Symposium Overview

Chairman and
Session Organiser Dr R G MCKINLAY

CROP PROTECTION IN SUSTAINABLE FARMING SYSTEMS

D ATKINSON AND R G McKINLAY

SAC West Mains Road, Edinburgh, EH9 3JG

ABSTRACT

Using the contributions presented at the conference on "Integrated Crop Protection: Towards Sustainability?" as a basis, current major issues are identified. These would seem to be the operational description of sustainability, the potential contribution of basic ecological understanding to sustainable crop protection, the importance of early diagnosis of problems, the optimal balance between food production and other land uses and the appropriate form of experimentation needed to develop sustainable agricultural systems. Key questions in relation to these areas are identified.

INTRODUCTION

The title of the conference, "Integrated Crop Protection: Towards Sustainability?" poses a series of questions. What is crop protection? Can it ever be integrated? What do we understand by sustainability? Do we believe that complete sustainability is achievable? How important do we believe sustainability, as it is being defined, to be relative to the need to feed an increasing world population? Although the title poses questions, it also states certainties; the critical importance of crop protection for any food production system, the importance of how we protect our crops today for future generations and the belief that current studies will produce answers to the above questions. To provide a balanced perspective on what has been achieved to date and where the future should lead us, it is helpful to visit some of the above questions and certainties.

SUSTAINABILITY

A definition of sustainability is implicit or explicit in all of the papers presented at the conference. The Bruntland (1985) definition of sustainability, "development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs" emphasises intergenerational transfers but is vague in relation to what is being transferred. Consequently, the definition requires further expansion before it becomes actionable. Tait and Pitkin (1995) draw from the generalised concept of sustainability, a number of aspects which they feel require to be emphasised; the ability of the system to continue to operate in its present form, the importance of a human interest in the system and the interaction between the desire to manage or exploit and sustainability. They also develop the concept of degrees of sustainability, i.e. sustainability not as an absolute concept but with the potential for systems to be more or less sustainable.

Atkinson *et al* (1994) emphasised the breadth of vision which must be applied to sustainability, even within the context of European lowland agricultural systems. They suggested the importance of considering land quality, natural heritage, the rural population, energy and rural infrastructure in any discussion of sustainability. All of these elements are equally important when assessing crop protection in sustainable systems.

A more practical starting point to a pragmatic discussion of sustainability might begin by asking the questions:- Why are our conventional agricultural systems not considered to be sustainable? What is wrong with today's farming? Most answers to these questions identify issues which relate to changed priorities in relation to the use of non-renewable resources, principally fossil fuels and a changed view on the acceptable balance between food production and environmental and wildlife impacts. Essentially the opportunity costs of current farming systems appear to be felt to be too high, so that a cost benefit analysis of farming today would seem to conclude that costs substantially outweigh benefits. This change in public attitude (Atkinson, 1990) to farming, which has occurred over a short time scale, suggests that what is today considered sustainable may not be considered so in the next decade as public perceptions of priorities change. Flexibility in approach seems likely to be a key element in the development of sustainable systems. In this context, both understanding and anticipation will be important to the future planning of agricultural systems.

ECOLOGICAL BASIS OF SUSTAINABILITY

Biological control, landscape management and forecasting all depend upon, and contribute to, our understanding of the basic ecological processes which control the range of interactions between the organisms which are managed within farming systems. Fry (1995) and Helenius (1995) both identify that decisions related to agricultural sustainability cannot be taken at field and farm levels alone, but that meta-population dynamics, and consequently between-population rather than within-population processes will have a major effect on the persistence of both pests and beneficial species. Helenius (1995) identifies the aim of adjusting spatial and temporal scales of rotations so as to drive pests, usually the species of early successions, into local extinction. He also identifies that in ephemeral habitats, such as arable fields, the role of specialist natural enemies to pests and diseases is likely to be restricted. Other papers within the conference volume provide case histories in relation to these basic theories.

Practically, the most attractive elements of conventional crop protection with chemicals are simplicity, predictability and the absence of the need for a full understanding of basic processes. For a well translocated broad spectrum herbicide, such as glyphosate (Grossbard and Atkinson, 1985), the most important understanding required for successful weed control relates to how to apply the chemical to the target species, rather than knowledge of the ecology or physiology of the species. In systems dominated by chemical control, knowledge of the interactions between species and the autecology of individual species is of limited importance. Many studies of biological control have adopted a similar conceptual approach and emphasised the bringing together of host and pathogen, or predator and prey (Wilson *et al* 1995). This is appropriate for specific relatively aggressive predators, pathogens and a targeted approach, but is less valuable in more complex situations. Here the introduced organism must first establish itself within a niche before it can begin to interact with its target and other species. In most real farming situations interactions between species will be important. Complex interactions are also important where the time scale extends over more than a single season. In situations such as these there is need for a true understanding of the ecology of the system, i.e. there is no substitute for knowledge. In analysing the problems of promoting biological control through the use of soil borne plant pathogens McQuilken (1995) documents the importance of this approach and hence the need for holistic crop protection to be based upon a clear understanding of the ecology of crop plants, weeds, pests, predators, pathogens and naturally occurring micro-organisms.

All crop protection systems, even those using targeted chemical control, involve the use of some knowledge of the ecology of the crop and the other organisms found within it. Without the use of information technology, the amount of information which can be used in decision-making is limited. The inability to process information has, in the past, limited our ability to design crop protection systems which more fully use the full range of available ecological information. Doyle (1995) indicates that mathematical models have now developed to a stage where they should be able to aid decision-making in relation to the management of herbicide resistance, weed-crop interactions and integrated weed management systems. In addition, complex decision support systems (Knight, 1995) seem likely to become more common, as part of crop protection practice, in the near future.

In the section above on "sustainability", we suggested that conventional agriculture has become less acceptable to the population in general, and hence unsustainable, at least in part, because the current balance between food production and biodiversity was felt to be inequitable, especially in relation to wildlife and conservation. Practice would seem to indicate that good farming and successful biodiverse management can be achieved on the same land area. Many of the recent adverse interactions between farming and conservation have occurred because of a lack of understanding of the complex interactions between species which may control the balances which exist within a biodiverse assemblage, i.e. field margins, hedge rows and species rich grass land. The ecological understanding, identified above, as necessary for soundly based biological control and decision support systems is also needed if wildlife is to become a normal component of sustainable agricultural systems (Atkinson *et al*, 1994).

ANTICIPATION AND SUSTAINABILITY

A high proportion of the agrochemical which is applied to all of our crops is wasted. Some is wasted because it is applied to give protection against diseases or pest outbreaks which do not occur, or to control weeds which are absent from a particular soil area. With hindsight, a significant amount of chemical could have been saved by making application only when pest or disease outbreaks develop to levels with economic significance or to areas from which weeds emerge. The balance of risk and benefit, however, normally indicates the wisdom of an appropriate insurance strategy. Reducing the level of insurance applications requires a greater confidence in the identification of the presence of the pest/pathogen/weed at a stage when it is most susceptible to treatment. It also requires a clear view of the likely development of the pathogen from an initial low level under the particular field conditions found at the site for treatment. The development of the decision support systems discussed above will aid the second of these aspects. The first is currently being aided through improved diagnostic techniques (Fox, 1995). Developments in this area suggest that this approach is likely to become more common.

Anticipation also involves the development of new technologies and modifications to existing technologies so as to meet changed needs. The papers in this volume indicate the continued development of chemical control agents, together with that of more novel strategies, such as a stimulo-deterrent diversionary strategy, where semio-chemicals are used to modify behaviour and, as a consequence, give protection (Pickett *et al*, 1995). The availability of such materials is essential to the success of the TIBRE (Targeted Inputs for a Better Rural Environment) approach detailed by Tait and Pitkin (1995). Here the sustainability of systems is enhanced, not by a reduction in input but, primarily, by using inputs with reduced environmental side effects.

FOOD PRODUCTION AND SUSTAINABILITY

The evolution of the sustainability concept, from absolute to relative, and the role of public acceptability in defining priorities for resource use is leading to a redefinition of key targets for sustainable systems. Perspectives on what are acceptable risks due to crop protection and the methods of crop protection permissible within sustainable agricultural systems seem likely to vary with time. The implications of these changes must be that flexibility in approach in public attitudes, and the development of methods firmly based upon ecological principles, are likely to be the best ways ahead. Only in this way will it be possible to increase either the intensity of agricultural production or the area of land given over to food production without the loss of, recently gained, benefits to biodiversity. Where biodiversity is being achieved in parallel with viable food production, this is likely to represent a sustainable system, as defined by Atkinson *et al* (1994).

EXPERIMENTATION ON SUSTAINABLE FARMING SYSTEMS

Sustainable systems of crop protection seem likely to be based upon a fuller understanding of ecological principles and especially upon knowledge of inter-specific interactions and the effects of scale-related factors, i.e. metapopulations. In any situation where either interactions or scale are important, attempts to develop a blue print of systems from the sum information derived from a series of targeted studies, i.e. effects of single bio-control agents, is likely to be unsuccessful. Only studies including the monitoring of whole systems will provide information based upon the full range of complexities. This volume includes information on five system experiments currently in progress in northern Europe. These experiments can involve substantial areas of land, i.e. up to 75 hectares per plot in the ACTA experiments (Viaux and Rieu 1995) and many sites, six in the LINK IFS project (Ogilvy *et al* 1995). The size of such experiments, and hence their cost, means that considerable care is required to ensure that designs deliver answers to substantial questions and provide information which is generally, and widely, applicable. The changes in the way in which research is currently funded in the United Kingdom and some other European countries, with increased emphasis on shorter term projects, clearly makes the maintenance of such experiments difficult. Field experiments, such as those detailed above, are expensive to establish. In the absence of committed funding, such experiments will either be ended prematurely, thus failing to obtain the best return on establishment and monitoring costs, or will simply not be done. Changes in the objectives of crop protection research clearly require a reappraisal of appropriate methods, so as to give full weight to scale-related factors and the interactions between species.

INTEGRATED CROP PROTECTION: TOWARDS SUSTAINABILITY?

The integration of the various crop protection and production aims seems likely to result in systems based on sound ecological principles which optimise resource use. This will arise from an enhancement of the role of native organisms and natural processes in regulating the extent of weeds, pests and diseases and consequently from the more targeted, and less extensive, use of crop protection materials. Such systems, in the context of the definitions given earlier, will thus be more sustainable. The title of the conference asks an explicit question. On the basis of the information presented here, it is possible to answer it with an unequivocal "yes" but also to identify some of the further research required if we are to go still further towards sustainability.

REFERENCES

ATKINSON D (1990). Land: agricultural resource or wildlife reserve? Reorganisation in the food factory. Aberdeen University Review 183, 218-225.

ATKINSON D, CHALMERS N, COOPER D, CORCORAN K, CRABTREE R, DENT B, WATSON CA (1994). The sustainability of lowland management systems pp 9-17. Scottish Sustainable Systems Project. Scottish Office Agriculture and Fisheries Department.

BRUNTLAND (1985). Mandate for change: Key Issues, Strategy and Workplan.

DOYLE C J (1995). The use of models in integrated crop protection. ibid.

FOX R T V (1995). Detection technology for plant pathogens. ibid.

FRY G L A (1995). Landscape ecological principles and sustainable agriculture. ibid.

GROSSBARD E, ATKINSON D (1985). The herbicide glyphosate. Butterworth UK.

HELENIUS J (1995). Regional - crop rotations for ecological pest management (EPM) at landscape level. ibid

KNIGHT J D (1995). Decision support systems for integrated crop protection. ibid.

MCQUILKEN M P (1995). Promoting natural biological control of soil-borne plant pathogens. ibid.

OGILVY S E, TURLEY D B, COOK S K, FISHER N M, HOLLAND J, PREW R D, SPINK J (1995). LINK integrated farming systems: a considered approach to crop protection. ibid.

PICKETT J A, WADHAM L J, WOODCOCK C M (1995). Exploiting chemical ecology for sustainable pest control. ibid.

TAIT J, PITKIN P (1995). The role of new technology in promoting sustainable agricultural development. ibid.

VIAUX P, RIEU C (1995). Integrated farming systems and sustainable agriculture in France. ibid.

WILSON M J, HUGHES L A, GLEN D M (1995). Developing strategies for the nematode *Phasmarhabditis hermaphrodita* as a biological control agent for slugs in integrated crop management systems. ibid.