Centre for Agricultural Strategy

The 'greenhouse effect' and UK agriculture

Edited by R M Bennett

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Discussion summary

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Summary of discussion during the Conference

Chairman: C R W Spedding
Rapporteur: J C Tayler

GENERAL DISCUSSION

Mr Phillip Needham, Director of the Farm and Countryside Service of ADAS, opened the general discussion. He said that farmers in the UK had already shown their ability to respond to changes and had adapted to changing circumstances rapidly over the last decade or two in response to economic and political signals.

Although there had been broad agreement among the speakers on the long-term trend of increase in temperature, there was still a major uncertainty about quantity and distribution of rainfall, which is crucial for agriculture. We had heard about the drift northwards in crop limits but before having visions of the Cairngorms ablaze with sunflowers we should remember the important effects of altitude, topography, soil properties and the rural infrastructure, as well as market factors of social and economic criteria which would influence the actual response of the farming industry. Ecology would determine what *may* be done but politics will determine what *will* be done. For the northern temperate zone, the range of possibilities open to the farming industry would be widened, and this should be a benefit.

Three questions could be raised on behalf of farmers:

(i) What is the effect on the competitive position of the farmer, in different parts of the UK, relative to the EC and the World as a whole, and how can he take advantage of any changes?
(ii) What annual variations in weather can be expected?
(iii) Given the timescale and the elasticity of the timescales discussed, is there anything realistic that a farmer can do at this stage in terms of forward planning, particularly of capital investment?

The following issues were raised and discussed during the discussion

periods following each paper presentation and during the general discussion after all the papers had been presented. These issues are summarised under general headings rather than recorded verbatim.

THE 'GREENHOUSE EFFECT' IN PERSPECTIVE

The first paper had placed the 'greenhouse effect' in the perspective of the earth's climatic history over 850 000 years. The meteorologists in the audience added further comment on current levels of CO_2. The CO_2 concentration is now at about 350 ppm, which is higher than at any time in the last 140 000 years, but it is expected to reach levels of 600 ppm (well outside the range experienced in the last million years) within the next few decades.

Continental drift can complicate the interpretation of geological data, but there is a useful indication to be derived from the tropical carboniferous fossil flora at the latitude of Ellesmere Island, which has been at 85°N for a very long time, showing that CO_2 levels were 4–6 times those of the present. Furthermore, a clear distinction should be made between the transient temperature response to a doubling of CO_2 by the year 2030, giving an increase of 3.2°C, and the time at which the climate would be in equilibrium with this increase, which would take 40–50 years longer. Even if the present increase in greenhouse gases was to cease now, a residual warming of about 0.5°C would occur.

The assumption that the greenhouse effect results mainly from man's activities since the Industrial Revolution was queried. It was admitted that it is difficult to distinguish the effect of these activities from natural changes and trends. However, what can be affirmed is that there are changes in atmospheric composition which are far beyond any that the earth has experienced in the past, and changes in temperature appear to coincide with what would be predicted by model simulation from these atmospheric changes.

CONTRIBUTORS TO THE 'GREENHOUSE EFFECT'

Agriculture

A question was raised on the contribution of nitrogen fertilizers to the greenhouse effect. It had been claimed that some 2% of the effect is contributed by nitrous oxide (N_2O), and that a considerable part of this comes from agriculture. Figures given for N_2O arising from the use of fertilizers seem excessive, particularly since there is no reliable method at present for measuring N_2O production from fields. Professor Treharne responded that nitrous oxide is produced by the process of denitrification in the soil – a

process that is temperature-dependent. If the soil is ploughed for arable agriculture, firstly, mineralisation (converting organic nitrogen into inorganic nitrogen, which is taken up by the crop) is increased. Secondly, denitrification (conversion of nitrate to nitrite and the release of N_2O) is increased. In view of the increase in land devoted to arable production over the last 40 years, the figure of 2% could be of the right order. The effect will be dependent on the level of nitrogen in the system which can be affected both by fertilizer use and manure use.

A general conclusion from this discussion was that some of the greenhouse gases such as methane and nitrous oxide are produced as a result of agriculture, and the agricultural industry worldwide may be required to do something about the use of ruminants, boglands, paddyfields and fertilizers.

Deforestation and afforestation

Deforestation has historically been an important factor and will continue to have an effect, but it will probably be outweighed by increases in the use of energy from fossil fuels. Primeval forest is in a state of equilibrium between respiration (and decay) and carbon fixation. Burning of rain forest not only adds a burst of CO_2 into the atmosphere, but leaching of nutrients from the soil reduces herbaceous regrowth and therefore the photosynthetic capacity of the deforested area.

Afforestation had been proposed as a palliative. However, calculations on the effect of planting forests to absorb CO_2 emissions have suggested that an ameliorating effect of no more than 10% could be achieved on the rate of increase of CO_2 resulting from the use of fossil fuels.

ACTIONS TO LIMIT THE INCREASE IN 'GREENHOUSE' GASES

Chlorofluorocarbons

Chlorofluorocarbons are important contributors to the greenhouse effect (as well as to ozone depletion) and international action is being taken to limit the use of these. Since the effect of these chemicals is so great, the possibility of recycling them was suggested. This was seen to have practical difficulties. In addition to their use as refrigerants, many other uses, such as in cleaning agents, are responsible for their unrecoverable release into the atmosphere.

SPECIFIC 'GREENHOUSE EFFECTS'

Regional effects

Taking a global view, effects are greater at the poles than at the equator. The effects expected are melting of the edge of the ice zones, the receding of

glaciers and a greater exposure of tundra regions. This will produce a major change from an ice or snow surface to a land or sea surface, which can have considerable feedback effects in the models.

In the UK, rainfall shortage would be likely to cause a westward shift in the distribution of the population. Already the supplies of potable water in the south-east of Britain are at limiting values, and the pressures of urban populations wishing to move would have considerable effects on agriculture.

It was concluded, however, that the most important impact on UK agriculture may be from effects in other world zones. Shortage of water when temperatures are increased would cause limitations to growth of crops elsewhere, which may increase pressures for their production in the UK.

Wind, rainfall, soil erosion

Wind has a considerable effect on livestock, tree planting, vegetation, evaporation, and erosion, but the effect of a warming of the atmosphere on wind is at present unpredictable. There are indications of probable increased frequencies in convective thunderstorms and tropical cyclones.

Little had been said by the speakers about the effect of lower rainfall and the need to conserve moisture. However, in a scenario assuming a shortage of rainfall this would be a critical issue which would affect the cost of ensuring an adequate water supply, not only for agriculture, but also for the many uses of water by urban populations.

Soil erosion could be a greater problem through the introduction of erodable crops such as maize, soybeans and sugar beet, or an increase in the area devoted to them. Furthermore, both a higher winter rainfall and the more widespread application of irrigation could increase soil erosion. Afforestation could be used to counteract these soil losses.

Grassland

Effects of the greenhouse effect on grassland received considerable discussion since grass covers two thirds of the surface of the UK and is of great importance to UK agriculture. Questions were raised on the main effect of climatic changes on white clover pastures and on the expected difficulty of grassland management. One view was that the expected temperature changes would increase the length of the growing period for grassland and so increase yield, but probably by no more than about 5%. Difficulties of management arising from the longer growing season are likely to be concerned with the effects of poaching in spring, of drought in mid-summer and of reduced nutritional value in the autumn. It was thought that the effects on clover-rich swards would be similar, and a move towards clover swards in the future was likely. These managerial aspects are likely to be important and to depend more on factors such as rainfall distribution, nitrogen flux and differences between years, than on a difference of 3°C in temperature over a period of 50 years.

Alternative views were also expressed. Professor Stoddart (AFRC, Institute for Grassland and Animal Production) suggested that a more prolonged growing season for grass, which could increase to 8–10 months of the year, would have limitations of utilisation in specific situations – for example, on heavy land with large livestock where poaching may occur, but these could readily be overcome by a change of management. An earlier start to grazing would be an advantage, since the best quality herbage is produced early in the spring. Clover starts growth relatively late in the season and this would be improved by an increase in temperature, leading to increased use of grass/clover swards and reduced costs of production.

At a higher altitude, earlier grassland growth would give substantial benefits. Increases in arable area had been predicted but the terrain and soil type in large parts of the country are only suitable for grassland and animal production. Short-term rotation may be needed for animal production and grass growth. Professor Stoddart added that where growth cannot be maintained through the year, grass reserves of stored carbon are important for persistence and subsequent production. With good reserves, grass can sustain higher growth in early season at low radiation levels. In winter, at higher temperatures, grass could respire to death. Examples from single species swards should not be the sole means of predicting effects on grassland production in general.

Energy costs, buildings

In contrast to the positive economic impacts attributed to the greenhouse effect it was suggested that there may well be increased energy costs, for example increased demand for air conditioning and hence for electricity, reaching a peak in the summer. Some scenarios suggest increased variability in the weather pattern, so that variation round 0°C may be more important than degree-days. There may be less demand for insulation in buildings but there could be an effect, in terms of drying-out of clay soils, on the need for foundations, both in accelerating the demise of existing buildings and in increasing the cost of new ones. Others doubted whether these effects would be incurred with a rise of temperature of only 3°C. Realistic pricing of energy would be needed, however, and this could have an effect on agriculture (eg through the fertilizer industry). It was suggested that wind and wave power could be used to reduce energy costs.

ACTION NEEDED TO AMELIORATE THE 'GREENHOUSE EFFECT'

This discussion dealt broadly with land use, the actions needed by the farming industry and the needs for research.

Land use policy and the agricultural industry

On land use and countryside implications, it was thought unwise to develop and build too widely on agricultural land because this would limit subsequent changes in use. There would be a need to have a means of managing change to ensure countryside and wildlife conservation. The suggestion that forestry may decline needed consideration in terms of a national reappraisal of land use. Agroforestry and energy forestry may both have attractions under the scenarios presented. It was pointed out that modern agriculture itself makes heavy use of energy and fossil fuels and that wider application of low-input systems is needed to reduce this.

A number of answers had therefore been given to the question posed in the opening of the general discussion, as to what can be done by farmers. They could directly reduce the greenhouse effect through changes in management. They could also help to identify critical points where research is needed.

RESEARCH NEEDS AND RESEARCH FUNDING

Throughout the discussion there were many suggestions for areas of research to help the industry respond to the huge challenges posed by the greenhouse effect. Global climatic models are central to prediction of the effects, and much work is needed to improve the precision of the predictions. Many of the feedback mechanisms in the system are not fully understood and more data are needed, for example on heat flux, circulation and biological activity in the oceans. Caution is necessary in predicting local effects since these are based on relatively few data.

Field studies

The theoretical effect of CO_2 enrichment on tree growth was discussed and the need for field trials with trees was stressed, including the effect on timber quality and on different species. The call for support of field trials was reinforced.

The question of field studies was raised again with the suggestion that much had already been done. Against this it was pointed out that this type of work had usually controlled only one of the many factors which might be involved in a new environment. Such experiments needed to be re-evaluated. For example, temperature gradients in crops, and increases in CO_2 throughout the life cycle of the crop would need to be studied so as to develop predictive, quantitative physiology modelling and responses in physiological plasticity. It would be very important that studies which have previously been done mostly in small-scale controlled environments, should be done on a field-scale, but with the ability also to vary moisture status,

relative humidity and many other parameters that will change, but which have been little studied previously.

Funding

On research funding, the cuts being made in the UK at present were not considered to be having an adverse effect on the work on models of global climate since, for example, the Government gave an increase last year of 27% in the budget of the Natural Environment Research Council which is involved in that particular activity. The budget of the Agricultural and Food Research Council was viewed differently. Calculations on the volume of agricultural research in relation to the size of the industry had indicated a decline of some 50% in relative funding over the past 15 years. This could have serious long-term effects. Existing research capacity has to be used to undertake a new direction and meet new crises which may arise, and it takes time to develop experienced research workers.

One aspect of the reduced budgets is that it is currently very difficult to attract good candidates in sufficient number to fill studentships, and so meet the gaps in expertise which are caused by retirement. A reasonable balance needs to be achieved between attracting people into research and the level of commercial salaries.

There was no dissent to the view that the resources currently available are inadequate and that a vast increase is needed to answer the questions posed at the Conference. It had to be remembered, however, that the Government believes that 'near-market' research should be funded by those who would benefit directly from it. Thus, some of the cuts imposed by Government are cuts in public funding of research which the Government still believes should be carried out, but should be paid for by other sections of the community. Furthermore, some of the questions raised at the Conference about research were from groups of the agricultural industry which are large enough and rich enough to support the research which is needed.

Research needs

Research should be integrated, but not only in the UK or the EC. Global models need to be constructed by increased worldwide co-ordination. The immediate return on such research is very small and is not suitable for funding by the industry. There is a degree of urgency about this research which is not properly assessed by any government in the World at the present time, not withstanding the Montreal agreement on chloro-fluorocarbons. It was hoped that this meeting would impose a greater sense of urgency on our own Government for international collaboration on these matters.

A specific greenhouse effect is that nitrogen content in leaf, seed and grain is reduced when CO_2 levels are high. This has major implications for food quality, herbivore nutrition, insect relations and for pests and diseases,

which need to be studied experimentally. It is important to ask about the sensitive points in crop and animal systems to determine what is a critical point of change in climate.

Grassland is a very complex community which is highly dependent on the interaction with the animal, and is a prime case where real experimental data are needed in order to model the effects. An overall view is needed – for example as to whether the effects in grassland would lead to overproduction or to extensive production. Much research is required and means of focussing on priorities are needed.

The Chairman referred to the Institute of Biology Natural Resources Policy Group which was studying the interface between agriculture and the environment. This Group would like to identify priorities in research, and participants were invited to provide lists, argued cases or papers to pass to the Institute of Biology Group.

CONCLUSIONS

The Chairman commented that some of the participants had found the technical level of the Conference beyond them at times. In his view, all were in that position for some parts of the topic. Few people could be highly competent technically across this enormous range of subjects. Nevertheless, the nature of the problem demands that discussions like this take place, and ways have to be found of communicating with others with different sorts of jargon. He concluded that this meeting was fairly successful in achieving that aim, and that in such a broad subject it would not be sensible to isolate the component parts for separate discussion. An overall view needs to be taken and the size of the topic is enormous.

Much research is clearly needed, particularly to reduce the uncertainties of prediction. Nevertheless, as the Prime Minister had concluded at the Downing Street seminar on the subject, which some of the participants of this Conference had attended, these uncertainties should not lead us to the conclusion that no action should be taken. Government-funded research over the next 5–10 years would allow better measures of these imponderables to be obtained. A vast amount of research is required and it is vital that this should be fully supported.

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Professor K J Treharne – a tribute

Professor Ken Treharne died suddenly in London a few hours after delivering his paper. The particularly lucid and forthright contribution which he made to the discussion on the cuts in agricultural research funding is printed here in full as a tribute to the great contribution which Ken Treharne made to the research which he so strongly defended.

Professor Treharne said "I believe the reductions in the research budgets that we've seen over recent years reflected to some extent a degree of a need to change. I think that Ken Blaxter analysed the position in respect of agricultural support of some 15 years ago, when indicating that if you took the whole of MAFF and AFRC, and those in universities involved in teaching or research in agricultural sciences, it represented something like one person per 14 farmers or per 1400 acres, which he said could well have been viewed as a fairly luxurious level of support. However, the rate of change of support that has occurred, notably in this decade, has taken that to more like 1 person per 30 farmers. He made the plea that enough is enough – that we are now in grave danger of missing opportunities, of eroding our science base to such an extent that we will not be in a position in the future to respond to desperate new needs and, notably, to provide the options for industry to maintain its competitive edge when one has a series of 'what if' questions such as we have been addressing today.

It has to be recognised that one of the largest problems that we have in coping with research cuts is that we are no longer in a position to develop our seed corn. We are trying to keep expertise alive. We are very successful in the way we are now persuading the private sector to work with us, and we have to recognise, quite correctly, that whilst we are losing funds in particular areas of work that my Council, AFRC, is involved with, there are genuine new funds coming in from Government which, like John (Dr John Bowman), I also applaud, and many of these are to underpin environmental issues. My own view is that, with the infrastructure we have, with the expertise of the science base of the UK with its world standing, we have gone far enough in these cuts and we need to re-evaluate what heritage my children and my grandchildren are going to have if the R & D base continues to suffer such massive erosion".

Appendix

List of authors

Dr J Bowman; Chief Executive of the National Rivers Authority, 30–34 Albert Embankment, London. (Formerly the Secretary of the Natural Environment Research Council).

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Dr P Hadley; Department of Horticulture, School of Plant Sciences, University of Reading, Whiteknights, Reading, Berkshire.

The Rt Hon John MacGregor, OBE, MP; Minister of Agriculture, Fisheries and Food (up to 25th July 1989).

Professor J S Marsh; Head of the Department of Agricultural Economics and Management, Dean of the Faculty of Agriculture and Food, University of Reading, Earley Gate, Reading, Berkshire.

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