

FARM SCALE EVALUATIONS OF GM CROPS:

EFFECTS OF THE MANAGEMENT OF FIELD SCALE RELEASES OF GENETICALLY-MODIFIED HERBICIDE- TOLERANT CROPS ON THE ABUNDANCE AND DIVERSITY OF FARMLAND WILDLIFE

Interim Report

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EXECUTIVE SUMMARY

1. This is the fifth Interim Report of the Farm Scale Evaluations of Genetically-Modified Herbicide Tolerant (GMHT) crops, covering the period February – September 2001. This period has covered the conclusion of the first year of the winter rape study and the start of the second year, and the field studies for the second year of the spring sown crops beet, spring oil seed rape and maize.
2. The field programme for this period has been much the most extensive so far, involving visits to a total of 181 sites. The autumn and winter was very wet, which resulted in the loss of several winter oil seed rape sites. The spring field season was then disrupted by the outbreak of foot and mouth disease (FMD). Perhaps the greatest effect of the disease on the data collected by the survey team was on site selection for forage maize, which was taking place when the outbreak started. There were also some farms where access was restricted for a period to our survey teams, giving a greater than desired number of missing values. However, in general, the disruption to the field survey was much less than it might have been.
3. The protocol revisions presented in the previous report were implemented during the 2001 field season, except for the suggested reduction in frequency of collecting seed rain traps.
4. Follow-up seedbank samples were taken on all spring 2000 crops except for a beet crop and a maize crop that were missed as a result of FMD restrictions, and is almost complete for the year 2000 winter rape crops. Follow-up weed seedling counts were taken for all but three spring-sown 2000 sites (excluding two maize sites that are in continuous cropping). 21 winter oil seed rape sites sown in 2000 were taken to harvest in 2001. Monitoring programmes were completed for 26 beet sites, 30 spring oil seed rape sites and 22 maize sites (nb. the maize programme has been particularly affected by both FMD and damage to sites).
5. All data entry forms and validation checks are in place. Almost all data for the summer 2000 programme have been entered, and data entry has begun for other data collected during 2001, with the emphasis on vegetation data. Invertebrate sorting will continue over-winter for the 2001 samples. Automated data analysis procedures are under development.
6. The issue of site selection for 2002 is considered. Adequate power is given by a sample of 60 sites, plus leeway for site withdrawal, failure to establish etc, and the sites need to be broadly representative of those where the crop is currently grown. We recommend that site selection for 2002 should be along the following lines:
 - 25-30 spring oil seed rape sites, with increased numbers in Scotland and in south-east and the far north of England
 - 15-20 beet crops
 - 33-40 maize crops, with greater representation in the south-west

- 17-24 winter oil seed rape sites, with more concentration in southern Scotland and the south-east of England (assuming little change in site numbers of the current crop)
 - A large pool of sites from SCIMAC, including substantial numbers of farms new to the studies
 - The pool may need to be delivered to the Consortium by the end of December (spring oil seed rape, beet); end of January (maize) and mid-May (winter oil seed rape).
7. Several publications have appeared, and the methodology papers have been submitted for publication. There was also an exchange of visits between Les Firbank and leading staff of the Danish experiments looking at impacts of biodiversity of GM herbicide tolerant beet crops, Beate Strandberg and Marianne Bruus Pedersen at NERI.
 8. The project co-ordinator gave evidence to the “Strategic decision-making” subgroup of the Agriculture and Environment Biotechnology Commission (AEBC) on 6 February 2001 in Norwich. This evidence contributed to the AEBC’s report “Crops on Trial”. We consider that the report is highly supportive of the FSE programme and its underpinning science.
 9. The Consortium has provided feedback to its farmers, including a report of the weed species found in their seedbank samples before the crops were sown.
 10. In general terms, the project is on timetable, with a slight slippage remaining on invertebrate sorting and hence on data entry. The following major tasks are scheduled for the next period of the report (nb the timetable overlaps with the previous report, and so some tasks also overlap)
 - Undertake the remaining planned rounds of site selection
 - Complete field work for all spring-sown crops and for the 2001-02 round of winter oil seed rape, except for follow-up studies of weed seedbank and seedlings
 - Begin field sampling for the final round of winter oil seed rape
 - Complete entry and validation of all data collected prior to May 2002
 - Have in place a programme of sample sorting, data entry and validation to deliver a finalised database for the spring sown crops by the end of November 2002
 - To have completed draft analyses using data from 2000-2001
 - To have developed working documents that will form the basis of the final reports of spring-sown crops.
 11. It is proposed to publish the papers that will comprise the final report of the spring sown crops in a special issue of the Journal of Applied Ecology, and discussions have started with the Journal editors about how this process would work. An outline list of possible papers is given.

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1 INTRODUCTION

This is the fifth Interim Report of the Farm Scale Evaluations of Genetically-Modified Herbicide Tolerant (GMHT) crops, covering the period February – September 2001. This period has covered the conclusion of the first year of the winter rape study and the start of the second year, and the field studies for the second year of the spring sown crops beet, spring oil seed rape and maize.

The following major tasks were scheduled to have been completed at this stage in the project:

- Resurvey spring 2000 sites
- Complete field work on winter 2000 sites
- Undertake site selection and field survey on the spring 2001 sites
- Completion of data entry and validation for spring 2000 sites
- Submission of manuscripts to journals on overall project approach, experimental design and protocols
- Provision of feedback to farmers that have taken part in the project so far
- Continued development of data analysis procedures
- Planning for publication of the final report

As will be seen below, the vast majority of this work has been completed, as has site selection and initial fieldwork for the 2001-02 winter oil seed rape sites.

2 RECORD OF ACTIVITY, FEBRUARY 2001 – SEPTEMBER 2001

2.1 Introduction

The field programme for this period has been much the most extensive so far, involving visits to a total of 181 sites. The autumn and winter was very wet, which resulted in the loss of several winter oil seed rape sites.

The spring field season was then disrupted by the outbreak of foot and mouth disease (FMD). Perhaps the greatest effect of the disease on the data collected by the survey team was on site selection for forage maize, which was taking place when the outbreak started. There were also some farms where access was restricted for a period to our survey teams, giving a greater than desired number of missing values. However, in general, the disruption to the field survey was much less than it might have been. This was largely because of the close communication between survey teams, farmers, police, regional veterinary officers and DEFRA officials, coupled with very clear and rigorous biosafety precautions by the survey teams themselves, including changes to the routing and planning of surveys. We are deeply indebted to all of those who supported us during this difficult time.

2.2 Protocol development

The protocol revisions presented in the previous report were implemented during the 2001 field season, except for the suggested reduction in frequency of collecting seed

rain traps, as the resource implications of maintaining the more frequent sampling programme were less than originally thought.

2.3 Follow-up field studies on crops sown in spring 2000

The follow-up studies involve sampling the weed seedbank and weed seedlings. While the first seedbank sample provides baseline data on levels of diversity throughout the whole field, the second sample, taken just before the subsequent crop is sown, gives treatment effects on the seedbank community. This has been done for all spring 2000 crops except for a beet crop and a maize crop that were missed as a result of FMD restrictions, and is almost complete for the year 2000 winter rape crops.

The spring 2000 crops were revisited during late spring / early summer 2001 for a round of weed seedling counts, intended to reveal effects on weed populations in following crops. This work was undertaken on all crops except for 1 beet site (out of 24) due to foot and mouth restrictions; 3 maize sites (out of 12), 1 due to FMD and 2 because the fields remain in the main experiment (i.e. continuous maize is being grown) and 1 spring rape, also because of FMD (out of 12).

We intend to analyse these data and report back to the SSC with a recommendation about the value of continued surveys of these same fields in 2002, i.e. the second season following the GM crop.

2.4 Winter oil seed rape, 2000 – 2001

The previous report described how the original sample of 25 winter oil seed rape sites had been reduced to 23, with one site lost because of flooding and another because of an error in field layout. Two further sites were withdrawn over winter because they had failed to establish, leaving a total of 21 sites that were taken through to harvest. This rate of loss was entirely acceptable given the extremely bad weather at the time. Access to two sites in particular was highly disrupted because of restrictions due to FMD; there were also problems with the early rounds of bee and butterfly sampling because of bad weather (Table 2.1). Note that the number of seed rain samples varies between sites, this is because we try to keep the seed rain sampling for as long as possible, but for many sites is not practical to maintain the traps long after harvest.

2.5 Spring sown crops, 2001

A total of 26 beet sites were sown, and while fieldwork was suspended at two sites because of foot and mouth restrictions, these restrictions were lifted and all sites monitored until harvest. 32 sites of spring oil seed rape were sown, but two in Dorset were withdrawn shortly afterwards. Of the sites had been disrupted because of FMD restrictions. 28 maize sites were sown, and 5 of these were withdrawn at various stages of the season, and two had been affected by FMD restrictions (Table 2.1). While deliberate damage to crops attracted less media attention than during 2000, it still took place. Deliberate damage was reported from 15 sites in total, varying from very minor incidents to the near-loss of the field. The situation was much the most serious for maize, where three of the sites were damaged so severely that subsequent data are likely to be unusable. Given these difficulties, and the highly variable

weather of the field season overall and especially at the time of the field season, we are delighted to record such a near-complete programme of fieldwork.

Table 2.1 Activity record for 2001 (until September – this record list is provisional)

PROTOCOL	Beet	Maize	Spring OSR	Winter OSR
Margin attributes	26	21	32	24
Soil seedbank	18	21	24	24
Gastropod verge 1	22	23	28	24
Gastropod verge 2	20	17	25	21
Gastropod trap 1 recover	25	24	29	21
Gastropod trap 2 recover	23	22	29	20
Gastropod crop 3 recover	N/A	N/A	N/A	18
First Seedling	25	24	30	23
Mezzanine	20	N/A	N/A	19
After Herbicide	26	22	30	19
Bee & butterfly 1	25	23	31	14
Bee & butterfly 2	25	21	29	20
Bee & butterfly 3	26	21	30	20
Bee & butterfly 4	24	N/A	N/A	20
Crop pest 1	26	23	27	23
Crop pest 2	26	22	28	19
Vortis 1	25	20	31	21
Vortis 2	25	20	29	19
Margins 1	25	24	30	21
Margins 2	25	21	30	21
Margins 3	26	23	30	20
Margins 4	23	N/A	N/A	20
Biomass	26	21	29	21
Seed rain 1 recover	17	15	26	21
Seed rain 2 recover	19	16	25	20
Seed rain 3 recover	25	22	29	20
Seed rain 4 recover	23	20	29	19
Seed rain 5 recover	15	11	24	12
Seed rain 6 recover	11	8	15	8
Seed rain 7 recover	5	4	10	6
Carabids 1 recover	25	22	29	20
Carabids 2 recover	25	22	27	20
Carabids 3 recover	24	22	25	20

2.6 Health and safety

The only safety incident during the period of the report was a car accident involving one of the survey teams. This reminds us that the health and safety risk of a driving accident remains much the greatest facing the field workers in this, and so many other, projects.

2.7 Training

There was a training session in March for field surveyors, and this was complemented by a variety of training supports for field staff and those involved in invertebrate sorting. A wash-up session is planned for November, along with a training programme for 2002.

2.8 Progress in data collation and validation

The reporting period has seen substantial developments in data entry and validation, and now all of the data entry forms and validation checks are in place. Validation takes place during the second punch interactively. Almost all data for the summer 2000 programme have been entered, except for some of the pitfall and vortis sample data. Seedbank data have been entered for all samples taken in 2000 and spring 2001. Data entry has begun for other data collected during 2001, with the emphasis on vegetation data. Invertebrate sorting will continue over-winter for the 2001 samples.

2.9 Progress in data analysis procedures

The Genstat programme for standard analysis of a single year's data was extended to provide estimates of the effects of years and of distance from the field edge and interactions of these two factors with treatment. Several farms occur in more than one year, and within years for more than one crop, so a method has been developed to examine how treatment differences, if they exist, might vary between farms. However, the situation is complex because of the many factors and covariates involved, including farmers and advisors. So, the approach needs to be considered within the wider context of the effect of crop management and the use of concomitant information. The analysis is relevant to interpretation of the test of the null hypothesis, and has implications for the broader picture and scaling up of results.

The statistical capability of the Genstat programme for standard analysis was also extended to study a range of statistical models that incorporates different variance-mean relationships, as is often required for count data. Analysis of current datasets indicates that the simple log normal model is robust and might provide an adequate basis for reporting the final results, although this will be monitored carefully over the next year. The robustness of the log normal model is important, because the implementation is particularly useful for some of the more complex models with many covariates and interaction effects.

Software is under development that provides a link from the Oracle database to the Genstat software for analysis, via Structured Query Language (SQL) scripts and Visual Basic code. A prototype program allows the automation of standard analyses that will provide a database of results.

A series of internal workshops for analysis are planned for early 2002, beginning with a workshop on vegetation in January. Issues of design and analysis of the FSE will be discussed in an invited paper at the International Biometric Conference at Freiburg, July 2002.

3 ISSUES FOR SITE SELECTION IN THE YEAR 2002

3.1 Introduction

We are now at the end of the second season of spring sown crops, and the start of the second season of winter oil seed rape. This means that there is now only one more round of site selection for each of the crops in the study, and so the site selection in 2002 becomes critical in ensuring that site selection results in an appropriate sample for each crop.

It is worth repeating what is meant by an “appropriate sample.” The size of this sample is determined by the power analyses, that underpinned the experiment design in its earlier stages and were updated in the previous report. These analyses suggest that data from 60 sites per crop gives adequate power for the purposes of this study, but some leeway is required for sites that withdraw or fail to establish. Also, the site numbers should be distributed over the years of the study in order to estimate treatment x year interactions. The distribution of the sample needs to broadly represent the range of conditions under which the crops are likely to be grown should they be approved for commercial release. The SSC minutes of 8 February 2000 clarify the approach:

“The consortium proposed that farm intensity and geographic location were among the most important factors in selecting farms, and that statistically, the best sample of farms would be one in which the range of practices and geography was included and the extremes were somewhat over represented. Farm intensity and geographic location would then be included as covariates in the analysis. This approach was agreed by the SSC.”

We recognise two additional factors in the site selection procedure. The first is the issue of repeat farms, and the extent to which the Consortium is content with resampling fields from farms that have already contributed to the study. The second is that the Government may require a six-week notification period, an increase of two weeks compared with the present situation.

In this section, we review the current range of sites selected thus far crop-by-crop, and make recommendations for the site selection process in 2002.

3.2 Spring oil seed rape

Thirty one spring rape sites were surveyed throughout the 2001 field season, bringing the total up to 43, although four of these were quite severely damaged. The geographic distribution of the sites is quite representative of the areas where the crop is grown (Table 3.1), except perhaps in the south-east of England. An increase in the number of sites in the north of England and in Scotland would also be welcomed (see also Fig. 3.2).

The present selection also seems reasonable in terms of crop management, as taken from the forms used to assess the sites for inclusion in the study (the audits of the crop management data for 2001 have not yet been completed).

We therefore propose to select around 25-30 sites of spring oil seed rape in 2002, with increased proportions in Scotland, the south-east and north of England.

Table 3.1 Geographical distribution of spring rape per DEFRA region in each year compared with MAFF totals for all oilseed rape (MAFF & Scottish Office 1999)

MAFF Region	Area grown (% UK) 1997	SR Sites 2000	%	SR sites 2001	%	SR sites, all yrs	%
Scotland	13	1	8	3	10	4	9
Wales	1	0	0	0	0	0	0
Northern	17	2	17	5	16	7	1
Midlands & Western	27	3	25	6	19	9	2
Eastern Region	19	3	25	12	39	15	3
South East	16	1	8	1	3	2	5
South West	7	2	17	4	13	6	1
Total no. sites		12		31		43	

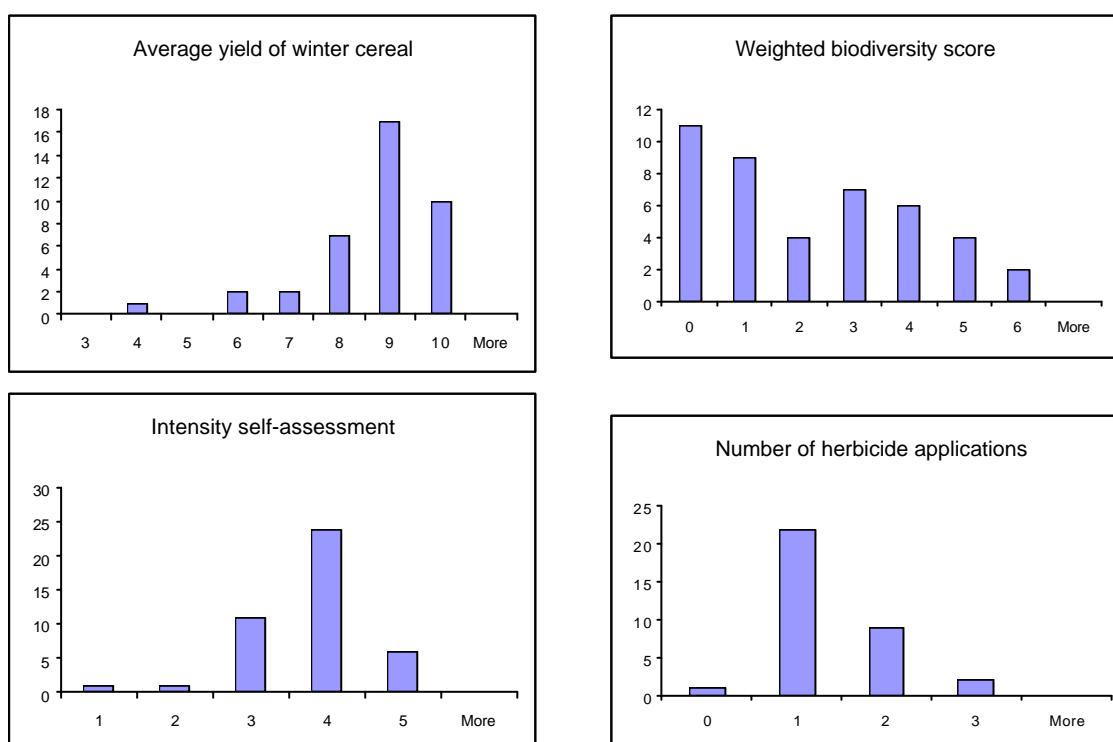


Fig. 3.1 Number of spring oil seed rape sites in relation to attributed of 2000 – 01. Yield is tonnes ha⁻¹. Biodiversity scores are weighted, and include use of FWAG advisor, LEAF audit, Beetle banks, Conservation headlands, Wildflower Strips, Game cover and management for game. All data provided by farmers during site selection procedure.

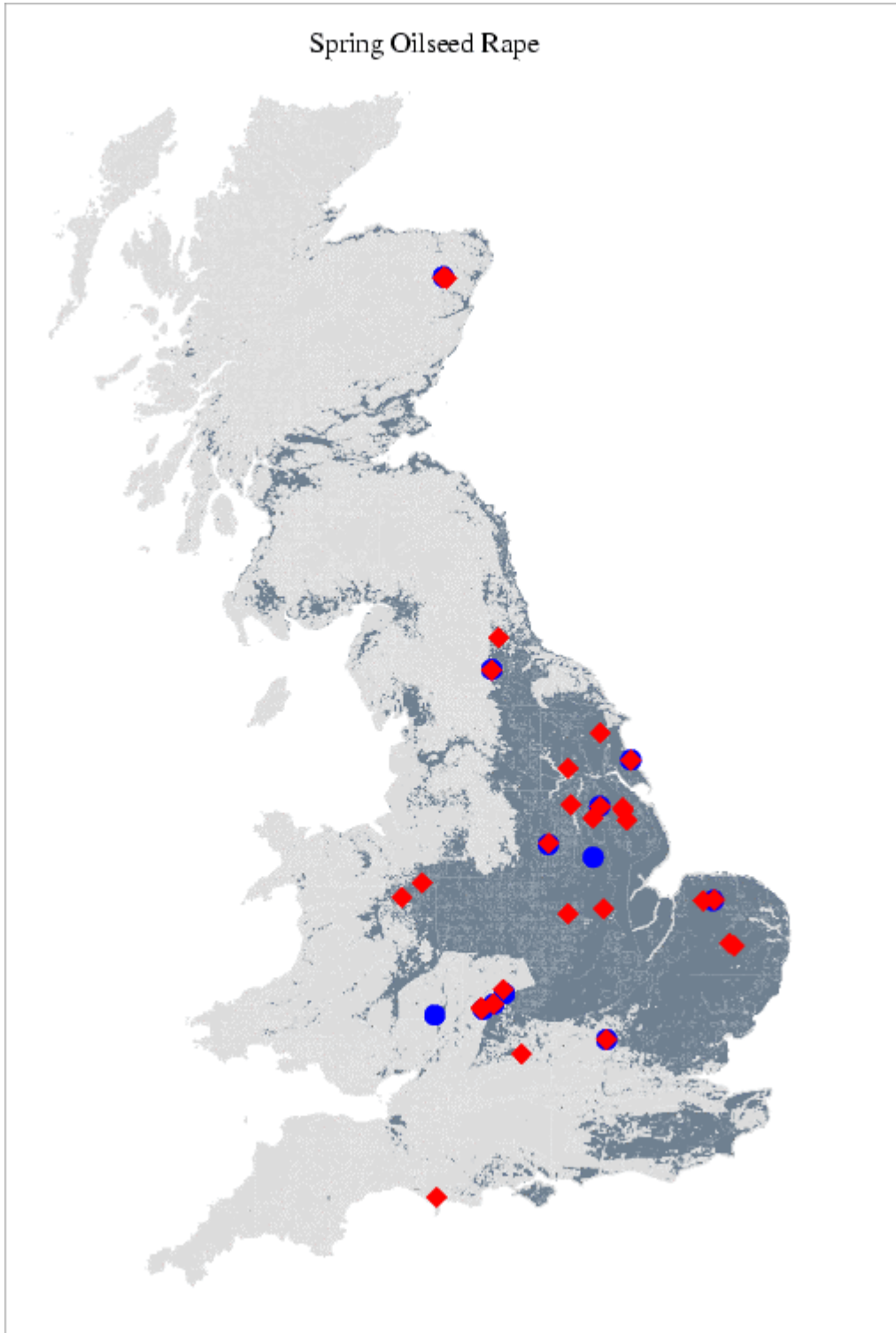


Fig. 3.2. *Distribution of spring rape sites in 2000 (blue circles) and 2001 (red diamonds). The shaded area corresponds to locations that are environmentally suitable for growing oil seed rape (using Countryside Information System and Countryside Survey 1990 data).*

3.3 Maize

Site numbers

28 sites were selected to enter the trial for the 2001 season. The selected fields were on 24 different farms and offered by 22 growers, 11 of who were new to growing maize in the FSE trials. Three of these selected sites were abandoned/ removed from the trial before drilling because of local and national pressure on the farmers, and three sites were very heavily damaged. In total 22 sites were followed completely through 2001.

To date 34 sites have successfully been followed:

Maize Sites 2000	16 selected	4 withdrawn	12 completed
Maize Sites 2001	28 selected	3 withdrawn, 3 damaged	22 completed

This leaves a shortfall of 26 on the minimum total number of sites recommended for the whole trial.

Indicators

Overall the 34 sites so far have been representative of UK Maize growing in many aspects. In the following section four of these indicators are summarised for all sites completed or continuing in the current trial.

Every MAFF region except Wales has been included in the trial so far. Table 3.2 details the numbers and percentage areas of field sites compared to the latest DEFRA summaries available. Most of the sites so far dominate a band through the middle of England (Fig. 3.3).

Table 3.2 *Geographical distribution of maize sites per DEFRA area in each year compared with MAFF statistics (MAFF & Scottish Office 1999).*

Region	Area grown (%UK) 1997	Maize sites 2000	%	Maize sites 2001	%	Maize sites all years	% to date
Scotland	0	0	0	0	0	0	0
Northern	2	2	17	2	9	4	12
Midlands & Western	21	2	17	5	23	7	20
Eastern	8	5	42	8	36	13	38
South Eastern	19	0	0	2	9	2	6
South Western	45	1	8	3	14	4	12
Wales	5	2	17	2	9	4	12
Total		12		22		34	

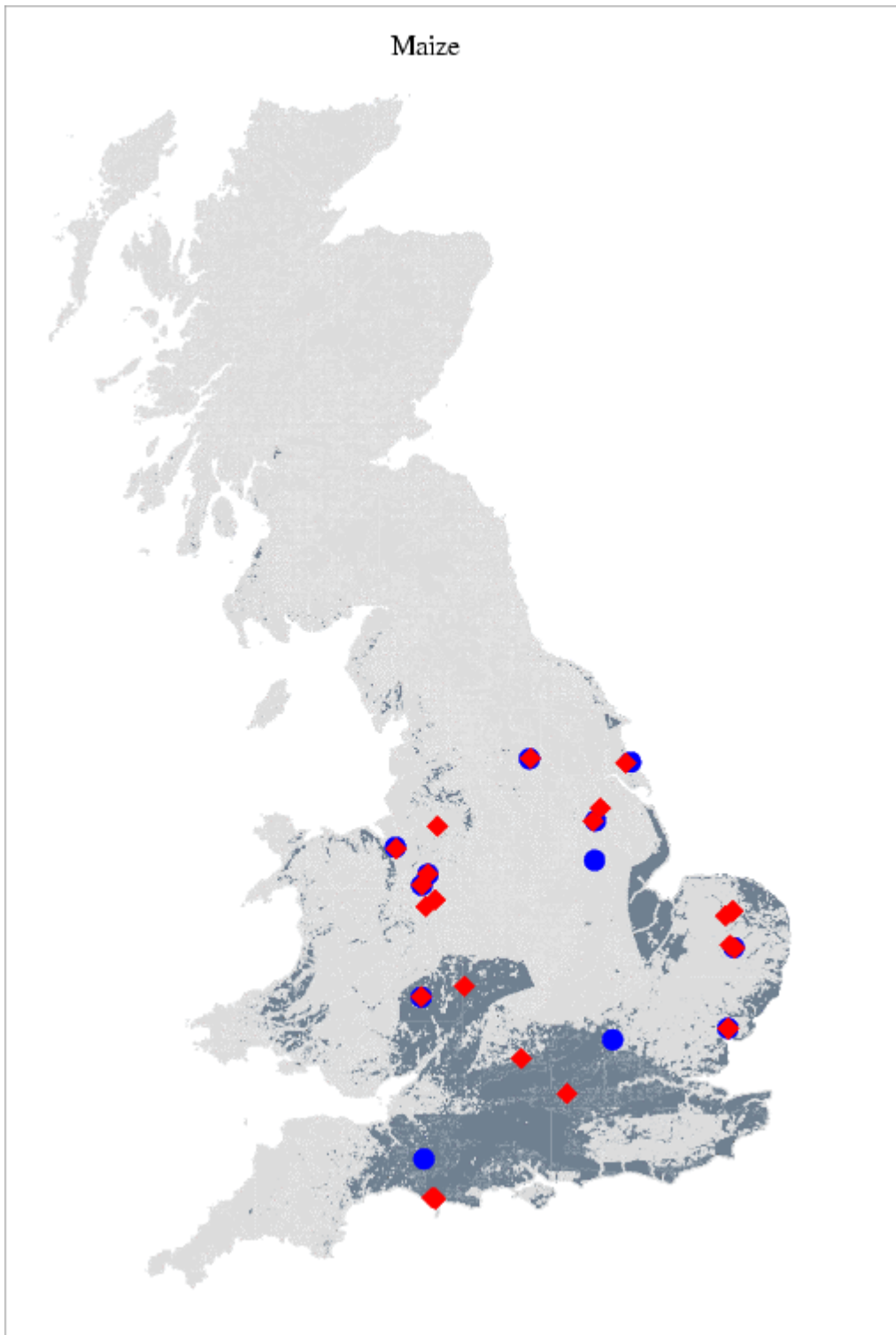


Fig. 3.3. *Distribution of maize sites in 2000 (blue circles) and 2001 (red diamonds). The shaded area corresponds to locations that are environmentally suitable for growing maize.*

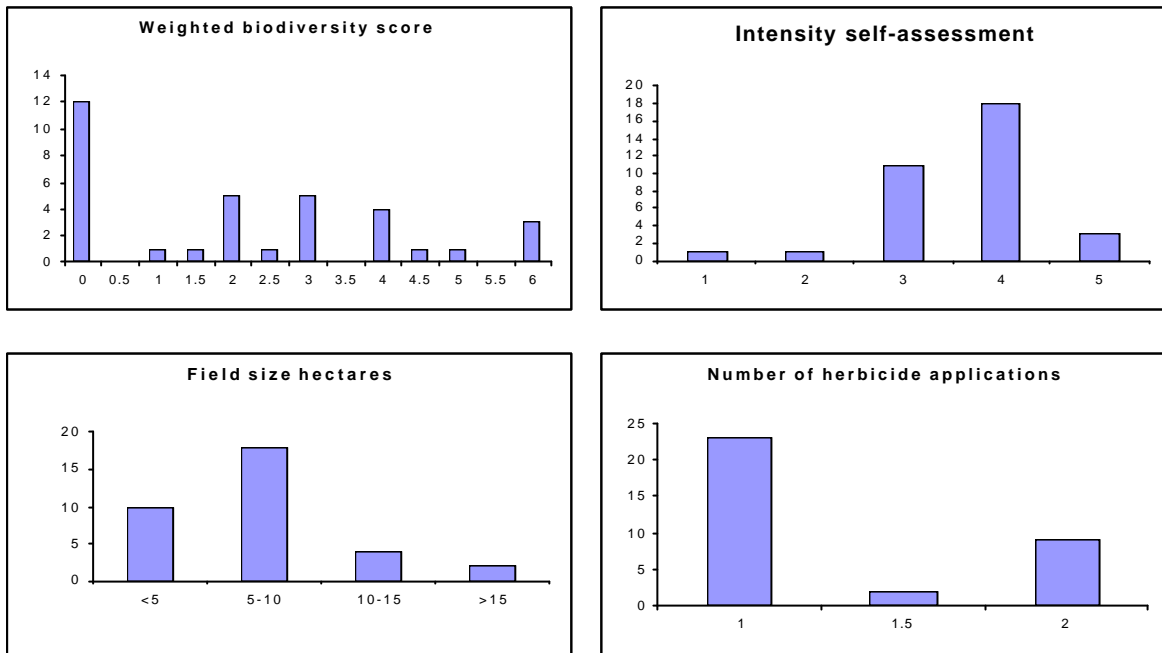


Fig. 3.4 Summary of characteristics of maize sites, 2000 – 01. The intensity score is a self-assessment by growers. Biodiversity scores are weighted, and include use of FWAG advisor, LEAF audit, Beetle banks, Conservation headlands, Wildflower Strips, Game cover and special management for game. All data provided by farmers during site selection procedure.

In general there has been a good spread of scores for “biodiversity indicators”. These are management practices that are considered most likely to improve the quality and abundance of wildlife (see Fig. 3.3). As expected there is a large number of zero values but over half the farms include some environmentally managed enhancement of biodiversity. As expected the subjective estimate made by the growers of how “intense” (in terms of inputs, general practice) the management of their whole farm was most frequently 3-4 and indicates average management of crop growing farms, typical of commercial agriculture. Field sizes on which crops are grown vary widely. The Maize Growers Association has estimated that the average maize field size is around 4 ha⁻¹. However, actual sizes vary depending on geographic location. In general the Eastern counties have larger fields, around 7 ha⁻¹, and in the west of the country fields tend to be smaller at about 3 ha⁻¹. Fields in the trial were on average 7.3 ha⁻¹ slightly above the estimated average (mean field size 2000 = 6.6 hectares, 2001 = 8 hectares), but this helped ensure that each half was large enough to be representative of a normal crop.

Recommendations for future site selection

Selected sites must be well in excess of 26 since the number of selected sites should allow for some losses, we suggest that 33-40 sites would allow for this. It is important that efforts are made to increase the numbers of growers new to the trial in the last year to ensure a wider variety of types of farms and farm managements. The proportion of sites that include some form of farmland wildlife enhancement should be maintained or even increased.

3.4 Beet

A total of 50 beet sites have been surveyed to date. These have been very well distributed, showing a tendency to over-sample the more outlying areas of beet cropping, as is intended (Table 3.3, Fig. 3.5).

Table 3.3 Geographical distribution of beet per DEFRA area in each year compared with MAFF and Scottish Office statistics (MAFF June 2000 Census, data for Wales unavailable, Scottish Office report for 1999)

(a) Fodder beet

DEFRA Region	Area grown (% UK) 2000	Fodder beet sites 2000	%	Fodder beet sites 2001	%	Fodder beet sites all yrs	%
Scotland	0	0	0	0	0	0	0
Wales	n/a	0	0	0	0	0	0
Northern	21	3	33	5	50	8	42
Midlands & Western	32	2	22	1	10	3	16
Eastern Region	12	3	33	2	20	5	26
South East	7	0	0	0	0	0	0
South West	24	1	11	2	20	3	16
Total no. sites	96	9	99	10	100	19	100

(b) Sugar beet

DEFRA Region	Area grown (% UK) 2000	Sugar beet sites 2000	%	Sugar beet sites 2001	%	Sugar beet sites all yrs	%
Scotland	0	0	0	0	0	0	0
Wales	0	0	0	0	0	0	0
Northern	13	1	7	0	0	1	3
Midlands & Western	14	3	20	4	25	7	23
Eastern Region	72	11	73	12	75	23	74
South East	0	0	0	0	0	0	0
South West	0	0	0	0	0	0	0
Total no. sites	99	15	100	16	100	31	100

(c) All beet

DEFRA Region	Area grown (% UK) 2000	Beet sites 2000	%	Beet sites 2001	%	Beet sites all yrs	%
Scotland	0	0	0	0	0	0	0
Wales	n/a	0	0	0	0	0	0
Northern	13	4	17	5	19	9	18
Midlands & Western	16	5	21	5	19	10	20
Eastern Region	68	14	58	14	53	28	56
South East	1	0	0	0	0	0	0
South West	2	1	4	2	8	3	6
Total no. sites	100	24	100	26	99	50	100

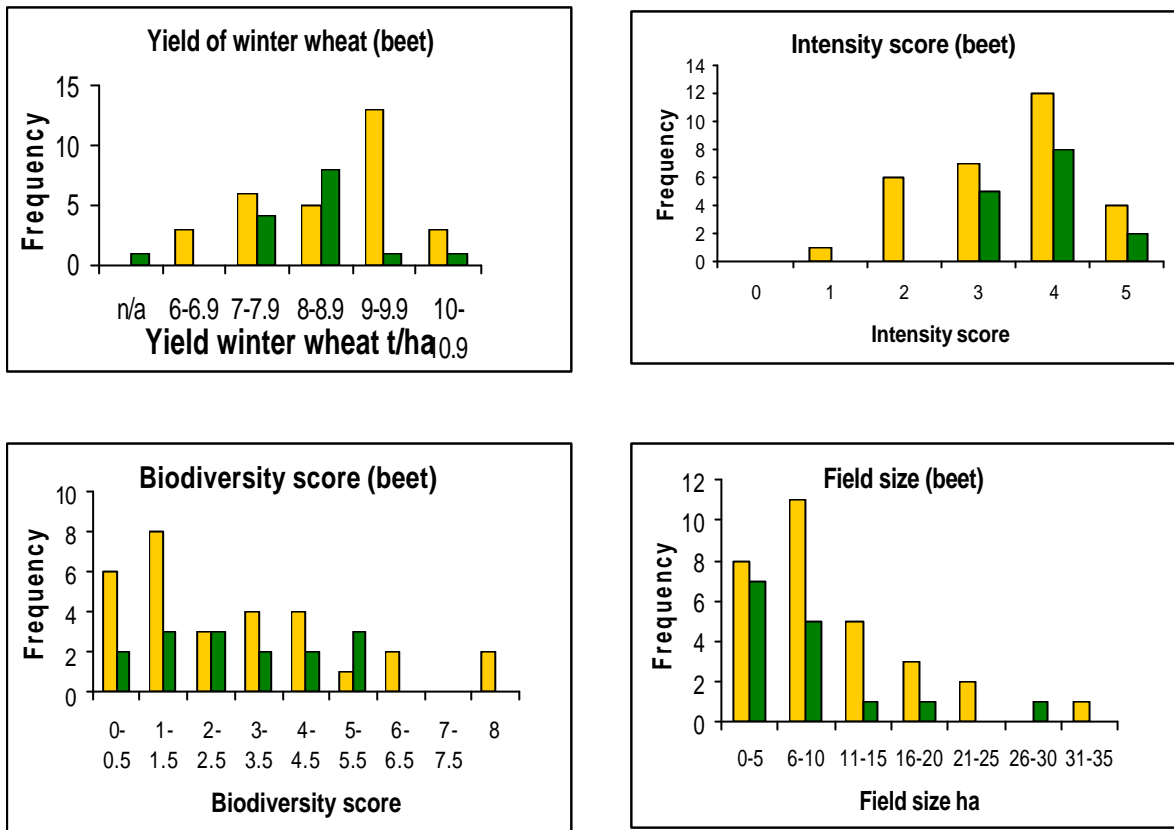


Fig. 3.6 Summary of characteristics of sugar (light) and fodder (dark) beet sites, 2000 – 01. Biodiversity scores are weighted, and include use of FWAG advisor, LEAF audit, Beetle banks, Conservation headlands, Wildflower Strips, Game cover and special management for game. All data provided by farmers during site selection procedure.

The farm characteristics also seem to be well distributed (Fig. 3.6). We therefore conclude that around 15-20 beet crops, distributed more or less as the previous sites, will be appropriate to complete this study.

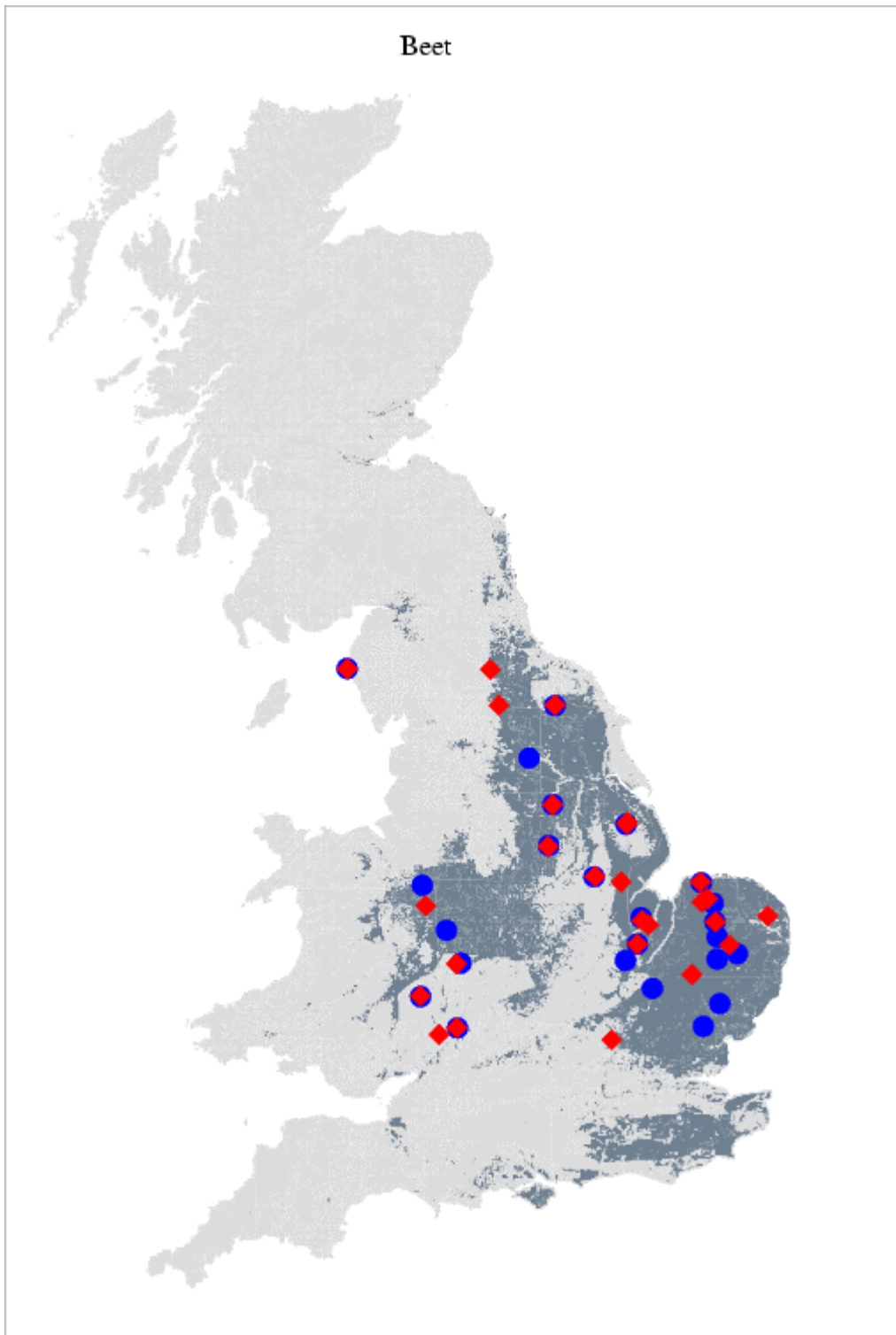


Fig. 3.5. *Distribution of beet sites in 2000 (blue circles) and 2001 (red diamonds). The shaded area corresponds to locations that are environmentally suitable for growing beet.*

3.5 Winter oil seed rape

In the first year of the winter rape study, 25 sites were selected, and 21 sites were taken to harvest. A further 30 sites have been selected for 2001-02. Taken together, these sites give a good geographical spread of sites, although more sites would be welcomed in the Scottish

border area and in south east England (Table 3.4, Fig. 3.7). The characteristics of the farms remain typically quite high yielding, with a range of biodiversity scores and typical levels of herbicide use (Fig. 3.8). This level of variation is appropriate for this crop.

We consider that selection is proceeding well, although this needs to be reviewed should there be site withdrawals over winter. We suggest that between 17 and 24 sites would be appropriate for 2002.

Table 3.4 *Geographical distribution of winter oilseed rape per DEFRA region in each year compared with MAFF totals for all oilseed rape (MAFF & Scottish Office 1999)*

DEFRA Region	Area grown (% UK) 1997	WR Sites 2000	%	WR Sites 2001	%	WR Sites, all yrs	%
Scotland	13	4	19	4	13	8	16
Wales	1	0	0	0	0	0	0
Northern	17	0	0	5	17	5	10
Midlands & Western	14	6	29	8	27	14	27
Eastern Region	32	10	48	9	30	19	37
South East	16	0	0	2	7	2	4
South West	7	1	5	2	7	3	6
Total no. sites		21		30		51	

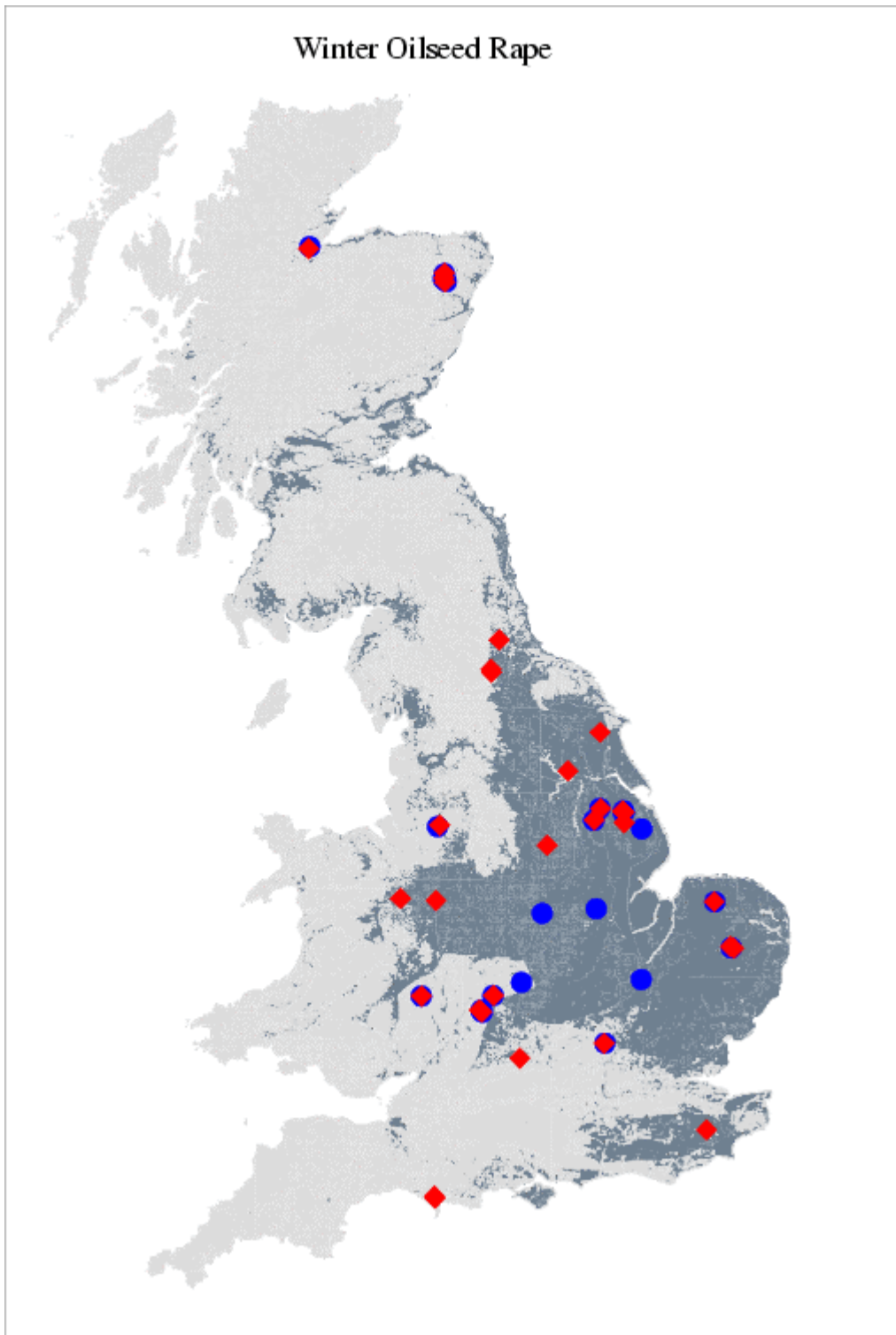


Fig. 3.7. *Distribution of winter oil seed rape sites in 2000 (blue circles) and 2001 (red diamonds). The shaded area corresponds to locations that are environmentally suitable for growing oil seed rape.*

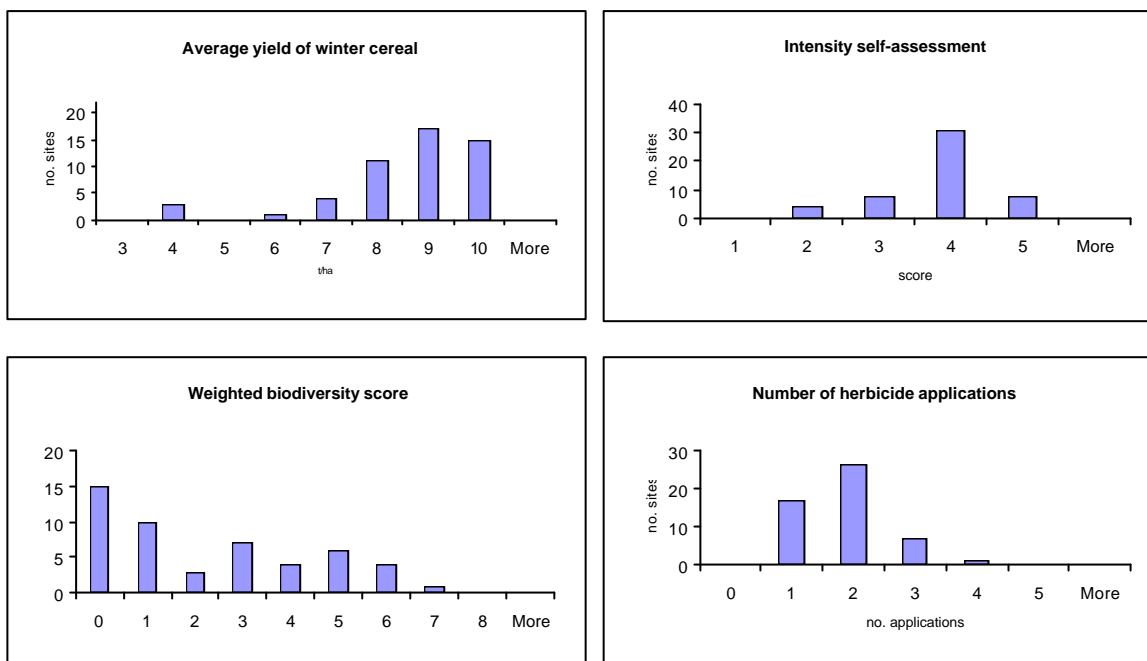


Fig. 3.8 Summary of characteristics of winter oil seed rape sites, 2000 – 01. Biodiversity scores are weighted, and include use of FWAG advisor, LEAF audit, Beetle banks, Conservation headlands, Wildflower Strips, Game cover and special management for game. All data provided by farmers during site selection procedure.

3.6 The issue of the overall pool of farms within the study

The FSE programme included 180 study sites in mid-September 2001. However, these were being grown by only 75 farmers. Should these same farmers contribute a high proportion of sites during 2002, there is a concern that the study may become too dependent upon a relatively small base of farmers, perhaps reducing the range of variation of farm management included within the study.

This issue is a complex one. We welcome the continued involvement of individual farmers with the FSE project, and we are most grateful for their support. We are also very aware that many farmers run a wide variety of sites; for example, ADAS has contributed fields at three farms at very distinct locations, and that we should consider sites at separate management units, rather than having the same point of contact. Nevertheless, we would like to be able to select from as wide as possible range of farms for 2002, and would like around half or so of the sites to be managed at farms new to the studies.

3.7 The issue of timing the selection process

The possibility of increasing the period for consultation to six weeks before sowing means that we need to consider the timing of the site selection process. Discussions are underway between SCIMAC and DEFRA on this issue, but in order to meet the deadlines, we may require site details to be delivered by the end of December (spring oil seed rape, beet), end of January (maize) and mid-May (winter oil seed rape).

3.8 Summary recommendations

In summary then, we recommend that site selection for 2002 should be along the following lines:

- 25-30 spring oil seed rape sites, with increased numbers in Scotland and in south-east and the far north of England
- 15-20 beet crops
- 33-40 maize crops, with greater representation in the south-west
- 17-24 winter oil seed rape sites, with more concentration in southern Scotland and the south-east of England (assuming little change in site numbers of the current crop)
- A large pool of sites from SCIMAC, including substantial numbers of farms new to the studies
- The pool may need to be delivered to the Consortium by the end of December (spring oil seed rape, beet); end of January (maize) and mid-May (winter oil seed rape).

4 PUBLICATIONS AND PUBLIC RELATIONS

4.1 Publications during the period February - September 2001

The new publications in the reporting period were

Firbank, L.G. (2001).

The Farm Scale Evaluations of Genetically Modified Crops: the story so far
Pesticide Outlook **12** 116-117.

Perry, J.N. (2001).

Genetically Modified Crops. pp. 22-91 in: *Genetic Engineering, Volume XV in the 'Christ and the Cosmos' series*. Edited by Brenda Beamond. Proceedings of the Consultation held in London Colney, 20-22 April 2001. ISBN 0953036057.

The following papers have been submitted to the Journal of Applied Ecology and are now in review:

L.G. Firbank, D. Brooks, G. Champion, A. Haughton, C. Hawes, M. Heard, R.J. Scott, A. Dewar, M.O. Hill, M. May, J.N. Perry, P. Rothery, G.R. Squire, I.P. Woiwod, D. Bohan, R.E. Daniels, J.L. Osborne, D. Roy and H.I.J. Black

The Farm Scale Evaluations of genetically modified herbicide tolerant crops – an overview

J.N. Perry, P. Rothery, S.J. Clarke

Design, analysis and power of the Farm-Scale Evaluations of Genetically-Modified Herbicide-Tolerant crops

M. S. Heard, C. Hawes, M. O. Hill, D. B. Roy, P. Rothery and G. R. Squire

Sampling vegetation and seeds in the Farm Scale Evaluations of genetically modified herbicide-tolerant crops

I.P. Woiwod, A.M. Dewar, A.J. Haughton, D.A. Bohan, D.R. Brooks, C. Hawes, M.S. Heard, J.L. Osborne, D.B. Roy.

Sampling invertebrates in the Farm-Scale Evaluations of genetically modified herbicide-tolerant crops.

4.2 Major presentations, 2001

L. G. Firbank

Farm scale evaluations of GM crops. University of Essex, 1 Feb 2001

Farm scale evaluations of GM crops. Centre for Population Biology, 7 June 2001

Farm scale evaluations of GM crops. NERI (Denmark) 27 June 2001.

Assessing harm to biodiversity in agricultural ecosystems. ESF meeting, *Risk Assessment Methods For GM Plants – Current Trends And New Developments*. Ceske Budejovice, 13-15 September 2001

J.N. Perry

Design and Analysis issues of trials of Genetically Modified Crops. Mathematics Department, University of Glasgow, 31 January 2001.

4.3 Scientific collaborations

There was an exchange of visits between Les Firbank and leading staff of the Danish experiments looking at impacts of biodiversity of GM herbicide tolerant beet crops. Beate Strandberg and Marianne Bruus Pedersen lead this work, and they are based at the National Environmental Research Institute at Silkeborg.

4.4 Policy issues

The project co-ordinator gave evidence to the “Strategic decision-making” subgroup of the Agriculture and Environment Biotechnology Commission (AEBC) on 6 February 2001 in Norwich. The transcript of this evidence can be seen on <http://www.aebc.gov.uk/aebc/norwich.pdf>

This evidence contributed to the AEBC’s report “Crops on Trial”, that can be seen on <http://www.aebc.gov.uk/aebc/publications/crops.pdf>

We consider that the report is highly supportive of the FSE programme and its underpinning science. The report recommends that that the FSE programme should be completed. There are caveats, but these relate to the consultation and communication process on the one hand, and the eventual policy response to the project on the other. The report notes the limitations of what is being undertaken within the FSE programme; we have always tried to clarify these within this series of interim reports and within our presentations to the public and to scientific colleagues. We also agree with the need for additional information on impacts of changing agriculture on biodiversity to help contextualise the findings of the FSE programme, and we welcome the Commission’s recognition of the potential value of the FSE methodologies in the more general assessment of the environmental impacts of agriculture. The report recognises the potential complexity of interpreting the FSE findings

5 THE FUTURE PROGRAMME

5.1 Progress towards completion

In general terms, the project is on timetable, with a slight slippage remaining on invertebrate sorting and hence on data entry.

5.2 Objectives for the period October 2001 – September 2002

The following major tasks are scheduled for the next period of the project (nb the timetable overlaps with the previous report, and so some tasks also overlap)

- Undertake the remaining planned rounds of site selection
- Complete field work for all spring-sown crops and for the 2001-02 round of winter oil seed rape, except for follow-up studies of weed seedbank and seedlings
- Begin field sampling for the final round of winter oil seed rape
- Complete entry and validation of all data collected prior to May 2002
- Have in place a programme of sample sorting, data entry and validation to deliver a finalised database for the spring sown crops by the end of November 2002
- To have completed draft analyses using data from 2000-2001
- To have developed working documents that will form the basis of the final reports of spring sown crops.

The major difference to the 2002 field programme compared with previous seasons is the degree of planning and staffing that is required to reduce the time between data collection and validated data entry. This is a particular problem for invertebrate samples; as so far in the project, much of the invertebrate sorting work has taken place after the field season has been completed, to make more efficient work of the entomology staff, but the invertebrate sorting will have to be undertaken during the field season in order to report on schedule.

5.3 Planning for publication of the final report

In the previous report, we suggested a possible structure for the final report, while this has changed in detail, we still consider that the spring-sown crops should be reported together, in a series of papers, each cutting across the three crops. We note that some of the data, notably the final round of seedbank counts and data from following crops in 2002, will not be available if the final report is to be submitted in the winter 2002-3 as timetabled. It is proposed to publish the papers in a special issue of the *Journal of Applied Ecology*, and discussions have started with the Journal editors about how this process would work.

Our proposed structure is intended to act as a basis for development; as analysis and interpretation develops, it is likely to change; in particular, some of the papers are likely to be subdivided. Moreover, the Consortium is seeking additional funds to develop the modelling aspects of the research, and the interpretation of the results with respect to farmland birds; should this work go ahead, our recommended structure may well be changed. Currently, though, it is as follows, and we expand the possible contents of one of the papers to give a flavour of the scope that these papers would cover.

Introduction

This will remind the reader of the background to the project, and the overall aims, objectives and designs. It would also give the full list of acknowledgements.

Site selection and sample characteristics

This will review the site selection process, provide evidence that the site selection has been appropriate to the study, and put the sites into the wider context of British farming.

Crop management

This will review the ways the crops have been managed and seek to identify patterns and syndromes of crop management among the farmers.

Seedbanks

This paper will review the effects of GM and conventional crops on the weed seedbanks.

Weed population dynamics

This paper will study the dynamics of the non-crop plants within the fields within and between season, contrasting GM and non-GM crops.

Gastropods and ground-dwelling arthropods within fields

This paper will study carabids, gastropods and other ground-dwelling species, contrasting GM and non-GM crops, and determining those factors that influence species composition and abundance.

Invertebrates on vegetation within the fields

This paper will study arthropods on vegetation within the fields, contrasting GM and non-GM crops, and determining those factors that influence species composition and abundance.

Invertebrates and vegetation of field margin

This paper will seek differences in field margin biodiversity (including bees and butterflies) due to crop management. It will also investigate the degree of interaction between species within the field and those in the boundary, and interactions between boundary vegetation and invertebrates.

Measures of biodiversity on GM and comparable non-GM crops

This paper will look specifically at measures of diversity and how they are influenced by crop management and other factors.

Integrated assessment of the ecological impacts of managing GM crops

This paper will draw together the findings on short and medium effects of GMHT cropping to make an overall assessment. The paper will also seek to evaluate potential effects of GMHT cropping on food resources for farmland birds, and how they may be influenced under difference scenarios of GMHT cropping. The paper will provide conclusions and recommendations concerning the commercialisation of GMHT crops.

To give a flavour of the possible contents of the papers, a plan of the weed population dynamics paper could be along the following lines:

Seasonal dynamics of non-crop plants subjected to contrasting herbicide regimes in the Farm Scale Evaluations

Introduction

Brief. Mainly covered already in methods paper. Present main questions of study.

Sites, crops and methods

Mostly covered elsewhere and in methods paper.

Results

Composition and abundance of the weed flora

climate and soil effects

crop species effects

management effects, especially previous crop and time of sowing

Treatment effects on emerged plants

Seedling germination (effects of pre-emergence herbicides)

Mezzanine weed counts (effects of conventional herbicide)

Post-herbicide weed counts (effects of two treatments)

Final weed counts (survival and germination of new individuals)

Biomass at final count (quantity of material)

Weed counts in subsequent crops

Effects on seed production

Factors affecting the response

management factors (time of sowing, previous crop, cover of crop)

crop species

weed species

years

distance from field margin

link with field margin species pool [link discussion to field edge paper]

Factors affecting weed diversity

relation between diversity and abundance

grasses in relation to broadleaved weeds

Discussion and conclusions

Differences and similarities of crops

Availability of weeds to animal consumers through the season

Factors resulting in high weed abundance and high production of weed seed

Seedling densities in relation to seed bank [link to seed bank paper]

Seed production in relation to life cycle of crops and subsequent weed densities [link to seed bank paper]

6 PUBLICATIONS TO DATE:

6.1 Refereed Journals

Firbank, L.G., Dewar, A.M., Hill, M.O., May, M.J., Perry, J.N., Rothery, P., Squire, G. & Woiwod, I.P. (1999). Farm scale evaluation of GM crops explained. *Nature*, 339, 727-728.

Firbank, L.G. & Forcella, F. (2000). Genetically modified crops and farmland biodiversity. *Science*, 289 1481-1482.

6.2 Other publications

Firbank, L.G. (2000) Science meets policy: farm scale evaluations of genetically modified crops. *NERC News, Spring 2000*, pp 10-11.

Firbank, L.G. (2001).

The Farm Scale Evaluations of Genetically Modified Crops: the story so far
Pesticide Outlook **12** 116-117.

Perry, J.N. (2001).

Genetically Modified Crops. pp. 22-91 in: *Genetic Engineering, Volume XV in the 'Christ and the Cosmos' series*. Edited by Brenda Beamond. Proceedings of the Consultation held in London Colney, 20-22 April 2001. ISBN 0953036057.

Schuler, T. H., Poppy, G. M., Woiwod, I. P. & Denholm, I. (2000) Impacts of GM plants on non-target arthropod fauna. In *WHO Seminar " release of Genetically Modified Organisms in the Environment: is it a health Hazard"*. Rome, Italy, 7-9 September 2000: <http://www.who.it/Emissues/GMO/gmos.htm>

Woiwod, I., Dewar, A., Hawes, C. & Heard, M. (2000a) Farm-scale trials for studying the effects of GM herbicide-tolerant crops on farmland biodiversity in the UK. *Antenna* 24, 66-68.

Woiwod, I. P., Dewar, A. M., Haughton, A., Hawes, C. & Heard, M. (2000b) UK field-scale trials of GM herbicide tolerant crops to detect the environmental effects on invertebrate abundance and biodiversity. In *XXI International Congress of Entomology*, vol. 1 (ed. D. L. Gazzoni), pp. 314. Foz do Iguassu, Brazil: Embrapa.