to lead to more rational political decisions. It may well be that in areas involving environmental protection, where uncertainties are great and where conflicts in value systems are of an extreme order, anything approaching rational political action is particularly difficult to achieve. Lord Ashby who presided over a UK Royal Commission on Environmental Pollution between 1970 and 1973 had, no doubt, genuine grounds for his observation that "There is copious literature on decision theory under conditions of uncertainty, but most of it deals only with very simple problems and I do not think it is of much use to those who have to make complex policy decisions".[13] He asserts incidentally that decisions involving a hazard to human health are comparatively easy as compared with decisions about the environment. This would seem to imply the zero-risk approach to human health hazards, but it is hard to accept that they should not be subject to some economic calculus, even though any sane person would accept that human life is on a different ethical plane to that of flora and fauna.

Ashby is prone to argue that, irrespective of the objective inputs of scientists and economists and the more subjective representations of affected parties and more broadly based pressure groups, the political decision-maker depends ultimately on hunch or intuitive judgement.[14] The politician, he says, is influenced by his value system and the relative weights he attached to particular beliefs. Perhaps much more attention needs to be directed to the factors affecting politicians' judgements and the whole processes of rational decision-making in this area,[15] because the scope for non-rational representations and decisions is greater than normal.

Again Rothschild, as might be expected of a scientist, has, in his Dimbleby lecture, criticized this stated dependency on politicians' judgements.[16] He thinks that there should be greater reliance on hard information, though he accepts that this is very difficult to achieve in practice. I believe he is saying that researchers and others should not be diverted from the task of assembling hard economic and scientific facts by the illogicality and emotionalism that currently surrounds decisions involving environmental risks.

What contribution can economists make by way of providing hard information which may assist in ensuring better environmental decisions, particularly those affecting agriculture? I concur with the view stated earlier that work on decision theory as such, at least in the short run, is likely to contribute little to public decision-making in the difficult area which is the subject of the present discussion. I believe the economist's immediate contribution potentially lies in two principal areas: (1) in defining the limits of public intervention and (2) in the area of cost-benefit analysis.

THE CASE FOR REGULATION

Economic literature dealing with environmental problems and with the problem of externalities in general, particularly in so far as it impinges on policy issues, is prone to come down heavily in terms of the "polluter pays" principle. Portney has recently examined the usefulness of the market solution as an alternative to government regulation of toxic hazardous substances.[17] A market solution would involve, among a number of other things (1) the use of wage premiums for workers who voluntarily accept hazardous jobs and (2) the associated incentive to employers to supply protective clothing or equipment in lieu of paying wage premiums. It can be argued that through a competitive market, benefits and costs are balanced through individual decisions and the market itself determines the optimal amount of risks. Portney however concludes that information at all levels is too imperfect for a market solution to be applied in this instance. As he says, "the necessary conditions for labour, land, or product markets to balance automatically the benefits and costs of exposures to toxic substances are not descriptive of the real world".[18]

At the other extreme, lies the possibility of a government's intervening to ban completely the manufacture or use not only of known but also of potentially toxic substances. Potentially toxic ones may be defined, for instance, as those shown to induce cancer or other serious disease in laboratory animals. Such a blanket policy is also unsatisfactory and unwise from the standpoint of public welfare. Though it may eliminate the risk of death or illness arising from exposure to the chemicals in question, it may deprive the public of very significant benefits. Such extreme policies ignore the fact that the risks incurred through the use of different chemicals may vary greatly, and imply that the benefits that may arise from even limited exposure to all such chemicals are always less than the costs. Assuming that all risks are equal implies that less than optimal decisions will be made.

There is therefore a case for public intervention somewhere between the two extremes. The difficulty is to find wise and prudent benchmarks which may help in setting the limits of government intervention. In areas where human life is in jeopardy there is a propensity for governments to

introduce coercive measures, such as bans, but even when the state does not go that far, paternalism and detailed regulation is frequently the order of the day. The tendency too often seems to be to treat all users (including both farmers and employees in an agricultural context) as morons devoid of any capacity to look after their own interests, insteady of relying on educational processes to encourage wise and careful use of the more dangerous agricultural aids. Issues of economic and personal freedom typically receive scant regard.

To illustrate the extremes to which recent pesticide control legislation may go, let me cite some of the provisions of the 1978 Act now in force in the State in which I reside. That legislation requires that "a person shall not before . . . using . . . a registered pesticide . . . fail to read, or to have read to him, the instruction contained on any label . . . affixed to its container" and provides a penalty of $500 in default.[19] A farmer is liable to a similar fine if he wilfully or carelessly disregards the instruction or if he should "wilfully and without reasonable cause of anything likely to cause a risk of injury by a pesticide to himself. . . ." Although the Departments of Agriculture of the various Australian States frequently make differing recommendations as to the appropriate dosages of pesticides that should be used against a specific pest, this legislation makes it a punishable offence to use the pesticide at a rate different to that recommended by a specific Department of Agriculture. Moreover some chemicals are licensed for designated uses only and farmers are liable to prosecution if they use them against other plant or animal species. Such specificity may restrict opportunities for economic substitution and is rarely justifiable on scientific, health or efficiency grounds.

Another difficulty about much current control legislation is the variety and inconsistency of the criteria laid down in the relevant statutes. They are typically vague and tend to give virtually unlimited discretion to the appropriate administrator. The Australian legislation cited above, for instance, requires that bans be instituted where the administrator "*thinks* [my italics] that (a) the interest of public safety or the safety of any individual: or (b) the protection of the environment from unintended harm that might be caused by the pesticide, so requires".[20] The United States legislation is more clearcut in that it defines the use of a pesticide as constituting an "imminent hazard" when "a situation . . . exists when the continued use of a pesticide . . . could be likely to result in unreasonable adverse effects on the environment or will involve unreasonable hazard to the survival of species declared endangered by the Secretary of the Interior. . . ."[21] Unlike the Australian case, the US administrator must publish reasons for denial of registration of a pesticide and this usually involves some assessment of risks relative to the benefits. But US environmental statutes as a whole are highly inconsistent as regards the need to take account of benefit and cost comparisons.[22]

BENEFIT–COST ASSESSMENTS

From the economist's standpoint, the use of benefit–cost analysis is a necessary condition for intelligent decision-making in this as in many other areas of public policy. In the broadest sense, using such a mode of analysis simply represents the application of ordinary commonsense. It is when the procedure is used more precisely and the attempt made to reduce all benefits and costs to a common monetary measure, that the technique becomes a target for criticism and economists are subjected to unjustified denigration by scientists and politicians. Ashby even goes so far as to describe economists who endeavour to convert into monetary terms noncommensurable effects, such as aesthetic attributes or the saving of human life, as being morally wrong, not in the commonly used sense but in the sense of being overbearingly presumptuous.[23] All the same, however, he is at pains to explain that attempts to quantify what he calls "fragile values" are not illogical. It would be hard for him as a distinguished scientist to claim otherwise, strongly committed as he was in his earlier days to Kelvin's doctrine that, without measurement, knowledge is meagre and unsatisfactory.

It has to be stressed that pollution control itself is costly. If a society devotes its scarce resources of labour, capital, administrative and technical skills to checking and controlling environmental pollution, these resources are not available to be used to produce other goods and services desired, and sometimes desperately needed by society. As indicated earlier, the opportunity costs of these measures are probably of more vital relevance to developing countries than affluent countries. But even in the latter countries, the economic justification of automobile emission controls is coming increasingly under scrutiny as the price of oil rises.

In an agricultural context, the cost is not simply the production currently lost and the increased costs incurred in producing current foodstuffs as a result of the banning of efficacious pesticides. It also involves the future production that may not come into existence as a consequence of the powerful disincentives for investment in research and development brought to bear on chemical companies as a result of complicated and costly hurdles that have to be surmounted before new pesticides can be registered in some countries. It is extremely doubtful whether those groups who have been most vocal about the need for controls over DNA research have any real understanding of the opportunities for increased food production this research may open up in agriculture alone not to mention its potential benefits in other areas of human endeavour.

Despite the disinclination of many to discuss the economic value of human life, it is clear that the harder a government works at trying to reduce the loss of human lives, the higher the marginal cost of control for each extra life saved. To abbreviate a hypothetical example of Myrick Freeman, it might cost $10 million to reduce the annual death rate from a certain form of pollution from 50 to 25 lives a year; it may cost an additional $90 million to reduce it to zero.[24] Clearly governments have to

make decisions as to whether the community should forego the benefits of $90 million invested in other directions in order to save every life from this specific form of pollution. Traffic engineers make these kinds of decisions every week of the year, though admittedly not in such explicit form. Exactly the same logic should apply in the area of environmental controls.

Costs and benefits are therefore important data in making policy choices though many environmental scientists wish they were not. Whether noncommensurable forms of benefit are quantified in some way by economists or whether their assessment is left to the politicians, it is impossible to avoid trade-offs between economic costs and the benefits which some people deem to be unquantifiable. There is reason to believe that in many areas of environmental control affecting agriculture "massive and certain costs are being expended to achieve small and uncertain benefits",[25] and that, as a result, a substantial misallocation of resources occurs. Greater resort to benefit-cost analysis, however crude the data and however great the problems of placing values on noncommensurables, could not do other than improve agricultural prospects in the short and longer run.

A FINAL COMMENT

As a contributor to the London *Observer* recently stated, "all technology has its risks and . . . those risks are the price society pays for the overwhelming benefit of such new technology".[26] Though admittedly large sections of the public remain to be convinced of the essential truth of this axiom, it is incumbent upon agricultural administrators to use their best endeavours to ensure that the "overwhelming benefits" which the rural industries and the public at large stand to gain from modern technology are not lost through inept, inefficient or unnecessarily restrictive legislation and regulation.

At the same time, it would be absurd to underestimate the difficulties that confront modern governments in attempting to come to grips with community reactions to risks associated with such recent technology, both in agriculture and other sectors of the economy. Today even trade unions and local government bodies are instituting bans on substances the use of which national governments after more thorough investigation have not deemed it wise to ban.

If indeed "truth is determined by a majority of voters", the application of science for the betterment of the human race is going to be greatly constrained until the public adopts a more rational approach to technological advances and their attendant risks. Unless a change of heart occurs soon (and that implies an educational task of massive proportions) it is likely to be in agriculture that the adverse consequences of societal risk aversion will first make themselves manifest. I believe that a resolution of the issues discussed in this paper is a necessary precondition if the

agricultural industries are to be able to feed the world at all adequately after the turn of the century.

NOTES AND REFERENCES

[1] For a wide ranging catalogue of estimates of voluntary and involuntary risks, see T.A. Kletz "What Risks Should We Run?", *New Scientist*, Vol. 74 (12 May 1977), pp. 320–1.

[2] See, for instance, David Elliott and Ruth Elliott *The Control of Technology*, (London, Wykeham, 1976).

[3] This phenomenon is doubtless due as much to the low status of agriculture in the scentific and political worlds, as to the latter-day pressure of the environmentalists. On the undervaluation of agriculture, see Theodore W. Schultz "On Economics and Politics of Agriculture" in Theodore W. Schultz (ed.) *Distortions of Agricultural Incentives* (Bloomington, Indiana University Press, 1978), pp. 10–13.

[4] For a more detailed discussion, see Keith Campbell *Food for the Future* (Lincoln, University of Nebraska Press, 1979), pp. 75–81.

[5] W. David Hopper "Distortions from Government Prohibitions" in Theodore W. Schultz (ed.), op. cit., p. 72.

[6] For a fuller discussion of these characteristics see Paul R. Portney "Toxic Substance Policy and the Protection of Human Health" in Paul R. Portney *Current Issues in U.S. Environmental Policy* (Baltimore, John Hopkins Press for Resources for the Future, 1978), pp. 110–11 and Talbot Page "A Generic View of Toxic Chemicals and Similar Risks", *Ecology Law Quarterly*, Vol. 7, No. 2 (1978), pp. 207–44.

[7] See John Ziman *Reliable Knowledge* (Oxford, Oxford University Press, 1978), especially pp. 137–42.

[8] Paul R. Portney, op. cit., p. 111.

[9] See, for example, William D. Rowe *An Anatomy of Risk* (New York, John Wiley and Sons, 1977); William W. Lowrance *Of Acceptable Risk* (Los Altos, William Kaufmann Inc., 1976); Robert W. Kates *Risk Assessment of Environmental Hazard* (New York, John Wiley and Sons, 1978); and Council for Science and Society *The Acceptability of Risks* (London, Barry Rose, 1977).

[10] cf. C. Starr et al. "Philosophical Basis for Risk Analysis" in J.M. Hollander and M.K. Simmons (eds), *Annual Review of Energy*, Vol. 1 (Palo Alto, Annual Reviews Inc., 1976), p. 630.

[11] Eric Ashby *Reconciling Man with the Environment* (London, Oxford University Press, 1978), p. 72.

[12] Lord Rothschild "Risk", *The Listener*, 30 November 1978, p. 716.

[13] Ashby op. cit., p. 73.

[14] Ibid., p. 76.

[15] See Lord Ashby "Protection of the Environment – The Human Dimension", *Proceedings of the Royal Society of Medicine*, Vol. 69 (October 1976), pp. 721–30.

[16] Rothschild op. cit., p. 717.

[17] Portney op. cit., pp. 112–14.

[18] Ibid., p. 118.

[19] New South Wales Pesticides Act 1978, No. 57.

[20] Ibid.

[21] US Federal Insecticide, Fungicide and Rodenticide Act Public Law 92–516 (1972) as amended.

[22] Portney op. cit., pp. 129–33.

[23] Ashby op. cit., pp. 52–3.

[24] A. Myrick Freeman "Air and Water Pollution Policy" in Portney op. cit., p. 20.

[25] Ibid., p. 21.

[26] *The Observer* (London), 8 April 1979.

DISCUSSION OPENING – STEFAN TANGERMANN

On many of these points Professor Campbell takes the risk of running counter to current fashions. We ought to be grateful that he has not shied away from dealing with such a touchy issue, and he has done this in a very stimulating and sometimes even provocative way, combining economic reasoning with political insights.

In discussing this paper we are not faced with the difficulty of not knowing which issues to address but rather the problem of deciding which of the many thought-provoking points to leave out. The paper covered two areas:

1 Evaluation of, and views on, current environmental policies;
2 Consequences for economic analysis.

I would suggest we leave out the first area, though its discussion is tempting, otherwise we might end up banging our value judgements on each other's heads.

With respect to the second area (consequences for economic analysis) I suggest we discuss the following four questions:

1 With respect to effects of new technology, do we really deal with *risks* in the sense of known negative events with a given random distribution or are we rather faced with uncertainty? If the latter, can we as economists help anyhow?

2 How can we find out more about people's willingness to take risks? Most related examples in the paper (such as smoking or car driving) refer to people's willingness to accept certain risks of their own individual activities with also individual benefits for them. But what about risks of public activities or other people's operations?

3 Should we as economists really claim (or should I rather say "pretend") that we could make good cost-benefit analyses of environmental policies? Everybody would agree that we should not only consider the benefits of environmental policies but also their costs. In this general sense nobody would oppose Professor Campbell's quest for CBAs but when it comes to empirical analysis we should make sure that we do not raise too high expectations. For example, how to value human health and life or the environment and how to obtain sufficient information about costs in terms of output lost?

4 To what degree is it the right or the obligation of the economist to try and persuade the general public that its current excitement over environmental risks is exaggerated? Or do we simply have to conclude that what some call a current fashion and what others see as the emergence of a new consciousness reflects a shift in values which we as economists have to take into account rather than trying to change?

GENERAL DISCUSSION – RAPPORTEUR: PAUL WEBSTER

It was suggested during the discussion that at least as important as the risks referred to in the paper were risks of natural hazards and uncertainties concerned with newer technologies in developing countries. A second discussant felt that the paper had been overly pessimistic in regard to the possibility of the analysis of risks. There were various approaches that might be fruitful that had yet to be followed up. Finally it was pointed out that the area was one of genuine public concern and that despite the methodological difficulties agricultural economists could and should be making significant contributions to the debate.

Participants in the discussion included Syed M. Ahsan, Jim Johnston and John W. Longworth.