ADVISORY COMMITTEE ON RELEASES TO THE ENVIRONMENT

Advice on the implications of the farm-scale evaluations of genetically modified herbicide-tolerant winter oilseed rape

Date: 18 July 2005

A. Summary

1. The Advisory Committee on Releases to the Environment (ACRE) has considered the results of the farm-scale evaluations (FSE) of genetically modified herbicide tolerant (GMHT) winter oilseed rape that were published on 21 March 2005. In addition to the results themselves, the Committee considered written submissions and heard evidence at a specially convened open meeting.

2. ACRE believes that these latest FSE data provide important and robust evidence concerning the impact of the herbicide regime associated with GMHT winter oilseed rape. The results add to the evidence provided by the FSE spring crop results published in 2003 and reinforce ACRE's judgement that the FSEs also have implications for agriculture in general and for the wider discussion concerning the positive and negative environmental impacts of agricultural practices.

3. The Committee concludes that, based on the evidence provided by the FSE results published in March 2005, if winter GMHT oilseed rape were to be grown and managed as in the FSEs, then this would result in adverse effects on broad-leaved arable weed populations, as defined and assessed by criteria specified in Directive 2001/18/EC, compared with conventionally managed winter oilseed rape. The effects on broad-leaved arable weeds would be likely to result in a reduced food supply for farmland birds, compared with conventional winter oilseed rape.

4. ACRE emphasises that this conclusion only applies to the management regime used in the FSEs. Alternative management strategies may have different impacts, which may be either beneficial or adverse. Any such alternative strategies will need to be assessed on the basis of appropriate evidence. In some cases further experimental evidence may be required. The Committee stresses again that the impacts are due to the herbicide management regime, not the genetic modification itself. ACRE also emphasises that cultivation of GMHT winter oilseed rape resulted in a shift in weed populations (a decrease in broad-leaved weeds and an increase in grass weeds) rather than a reduction in total weed abundance as observed in trials of GMHT spring oilseed rape.

B. The Advisory Committee on Releases to the Environment

5. The Advisory Committee on Releases to the Environment (ACRE) is the statutory advisory committee appointed under section 124 of the Environmental Protection Act 1990 (the EPA) to provide advice to Government regarding the release and marketing of genetically modified organisms (GMOs)[1]. The Committee works within the legislative framework set out by Part VI of the EPA and the GMO Deliberate Release Regulations 2002 which together implement Directive 2001/18/EC[2]. Sections of the Directive most relevant to the assessment of the farm-scale evaluations (FSEs) are discussed in more detail in Annex 1.

6. ACRE advises the UK Government and Devolved Administrations of Scotland, Wales and (when in operation) Northern Ireland. Advice is given, in England, to the Secretary of State for Environment, Food and Rural Affairs (Defra). In Scotland and Wales we advise the Scottish Ministers and the Welsh Assembly Secretaries, while in Northern Ireland ACRE's advice is received by the Department of the Environment. In addition to Ministers, ACRE also advises the Health and Safety Commission/Executive on human health aspects of releasing GMOs in respect of England, Scotland and Wales.

C. The farm-scale evaluations (FSEs) of genetically modified herbicide tolerant crops

History, objectives and scope

7. The farm-scale evaluations (FSEs) of genetically modified herbicide tolerant (GMHT) crops were a four-year[3] programme of research by independent researchers aimed at studying the effect that the weed management practices associated with these crops might have on farmland wildlife, when compared with weed control used with non-GM crops. The FSEs were initiated in response to concerns raised by English Nature and others that the introduction of GMHT crops might further exacerbate declines in farmland wildlife that have been observed since the middle of the 20th century. The FSEs were designed to test the null hypothesis "that, for each crop, the effect on the abundance and diversity of wildlife of the management of the GM crop does not differ from the effect of the management of the conventional equivalent".[4]

8. The FSEs do not replace existing elements of the regulatory system designed to assess the direct impacts of the crops themselves; instead they augment them by extending the consideration to cover the entire production system. The FSEs did not, therefore, investigate possible direct effects of GMHT crops on human health or the environment (such as the

[1] The Committee also advises Government on the releases of non-native species under the Wildlife and Countryside Act 1981.
[2] For further details concerning ACRE and its remit see http://www.defra.gov.uk/environment/acre. For further details of the regulation of GMOs see http://www.defra.gov.uk/environment/gm/regulation/index.htm.
[3] The FSEs began in 1999 with a pilot year. The crops were cultivated over a three-year period (2000-2003).
[4] For further information about the FSEs see http://www.defra.gov.uk/environment/gm/fse.

consequences of gene flow). They are also not concerned with the exact nature or derivation of the herbicide tolerance. For example, tolerance to broad spectrum herbicides may also be produced in crops through conventional breeding, allowing similar weed management strategies to be used with non-GMHT crops.

Results for spring oilseed rape, maize and beet (published in 2003)

9. The results for the three spring-sown crops tested in the FSEs became available in October 2003. The management associated with GMHT spring oilseed rape and beet was found to reduce the biomass and seed rain of broad-leaved and grass weeds, which had knock-on effects on certain invertebrates. Some insect groups were less abundant in and around GMHT beet and spring oilseed rape crops while springtails were found in greater number in the GMHT crops compared to their conventional counterparts. In contrast weed biomass, weed seed rain and invertebrate abundance was higher in GMHT maize crops compared to conventional maize crops[5]. ACRE produced advice to ministers on the FSE spring crop results in January 2004[6].

10. The Secretary of State for Environment, Food and Rural Affairs set out the Government's overall policy on GM crops in a statement to Parliament on 9 March 2004[7], in which she concluded that the UK should oppose the commercial cultivation of the relevant varieties of GM beet and oilseed rape anywhere in the European Union using the management regime tested in the farm-scale evaluations but that the UK should agree in principle to the commercial cultivation of GM herbicide-tolerant maize subject to certain specified conditions.

Results for winter oilseed rape

11. Results for the fourth and final crop tested in the FSEs, GMHT winter oilseed rape, were published in March 2005. All crop cultivation required for the FSEs is now complete, although some further data collection and analysis is continuing.

12. The winter oilseed rape results were published by the FSE research team on 21 March 2005 as a peer-reviewed scientific paper in the Proceedings of the Royal Society (Biological Sciences)[8]. In addition the scientific steering committee (SSC) for the FSEs together with the FSE research team published a non-specialist summary of the results[9].

[5] http://www.defra.gov.uk/environment/gm/fse/results/fse-commentary.pdf
[6] http://www.defra.gov.uk/environment/acre/advice/pdf/acre_advice44.pdf
[7] http://www.defra.gov.uk/corporate/ministers/statements/mb040309.htm
[8] Bohan *et al. Proceedings of the Royal Society* B (2005) vol. 272, p. 463-474.
[9] A pdf file of the summary is available via http://www.defra.gov.uk/environment/gm/fse.

13. The SSC published its final advice to government on the day of publication confirming that for winter oilseed rape the null hypothesis had been adequately tested and was rejected[10].

D. ACRE's consideration of the FSE results

Consideration of the FSE results

14. The FSE winter oilseed rape results, non-specialist summary and the SSC advice were forwarded to ACRE on the day of publication. Members of ACRE also attended a presentation of the results given by the research team on the day of publication at the Royal Institution in London[11].

Key findings of the FSE of winter oilseed rape

15. The summary of the key findings produced by the FSE research team is reproduced verbatim in Box 1.

Box 1: The FSE research team summary of the winter oilseed rape results[8]

We evaluated the effects of the herbicide management associated with genetically modified herbicide tolerant (GMHT) winter oilseed rape (WOSR) on weed and invertebrate abundance and diversity by testing the null hypothesis that there is no difference between the effects of herbicide management of GMHT WOSR and that of comparable conventional varieties. For total weeds there were few treatment differences between GMHT and conventional cropping, but large and opposite treatment effects were observed for dicots and monocots. In the GMHT treatment, there were fewer dicots and more monocots than in conventional crops. At harvest, dicot biomass and seed rain in the GMHT treatment were one-third of that in the conventional, while monocot biomass was threefold greater and monocot seed rain almost fivefold greater in the GMHT treatment than in the conventional. These differential effects persisted into the following two years of the rotation. Bees and butterflies that forage and select for dicot weeds were less abundant in GMHT WOSR management in July. Year totals for Collembola were greater under GMHT management. There were few other treatment effects on invertebrates, despite the marked effects of herbicide management on the weeds.

16. ACRE agrees with the summary provided the FSE research team and stresses the following points:

i. The winter oilseed rape FSE trials were well designed, executed and analysed. Like the spring crop FSE trials, the winter oilseed rape studies were sufficiently replicated to ensure that there was adequate statistical power allowing changes to be determined with the required certainty.

ii. The differences observed between GMHT and conventional winter oilseed rape were explained by the weed management and the

[10] The SSC advice is available at http://www.defra.gov.uk/environment/gm/fse/results/ssc-advice-05.htm
[11] Online video streams of the presentations are available on http://host1.oliveserver.co.uk/sscfarmscale/default.aspx

properties of the herbicide associated with the GMHT crop and there was no indication of a direct effect of the GM crop itself.

iii. Reductions reported in biomass, seed rain and seed bank of broad-leaved (dicot) weeds were key to ACRE's considerations. These reductions persisted for two years following GMHT winter oilseed rape. The Committee notes that further data on weed populations at the FSE sites are being collected, which will provide further information on the medium-term impact of GMHT management.

iv. Invertebrate numbers in winter oilseed rape were generally less affected by the management associated with GMHT winter oilseed rape than by GMHT spring oilseed rape. The reasons behind this difference are not clear.

v. Bee and butterfly numbers were unaffected for most of the year by the management of GMHT winter oilseed rape except in July, when numbers in the GMHT winter oilseed rape crop were lower than in the conventional crop.

vi. GMHT winter oilseed rape received fewer herbicide applications than conventional winter oilseed rape and herbicide applications were applied later in the GMHT crop than in the conventional crop.

Submissions of written evidence

17. Prior to the release of the FSE results it was announced that ACRE would give any interested parties the opportunity to consider the FSE winter oilseed rape results and their implications and to submit evidence as part of the deliberation process. Evidence was accepted in the form of up to two pages of A4 for a period of six weeks following publication of the results. The submission deadline was 4 May 2005. Ten submissions were received and copies of all submissions were forwarded to ACRE for consideration[12].

Open meeting

18. ACRE held a public open meeting on 25th May 2005 in London. The FSE researchers were invited to make a presentation. Prior to the meeting ACRE members selected from the written submissions a number of contributions to be heard in person. The selection was made to provide a range of opinions concerning the implications of the FSE winter oilseed rape results, with a focus on submissions that the Committee felt addressed issues that were of particular relevance for their deliberations. Each invited contributor was given the opportunity to present their argument and then ACRE members asked questions of the contributor. The whole meeting concluded with a period of questions from the floor.[13]

[12] Submissions are available at http://www.olive360.com/acre.
[13] Online video streams of the presentations are available at http://www.olive360.com/acre.

Summary of written and oral evidence

19. Several submissions emphasised that differences in weeds and invertebrates observed between the GM and non-GM oilseed rape crops were due to the herbicide management and were not a direct effect of the GMHT crop itself.

20. Most submissions agreed that the FSEs were scientifically rigorous and provided very valuable information on farmland ecology. The design was described as conforming well to the criteria stipulated in Annex II of Directive 2001/18/EC and felt to be suitable to answer the question posed.

Effects on weeds and higher trophic levels

21. Opinions differed with regard to the impact of the observed changes in weed populations. Some of those making submissions stated that the changes associated with the management of GMHT winter oilseed rape would be more damaging to farmland wildlife than conventional winter oilseed rape and that commercial approval of GMHT oilseed rape should not be permitted. Others felt that the shift in weed populations observed was within the normal range associated with changes in agricultural practice and should not form a barrier to commercialisation of GMHT oilseed rape.

22. The greatest concerns expressed were about the impact that the reduction in broad-leaved weeds and seeds would have on declining populations of seed-eating farmland birds. There is evidence that broad-leaved weed seeds are more important in the diets of farmland birds (e.g. skylark and linnet) than grass seeds. Although a few bird species might benefit from the increase in grass seeds in GM winter rape, several contributors considered them to be substantially less important in bird diets than broad-leaved weed seeds.

23. The growing of GMHT oilseed rape was considered by several submissions to further exacerbate the general decline in the arable broad-leaved weed flora observed since the 1940s. One submission expressed concern that populations of rare arable plants may be threatened by the cultivation of GMHT oilseed rape.

24. Several submissions drew attention to the fact that the total number of weeds (grass and broad-leaved weeds pooled) was similar in the GM and conventional winter oilseed rape and that, due to the later application of herbicide to the GM crop, total weed numbers were higher in the GM crop early in the season.

25. It was pointed out in submissions that winter oilseed rape plays an important role for broad-leaved weeds in conventional arable rotations in the UK. It allows more broad-leaved weeds to survive and set seeds than cereal crops, thus playing an important role in the replenishing of broad-leaved seed banks. The concern is therefore that GM oilseed rape, by

reducing the broad-leaved weed seed bank, is likely to exacerbate the long term decline in these weeds and the wildlife dependent on it.

26. There was disagreement regarding the biological significance of the lower numbers of bees observed in the GM winter oilseed rape crop in July. Some people considered this observation to be an important harmful effect while others considered it a minor effect. The latter argued that the abundance of bees was not significantly different during the period April to May, when the flowering winter oilseed rape provides an important nectar source for foraging insects and numbers of bees were only found to differ between the GM and conventional crop in a month when numbers of bees were low as the oilseed rape crop was mature and drying out, offering very little attraction to pollen and nectar seeking insects. It was also stated that bees are highly mobile insects able to seek out nectar sources.

27. There was also disagreement whether the lower numbers of butterflies observed in the GM winter oilseed rape crop in July was a harmful effect considering that the difference was mostly due to *Pieris* butterflies, which are pests of brassica crops. It was suggested that field margins are more important for butterfly biodiversity than fields. Also butterflies, like bees, are highly mobile species able to seek out changing nectar sources in the landscape.

28. Several submissions emphasised that springtails (Collembola) were more common in GM winter oilseed rape and that the abundance of most other invertebrates did not differ between GM and conventional winter oilseed rape. There appears to be currently a lack of scientific information regarding any impact of the increase in springtail numbers on higher trophic levels.

29. One submission stated that modelling should not play a part in assessing the effects of GMHT crops on biodiversity. However, several contributors to the open meeting disagreed and thought that modelling is likely to play an important role in the future. It was stated that the FSE results provide strong evidence that such impacts can be modelled since they show that weeds drive the food chains. Predictions for species that range over long distances were considered more difficult but it was suggested that it is probably just a matter of time until the tools for more accurate predictions will become available.

Crop agronomy

30. It was emphasised by several submissions that weed control is carried out by farmers to prevent weeds reducing crop yield and crop quality by competing for soil nutrients, light and water and by contaminating the harvested product with potentially noxious substances. Evidence presented, however, also suggested that weed control could be relaxed to a certain extend without yield loss.

31. It was pointed out in several submissions that as herbicides are designed to control weeds, a reduction in the target weed species after application is

an expected and desirable outcome. It was further stated that any new method of soil cultivation, whether chemical or mechanical, is likely to affect the range and abundance of weed species in fields differently. Concern was expressed whether too much emphasis is being placed on small shifts in in-field weed populations that are just as affected by cultivation and cropping change as by herbicide use.

32. Several submissions stated that GMHT crops provide farmers with more flexibility in weed control (as e.g. demonstrated by studies with GMHT sugar beet at Broom's Barn[14]) and therefore provide the potential for cropping practices that deliver environmental benefit. In contrast, the range of currently available herbicides available for oilseed rape in the UK was described as limited, expensive and of limited reliability.

33. Some submissions emphasised that the results of break crops such as oilseed rape have to seen over the whole crop rotation.

34. The trials were criticised for not measuring crop yield for two reasons: (a) farmers may have been less inclined to produce a commercially viable yield, and (b) the fact that the GM oilseed rape crop may have produced a higher yield than the conventional oilseed rape crop. Submissions referred to evidence from commercial GMHT oilseed rape cultivation in Canada, which suggests that the hybrid vigour of Ms8XRf3 (this event carries a male sterility gene and associated restorer gene in addition to the herbicide tolerance trait) alone may provide a yield advantage compared to conventional oilseed rape.

35. Herbicide management of GMHT oilseed rape may evolve as farmers gain more experience with the crop. Oilseed rape is commonly grown as a break crop in rotation with cereals and a possible scenario suggested was that farmers may use less herbicide in the cereal parts of the rotation if weed control is improved in oilseed rape.

36. There was disagreement whether the increase in grass weeds (particularly in the problematic blackgrass) observed in GMHT oilseed rape would lead to an increased use of herbicides. It was suggested that farmers with particular grass weed problems would not plant glufosinate resistant oilseed rape.

Economic issues

37. Several submissions suggested that UK farmers may be disadvantaged if they do not have access to the advantages offered by technologies available to their competitors in the rest of the world and may be less able to meet the challenges of changing economic, regulatory and climatic conditions. The suggestion was that GM crops have the potential to help farmers to deliver profitably the environmental and public goods that society demands.

[14] May *et al.* Proceedings of the Royal Society B (2005) vol. 272, p. 111-119

38. Two submissions suggested that present low oilseed rape prices combined with high fertiliser prices may cause farmers to replace oilseed rape with cereals or fallow and that the performance of winter oilseed rape needs to be improved for the crop, with its associated wildlife benefits, to continue to be grown on UK farms. The hybrid GMHT oilseed rape tested in the FSEs was seen as having the potential to contribute to such an improved performance. It was also suggested that such an increase in yield could give farmers the opportunity to produce the same amount of food on less land. In contrast, another submission suggested that none of the crops tested in the FSEs would be of commercial interest to UK farmers.

39. Several submissions suggested that an advantage of the GM herbicide tolerance studied in the FSEs lies in its ability to deliver a range of farming and/or environmental objectives. In the case of winter oilseed rape, this may be through increased flexibility in the timing of weed control and improved effectiveness of low tillage options within the rotation.

Measures to improve the balance between agriculture and wildlife

40. Evidence was submitted on measures to reduce the impact of GMHT crops on weeds and associated wildlife. A distinction was made between (a) measures within fields and (b) measures to improve wildlife conditions on agricultural land surrounding crops (such as untreated borders, hedges, wildflower mixes, etc.).

41. Herbicide product labelling, environmental stewardship schemes and consumer pressure were listed as tools for encouraging farmers to relax their weed control for wildlife benefit. However, doubts were expressed in some submissions that farmers would comply with restrictions imposed by herbicide product labelling.

a) Measures that can be applied within crops

42. There was a range of opinions regarding the ease with which oilseed rape crop management could be modified to allow for more weeds to survive. One suggestion was that conventional control of broad-leaved weeds in oilseed rape was already minimal with little scope for reducing the numbers of herbicide applications while others felt that a reduction in weed control levels would not be a difficult challenge if required. Extensive data available from 20 years of herbicide efficacy trials could be used to fine-tune herbicide applications. However, clear prescriptions of which weed levels and weed species are desirable would be needed. It was also stated that weed seed banks present in fields provide an opportunity to reverse the decline in broad-leaved weed species.

43. It was suggested that the FSEs did not exploit the flexibility in herbicide timing that GMHT crops offer farmers and that the efficacy of glufosinate against larger weeds would allow farmers to take a more relaxed attitude

towards weed control (i.e. to spray less often or later). Studies carried out at Broom's Barn[15] with GMHT sugar beet were quoted as an example of how GMHT crops can be managed to provide wildlife benefits compared to conventional crops.

b) Measures that can be applied to agricultural land surrounding crops

44. There was disagreement in submissions as to whether mitigation measures would be appropriate or not. One opinion was that risk mitigation plays an important role in risk management and was being successfully employed to mitigate the risks associated with other GM crops (e.g. the use of refuges to counteract the risk of pest resistance to Bt crops). Another opinion was that mitigation measures would not be appropriate as they would be difficult to enforce. The option of taking some land out of production to set aside for wildlife was discussed with particular reference to scale, rewards to land managers and wider environmental benefits. One contributor recommended that research should be aimed at reducing the negative wildlife impact of weed control in non-GM crops rather than at mitigation measures for GM crops.

The wider context

45. Several submissions drew attention to the fact that biodiversity differences between crop species in the FSEs were greater than those between GM and conventional varieties of the same species. Winter oilseed rape, regardless of whether it was GMHT or conventional, supported significantly more biodiversity compared to conventional maize and beet. An increase in the area sown with winter oilseed rape crop at the expense of other crops, including cereals, was considered to be beneficial for farmland wildlife by a number of stakeholders.

46. Several submissions suggested that the environmental impact of herbicide tolerant crops should not be judged solely based on biodiversity impact but other environmental benefits such as reduced inputs of pesticides, low tillage systems, soil management, targeted crop management and the potential for more efficient biofuel production should be taken into account.

47. ACRE was asked to take the realities of modern agricultural production and the global food and feed supply chain into account.

Regulatory and policy issues

48. It was stated that there was an ongoing discussion in Europe about where environmental risk assessment of herbicide tolerant crops should realistically begin and end, and how much should be considered as a function of risk management and thus be considered in post-market monitoring.

[15] May *et al.* Proceedings of the Royal Society B (2005) vol. 272, p. 111-119

49. Several submissions referred to a discrepancy in the regulations governing pesticides and GM crops regarding the need for high herbicide efficacy. While some acknowledged that the FSEs fulfilled the requirements of Directive 2001/18/EC regarding the assessment of indirect management-related effects on the environment, others felt that the impact of the herbicide management associated with GMHT crops falls under the remit of the Advisory Committee on Pesticides. Another opinion was that in the absence of safety issues, government or regulators should not limit access for consumers or farmers to GM technology.

50. The government's adoption of wild bird populations as a headline indicator and Defra's Public Service Agreement target of reversing long-term declines in the number of farmland birds by 2020 were highlighted as important policy goals to take into account when considering the implication of the FSE winter oilseed rape results.

51. Several submissions expressed the view that the FSE results will play an important role in informing wider agricultural policy. It was pointed out that delivery of environmental goods is central to future policy goals but that such objectives will not be realised if agricultural production is not profitable. Some submissions suggested that GM crops could play a role in balancing environmental stewardship with profitable agricultural production.

52. Although the FSEs provide a model for further studies, some submissions questioned to what extent such expensive large-scale assessments would be possible for new GM crops. Another opinion was that all novel crops (e.g. energy crops) as well as new agricultural processes (e.g. change in cultivation techniques), not only GM crops, should be assessed for biodiversity impacts**.**

53. Some submissions expressed concern about the long persistence of GM oilseed rape seeds in the soil seed bank. One submission emphasised the importance of having realistic assessment of risk and contingency plans in place for experimental releases of GM crops.

Current status of the regulatory process

54. The application for event Ms8xRf3 (C/BE/96/01)[16] is currently the only GMHT oilseed rape application for cultivation in the EU although Bayer Crop Science is aiming to reduce the scope of this application to exclude cultivation. Ms8xRf3 was the event used in the GM winter and spring rape in the FSE.

Writing the advice

55. Following the open meetings ACRE met on 26th May 2005 to deliberate on the implications of the FSE results and to consider evidence submitted from stakeholders. This advice was then drafted.

[16] http://www.defra.gov.uk/environment/gm/regulation/pdf/euconsent.pdf

E. ACRE's advice

56. ACRE has been asked by Government to advise on the implications that the FSE findings have for the cultivation of GMHT crops in the UK. Consequently, this document and the advice it contains is based solely on the assessment of the management effects reported in the FSE results. The Committee has considered whether the data produced by the FSEs provide evidence that the management associated with GMHT winter oilseed rape results in direct or indirect adverse effects on the environment compared with the management of conventional winter oilseed rape.

57. ACRE concludes that:

> Based on the evidence provided by the FSE results published in March 2005, if winter GMHT oilseed rape were to be grown and managed as in the FSEs this would result in adverse effects on broad-leaved arable weed populations, as defined and assessed by criteria specified in Directive 2001/18/EC, compared with conventionally managed winter oilseed rape. The effects on broad-leaved arable weeds would be likely to result in a reduced food supply for farmland birds, compared with conventional winter oilseed rape.

58. ACRE has arrived at this conclusion because the results published by Bohan *et al.* (2003) demonstrate that there were fewer broad-leaved weeds in the GMHT oilseed rape fields compared with conventionally managed winter oilseed rape. At harvest, the biomass and seed rain of these broad-leaved weeds in the GMHT winter oilseed rape fields were one-third of that in the conventionally managed winter oilseed rape (Table 1 in Bohan *et al.* 2005). Numbers of broad-leaved weed seeds in the soil remained lower in the GMHT treatment in the following two years of the rotation. The negative effects of GMHT winter oilseed rape management on broad-leaved weeds followed a similar trend as reported in 2003 for GMHT spring oilseed rape (Heard *et al.* 2003).

59. In the FSEs, the management of GMHT winter oilseed rape resulted in a shift in weed population (a decrease in broad-leaved weeds and an increase in grass weeds) rather than a reduction in total weed abundance. This is in contrast to the FSE results for spring oilseed rape, where total weed abundance was lower in GMHT spring oilseed rape compared to conventional spring oilseed rape. Many farmland bird species depend on weed seeds for food, particularly outside the breeding season, and lower adult survival is one of the main causes of the declines in farmland bird populations. Evidence indicates that seeds of broad-leaved weeds feature more prominently in the diet of many bird species than seeds of grass weeds. Given the reduction in broad-leaved weed populations observed under GMHT winter oilseed rape management, it is likely that this crop when managed as in the FSEs, would have a negative impact on farmland bird species already in decline, when compared to conventional winter oilseed rape.

60. Current evidence and theoretical predictions indicate that the increase in grass weeds observed under GMHT winter oilseed rape management would not counteract the negative impact of a reduced availability of broad-leaved weed seeds although there is uncertainty regarding the ability of affected bird species to survive on an altered seed diet and regarding the scale of the negative indirect impact. The Committee recommends that its conclusion be considered within the wider context of agriculture.

61. The Committee emphasised that its conclusion can only be confidently ascribed to future GMHT winter oilseed rape crops if the crops are managed in the same way as they were in the FSEs. ACRE makes the following points:

    i. The attitude of farmers to weed control is currently cautious and dominated by the fact that the herbicides available for conventional oilseed rape weed management are only effective against very young weeds. The use of GMHT oilseed rape allows for weeds to be controlled when they are larger, thereby providing farmers with more flexibility in the timing of application. Evidence indicates that the flexibility and reliability of herbicide management in GMHT crops could be exploited to relax the intensity of weed management. Seed banks present in soil have a buffering effect and give the system a certain level of resilience. A relaxation in the intensity of weed control would not only improve conditions for farmland wildlife but would also reduce inputs and thus the environmental costs associated with herbicide production. The study with GMHT sugar beet by May *et al.* (2004)[17] provides an example for ways in which GMHT crops could be managed for wildlife benefits without incurring yield penalties.

    ii. It is for those applying for consent to market GMHT oilseed rape to propose alternative management strategies, and such proposals should be supported by appropriate evidence. The Committee suggested that product labels would be one way for companies to implement specific environmentally friendly herbicide management strategies for GMHT crops. It may also be necessary to determine the effectiveness of management strategies as part of post-market monitoring plans. In this context it is clear from the FSE results that biomass, seed rain and seed bank densities of broad-leaved weeds are important indicators of biodiversity impacts.

    iii. Modifications in other crop management practices within fields, e.g. changes in the timing of stubble cultivation (which buries weed seeds), may have a greater impact on seed availability to birds than a change from conventional to GMHT varieties

    iv. Field margins support more biodiversity than crops and improving conditions for wildlife in the field margins could offset reductions of

[17] May, M. J., Champion, G. T., Dewar, A. M., Qui, A. and J. D. Pidgeon (2005) Proceedings of the Royal Society, London, B 272, 111-119.

broad-leaved weeds in a crop. Such approaches could for example include buffer strips and conservation headlands[18]. The higher yield potential of hybrid GM oilseed rape may allow farmers to dedicate more land to such biodiversity friendly approaches without loss of income.

v. The FSEs showed that large differences exist between crop species in terms of weed and invertebrate populations they support. Further opportunities to improve the balance between farming and wildlife conservation therefore lie with the crop species farmers choose to plant and the area they chose to dedicate to each crop.

62. ACRE recommended that potential environmental benefits of GMHT crops, such as reductions in CO_2 emissions from herbicide manufacture, transport and field operations (as shown in the study be Bennet *et al*.[19]) should also be considered.

63. The regulatory process requires ACRE to compare the environmental impact of a GM crop with that of the non-modified crop from which it was derived. However, ACRE emphasised the importance of considering the FSE winter oilseed rape results within a wider context. The FSEs showed that although GMHT winter oilseed rape crops supported fewer broad-leaved weeds than conventional winter oilseed rape, they supported more broad-leaved weeds than conventional maize or beet. These results show that the choice of crop species by farmers, as part of their crop rotation and within the landscape, is more likely to impact farmland wildlife than if they were to choose a GMHT variety over a conventional variety of the same crop. The FSE results show that oilseed rape promotes more biodiversity than many other crops and ACRE suggests that the planting of such biodiversity-promoting crops should be encouraged. ACRE's subgroup on wider issues raised by the FSEs will consider this issue in its deliberations.

64. The Committee emphasised that the FSE winter oilseed rape results applied to the herbicide glufosinate, not to all broad spectrum herbicides in general.

F. Annex 1 – The risk assessment of genetically modified organisms

The entire regulatory process is underpinned by a detailed environmental risk assessment, prepared by the applicant, which examines and evaluates any possible adverse effects associated with the release of a particular GMO. This risk assessment is reviewed by ACRE.

In assessing applications every possible precaution is taken to ensure that human health and the environment are protected. Only if the risks are considered to be very low will the release be allowed to proceed. In the

[18] http://www.defra.gov.uk/funding/schemes/es.htm
[19] Bennet, R. , Phipps, R., Strange, A. and P. Grey (2004). Environmental and human health impacts of growing genetically modified herbicide-tolerant sugar beet: a life-cycle assessment. Plant Biotechnology Journal 2, 273-278.

context of GM plants, a very low risk generally means that the GM variety is not thought to pose any greater risk than the release of its non-GM equivalent[20]. In addition to an assessment of direct effects of a GMO the risk assessment must also consider indirect immediate and delayed effects arising from management practices specific to that GMO.

Some sections of Directive 2001/18/EC are especially relevant to the assessment of the FSE results. These include Article 4(1):

"Member States shall, in accordance with the precautionary principle, ensure that all appropriate measures are taken to avoid adverse effects on human health and the environment which might arise from the deliberate release or the placing on the market of GMOs."

Annex II of the directive goes on to give further detail of the scope of the risk assessment, stating that:

"Adverse effects may occur directly or indirectly through mechanisms which may include changes in management, including, where applicable, in agricultural practices"

The potential environmental impact must therefore take into account:

"Possible immediate and/or delayed, direct and indirect environmental impacts of the specific cultivation, management and harvesting techniques used for the GM plant when these are different from those used for non-GM plants"

ACRE has produced guidance of how such management affects should be assessed[21].

[20] See http://www.defra.gov.uk/environment/gm/background/risk/index.htm for details of the risk assessment conducted.
[21] Further details are available from http://www.defra.gov.uk/environment/acre/biodiversity/index.htm