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Review of HGCA-funded weed research (including LINK projects) 1994-2005

by

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CONTENTS

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INTRODUCTION

This review loosely follows the style of ***Theme Review: Weeds*[1]*,*** produced in collaboration with Jim Orson, which was published by HGCA and distributed via 'Crops' in 1994.

The 1994 review was written to inform farmers on research findings. This review has been prepared mainly to assist the commissioning of new projects. It does not particularly aim to help farmers, and has not been subjected to widespread scrutiny. It reviews relevant reports published from 1994, as well as ongoing projects. Only projects funded wholly or partly by HGCA are covered, so Defra LINK and commercially co-sponsored projects are included. It does not cover Defra, SEERAD and DARD-funded weed research, although HGCA aims to integrate its R&D with such work. The agro-chemical manufacturers carry mainly-herbicide related work which is also relevant to levy payers.

This review is mainly based on project findings reported in Project Reports and Research Reviews but also summarised in Topic Sheets and HGCA guides. Much valuable information has also been presented at HGCA conferences (for example there are three relevant papers in the 2006 conference at Belton Woods on resistance, rotations and SAFFIE), roadshows and in the press, to which specific reference is not made.

The past decade has been a challenging one for weed control. Farmers have had to cope with many new restrictions on herbicide use, fewer active ingredients and increasing levels of herbicide resistance, whilst profit margins have become ever tighter. Both numbers of farmers and of researchers have probably halved, and Long Ashton Research Station, together with research facilities at ADAS Drayton and Bridgets, which made significant contributions to weed research have closed. The agro-chemical industry has also contracted considerably, with fewer new active ingredients being produced by an industry increasingly based outside the UK and focused on non-UK crops. Some herbicide use on minor crops, including rye, triticale, linseed and soya is now only allowed if SOLAs (Specific Off-Label Approvals) have been granted for the appropriate crop/herbicide combinations.

CEREALS

1. Brome

HGCA funded six projects (1998-1992) coordinated by Jim Orson, ADAS on the incidence of dormancy and control of volunteer cereals and brome grass species in cereals. Most of the work was on *Anisantha (*formerly *Bromus) sterilis* (barren brome), commonly found on crop headlands while *A. commutatus* (meadow brome) and *A. hordaceus* (soft brome) frequently infest continuous winter wheat crops. Problems with barren brome are greatest in winter cereals grown after a dry late summer / early autumn, when shed seed in enforced into dormancy. Projects covered: a survey of the quality of UK wheat and barley for brome contamination; effects of cultivations, herbicide and soil type; volunteer cereal and brome grass control in cereals; and two studies on dormancy and seed survival in soil[2].

A further three projects led by Jim Orson and Alister Blair, ADAS, and Nick Peters, Long Ashton (1991-1994) investigated factors affecting cultural and chemical control of brome species in winter cereals. Factors studied included effects of: straw, soil type and soil moisture content on seed dormancy; cutting or glyphosate on seed set; soil conditions on herbicide activity; and different cultivation methods on brome control[3].

Topic Sheet 17 summarised the findings of work on brome for farmers. With all bromes, fields should ideally be ploughed to bury seed to at least 15cm; spring cropping and delayed drilling also can play a useful part in control. Shallow stubble cultivation immediately after harvest encourages barren brome seeds to germinate. Recommended herbicide sequences were based on tri-allate (Avadex) – applied pre-weed emergence followed by isoproturon, with or without cyanazine (Fortrol)[4]. The availability of these herbicides is under constant review. Cyanazine is no longer available for use on cereals and oilseed rape.

2. Black-grass (also other species where relevant)

A project on herbicide resistance in black-grass, which now covers all of England, was carried out by Stephen Moss, Rothamsted Research and James Clarke and Lynn Tatnell, ADAS (1991-1994). They tracked the spread of resistance, investigated its genetic control, assessed effects of soil and weather on herbicide efficacy, developed resistance tests and assessed various strategies, including cultural ones, for control[5].

Two projects (1996-2000) led by Andy Cobb, then at Nottingham Trent University, in collaboration with Novartis, tested a new method of assessing resistance level for black-grass with ‘enhanced metabolism’ or partial resistance. The study focused on the enzyme GST (glutathione S-transferase). Enhanced levels of enzyme activity were demonstrated in resistant biotypes, including the one from Peldon. An ELISA test was developed using monoclonal antisera raised against the Peldon polypeptide. To date the test has not been used[6] because resistance based on GST activity is not the only cause of enhanced metabolism.

Topic Sheet 22 summarised findings and messages to 1999 on herbicide-resistant black-grass (also wild-oats and rye-grass), with a major focus on preventing resistance. Populations may have ‘target site’ or complete resistance to ‘fop’ and ‘dim’ herbicides which, in most cases, has arisen independently on individual farms where intensive herbicide programmes heavily reliant on their mode of action have been used over several years. The correct balance of cultivations, herbicides (mixtures or sequences) and cultural control is important. The Topic Sheet drew attention to the ‘Rothamsted Rapid Resistance Test’, a quick test developed at Rothamsted, and available through ADAS Boxworth, Rothamsted Research, Oxford Plant Sciences and GrowScience[7].

A bioassay for herbicide resistance previously developed for use with weeds of rice was tested with herbicide-resistant black-grass, wild oats and rye-grass in a project led by

John Caseley and Stephen Moss (1999-2001). Soil was washed from the root systems of seedlings or rooted tillers. Roots and shoots were then trimmed to 5cm prior to immersion in a range of herbicide doses. Dose-response curves were produced based on length and fresh weight of new shoot growth. The bioassay discriminated between resistant-R and susceptible-S biotypes over a range of herbicide doses with all three species. Fresh weight provided the most accurate measure and the test was suitable for use until nodes are detectable on the weed. Again it has not been used in practice, possibly because the test is technically more complex than the Rothamsted Resistance test[8].

Lynn Tatnell, ADAS leads a new four-year LINK project on grass weed resistance (2005-2009). The aim is to develop more sustainable and appropriate resistance management strategies in individual fields by knowing the incidence and mechanism(s) of resistance and quantifying the effectiveness of any mitigation strategies on the population dynamics of the target weed at a local level[9].

HGCA has supported publication of guidelines by the Weed Resistance Action Group (WRAG) and over the past 12 years has contributed to 1993, 1997 and most recently, 2003 revisions. Dr Moss is current Secretary and James Clarke Chairman of WRAG, which is active in technology transfer and a valuable link between the independent research sector, Defra PSD and commercial companies[10]. In October 2005, WRAG submitted a document to PSD to defend the use of trifluralin (being considered for Annex 1 listing) in cereal weed control because of its valuable role in resistance management.

3. Wild-oats

Resistance in wild-oats is not as common and arose more recently than resistance in black-grass, but is now widespread. Stephen Moss and James Clarke led a major collaborative project (1995-2001) involving Aventis (now Bayer), Cyanamid (now BASF), Monsanto, Novartis and Zeneca (both now Syngenta). This investigated distribution, types of resistance, and control strategies to reduce the risk of selecting for herbicide resistance. Some populations with 'target site' resistance, were only resistant to 'fops' but not to 'dims' or to any other herbicide group; other 'fop'-resistant populations, with 'enhanced metabolism' resistance, were also resistant to the 'dim' tralkoxydim and to other herbicides. No resistance was found to tri-allate (Avadex), IPU or cycloxydim (Laser)[11].

Topic Sheet 46 summarised findings on wild-oats to 2001. It stressed the need for monitoring and identifying causes of poor activity. Testing is important and control options need to be tailored to resistance type. Correct timing is critical to maximise control of partially resistant wild-oats. Cultural means should be used wherever possible and control should never rely solely on 'fop' and 'dim' herbicides[12].

4. Italian rye-grass

Italian rye-grass is grown as a forage crop or for seed but has become an annual grass weed of intensive cereal rotations on many farms. It can spread on cultivation and harvesting machinery and occurs on some farms where rye-grass has never been grown.

Herbicide-resistance (both mechanisms) is increasing, particularly to 'fops' and 'dims'. A current three-year project (2002-2006), led by Ben Freer, TAG is examining strategies for sustainable control in winter wheat, based on testing effects of drilling date on rye-grass numbers, and seed-bed conditions and rainfall patterns on efficacy of different herbicide programmes, including sufonylureas. Peak emergence was in October and November. Weed emergence was reduced when drilling was delayed. Efficacy of some herbicides was more affected by weed size, soil moisture and rainfall than others[13].

A PhD CASE student in collaboration with Syngenta and supervised by Stephen Moss starts in January 2006 on a project to understand and combat the threat posed by rye-grass as a weed of arable crops[14].

5. Competition studies

George Cussans, Long Ashton Research station led a five year project (1987-1992) in collaboration with SAC and Queen's University, Belfast. Aims included assessing the competitiveness of a range of weed species, calculation of treatment 'thresholds' based on 'Crop Equivalent' (CE) values and testing herbicides at full and half rates. The most competitive weeds, e.g. cleavers and wild oats, have high CE values at low weed numbers, whereas less competitive weeds, e.g. field pansy and parsley piert, have low CE values even when weed numbers are high. Application of such principles usually involves greater management input and accepting some degree of risk to grain contamination, yield, weed levels in current crops and soil seed burdens in future crops. Soil seedbank studies provided information on the long-term behaviour of weeds. Many of the ideas developed in this project have been used in subsequent projects, such as the Weed Management Support System (WMSS)[15].

6. Patch spraying

Silsoe Research Institute developed in the 1990s a spatially selective 'patch sprayer' which uses the principle of injection metering to ensure specified herbicide doses in each nozzle in the early 1990s. HGCA co-funded two major LINK projects led by Paul Miller, Silsoe Research Institute and George Cussans and Peter Lutman, Rothamsted Research based on the prototype.

The first project (1993-1997) exploited the early stages of the satellite-based global positioning system (GPS) to locate weedy areas in fields, tested the use of the sprayer in cereals and assessed weed species for which it may be appropriate. These include black-grass, brome, wild-oats and thistles because patches of these species tend to occupy the same areas over several years and can be mapped visually in relation to tramlines or using GPS[16].

The second project (1998-2002) carried out in association with AGCO UK, Patchwork Technology and Micron sprayers aimed to commercially develop patch spraying and to test it more widely. GPS location technology was now more reliable. Weed mapping was based on visual techniques with most patches receiving full product rate through a dual boom, variable volume rate Micron sprayer, and with the non-patch areas receiving a lower rate or no treatment. Applications were generally successful. Estimated savings ranged from £6/ha to £20/ha[17].

The work to 1998 was summarised in a Topic Sheet[18]. As a result, more farmers started to 'patch spray' weed patches, either using a knapsack sprayer or by selectively turning the sprayer nozzles on and off for particular weed patches, so reducing the amount of herbicide applied and its environmental impact. Reluctance to devote time to creating weed maps and declining farm incomes have deterred potential users from investing in this technology.

8. Herbicide rate and water volume

Ken Davies and Simon Oxley, SAC led a short project (1997) investigating the effect of water quality on pesticide (including herbicide) efficacy in which water from three mains sources was used at reduced doses. Water quality influenced efficacy, depending on pesticide used. Isoproturon was less active on chickweed in deionised water, as also against black-grass. Results with metsulfuron methyl, imazamethabenz, bromoxynil/ioxynil and fenoxaprop-p-ethyl were less easy to interpret. Overall best herbicide efficacy was obtained with intermediate and hard waters[19].

Two projects up to 1997 led by Neil Fisher and Ken Davies, SAC respectively tested the use of reduced herbicide doses for broad-leaved weed control in cereals (1989-1992 and 1991-1994). Success in reducing doses was related to crop vigour, species, variety and growing conditions[20] [21].

Topic Sheet 2 reviewed findings on opportunities for reducing herbicide dose for broad-leaved weed control in winter cereals and concluded that there was considerable potential, especially in winter barley[22]. The practice of using reduced doses is now quite widespread and although there have been changes in herbicides available, the principles remain the same.

Jim Orson and Paul Miller collaborated in a project (2000-2003) to define target size for air induction nozzles, which produce relatively large droplets containing air inclusions. Pot and field trials over two years tested effects on a grass (black-grass) and a broad-leaved weed (common field speedwell). Droplet sizes differed with nozzle type and sprays were grouped as large, medium and small[23.]

HGCA published two 'nozzle selection chart' posters based on this and other work, which were distributed by 'Crops'. These covered the use of all nozzle types with conventional boom sprayers with cereals and oilseed rape using herbicides, as well as fungicides and insecticides. Air induction nozzles provide good drift control but with some risk to efficacy on small targets with foliar-acting herbicides. Risk can be reduced when using air-induction nozzles by choosing those that produce relatively small droplets and spraying grass weeds at the 2-3 leaf stage[24].

Paul Miller leads an ongoing LINK project on reduced application volumes for T2 fungicides and small grass weed herbicide application in association with Syngenta, Crop

Protection Association, Hypro EU Ltd, Billericay Farm services Ltd, Micron Sprayers Ltd and Cleanacres Machinery Ltd. Work started in November 2004 and lasts for 18 months. Experiments tested reducing application volume from 100l/ha to 37l/ha, use of conventional flans fan and air induction nozzles and effect of angling nozzles backwards. So far there have been no statistically significant effects[25].

HGCA also funded a student project to include nozzle selection in WMSS (see section 18). As a result of the work a module is incorporated within Weed Manager.

9. Cultural weed control

Jim Orson and Alister Blair, ADAS led a LINK project (1995-1998) in which crops were weeded mechanically, with or without the additional application of a low dose herbicide. Crops grown at different row spacings were weeded with a tined finger weeder, which did not discriminate between rows and the inter-row gaps. Row width did not improve crop safety or weed control achieved. The use of low doses (down to 20%) was successful with annual broad-leaved weeds (depending on species) but not with annual grasses[26].

Another LINK project (2002-2005) was led by Nick Tillet, Silsoe Research Institute, in association with Robydome. This tested a 'guided hoe' developed by Silsoe Research Institute, where 16cm wide rows were adopted. Computer-guided vision ensures that tines destroy weeds between rows and not the crop. Trials assessed its use for organic crops and also for conventional crops with band spraying of selective herbicide. The technique was effective but at present equipment cost is prohibitive[27].

A four-year LINK project (2001-2005) led by Sarah Cook, ADAS and involving J C Mann Trust, Monsanto, Simba, Velcourt and Syngenta as co-sponsors, explored the interactions of black-grass dormancy and cultivations. The aim was to generate and exploit information on black-grass ecology to reduce production costs of combinable crops by optimising cultivation strategy. The physiology of black-grass dormancy is being investigated in small plot studies while management and environmental effects are being studied in field plots in long and short-term sites. A dormancy test has been developed and is producing consistent results. Temperature during seed maturation was the major factor determining seed dormancy; moisture status was less important. Dormancy in black-grass was shown to be more important than previously thought. In years when there is greater dormancy, e.g. 2002 and 2004, the start of emergence was delayed by 6-8 weeks. In years of high dormancy, drilling after 20 October resulted in significantly lower black-grass populations in the crop. Where earlier drilling was necessary, ploughing always resulted in lower black-grass numbers than following discing. In contrast, in low dormancy years there were no significant differences between cultivation treatments. There was a consistent trend for lower black-grass numbers with discing, if cultivation took place immediately after drilling. Usually the lowest number of black-grass resulted from ploughing[28].

10. Organic production

Mike Carver, ARC led a project (1999-2002) on various aspects of organic cereal production, including varieties, seed rate and weed control using permitted products. One of the most effective weed control methods tested was comb harrowing – as a season-long operation, often beginning with hand-roguing the preceding crop. The use of stale seedbeds was also effective. Harrow roguing was most effective when soil and weather were fairly dry[29].

Debbie Sparkes led a project (2000-2003) at Nottingham University in which seven different two year stockless organic conversion regimes were compared and effects on the first organic wheat crop (the third year of trials) were measured. Lasting effects were noted, for example on soil and nitrogen levels, but also on weeds in following cereal crops[30].

This work is currently being continued by a Ph.D. student supervised by Debbie Sparkes in a project investigating the long term-impact of conversion strategies on organic crops[31].

OILSEEDS

11. Weed control in oilseed rape

Oilseed rape – a grower's guide, HGCA (2005) summarises weed management advice and HGCA-funded R&D on oilseed rape to early 2005[32].

Peter Lutman carried out an initial Research Review on weed control in oilseed rape in 1991. Weed control was uneconomic in many winter crops, although oilseed rape presents a good opportunity to control weeds, especially herbicide-resistant grass weeds (e.g. propyzamide, carbetamide) in cereals grown in the same rotation. Weed control is often unnecessary in spring oilseed rape unless establishment has been poor[33].

Peter Lutman then led a three year project (1991-1994) involving 17 trials at four sites on weed control in winter oilseed rape. Aims were to investigate: effects of broad-leaved weeds on yield, effects of crop vigour on weed competition and the possibility of predicting yield losses. Chickweed had a large effect on yield compared with scentless mayweed, which was not competitive. Cleavers caused substantial yield losses, even at low densities. Other weeds were ranked in multi-species trials. Crop vigour was very important in suppressing weeds, but density was not. Autumn nitrogen increased vigour of both crop and weed. Methods of predicting yield losses based on weed density, relative dry weights and visual assessment were compared, but were not developed for practical use, although much of the information is included in the rotational models of WMSS (section 18) and would be of great value in the development of a rape weed management DSS[34].

12. Oilseed rape as a weed

Peter Lutman led a three-year project (1994-1998) studying problems posed by shed oilseed rape seed and investigated seed persistence and dormancy in Petri-dish and field experiments. Aims included quantification of losses, physiological control of dormancy, effects of agronomic factors on persistence, and modeling of population dynamics of volunteers. Seed losses ranged very widely between years and may commonly be 5,000/m^2 up to 10,000/m^2. Seeds are not dormant when shed but can become dormant in the right conditions – primarily water stress and darkness. There were also variety differences, with Apex being particularly prone to dormancy. Persistence varied with soil conditions and was longest after dry harvests. Perhaps 10% of seed may survive for five years and 1% for ten years. The prediction model was based on limited data[35] but has subsequently been improved as longer-term persistence data has been collected.

The main messages for farmers are to grow varieties with limited persistence, lengthen rotations, especially if food and industrial varieties are grown, minimize shedding losses and leave soil uncultivated for as long as possible after harvest, preferably four weeks, before sowing the following crop[36].

13. Winter linseed

Following an initial rapid increase in area of winter linseed varieties in the mid-1990s, Simon Kightley, NIAB led a project (1995-1997) covering various aspects of crop agronomy, including weed control. Treatments included pre-drilling incorporated trifluralin and pre-emergence trifluralin, linuron, trifluralin+linuron and metazachlor decreased. All chemicals except linuron decreased weed populations. Pre-drilling incorporated trifluralin and pre-emergence metazachlor decreased linseed plant populations[37].

Dave Turley, ADAS led a project (1998-2001) on strategies for grass and broad-leaved weed control in collaboration with Dow Agriculture. Four studies evaluated effects of: grass weed competition and timing of weed removal on winter linseed yields; pre-emergence herbicide on sensitivity of grass weeds to post-emergence graminicide, pre-emergence herbicide on sensitivity of broad-leaved weeds to post-emergence herbicide; incorporation of trifluralin on weed control and over-winter survival of winter linseed. Trials were carried out on different sites and soil types with different weed flora. Effects on yield were measured as were yield responses required to justify herbicide application[38].

Topic Sheet 30 summarised findings (also on disease control) of the above two projects. Trifluralin, both incorporated and applied as a surface treatment, provided useful control of autumn grass weeds, but effects did not persist. In 60% of cases, trifluralin reduced broad-leaved weeds prior to spring herbicide application. Usually spring herbicides could be delayed to March without compromising yield. Relatively high doses of cycloxydim (Laser) were required to control brome and volunteer wheat. Application of metsulfuron-methyl (Ally) was easily justified in sequence with trifluralin, but bentazone (Basagran) was not[39].

Before the winter linseed project ended the area grown declined steeply and it seems unlikely to recover.

14. Spring linseed

Spring linseed is a poor competitor with crops, so weeds can significantly reduce yields. Peter Lutman, Rothamsted and Richard Overthrow, ARC assessed effects of three broad-leaved species and oats (as an example grass weed) on yield of linseed (1995-1997). Trials were carried out in three dry summers and in such water-stressed conditions weed competition was relatively low. Oats was the most competitive. Knotgrass was more competitive than fat-hen, while chickweed was the least competitive. Suggested treatment thresholds (plants/m^2) were: oats (14), knotgrass (5), fat-hen (6), chickweed (42)[40].

The area of spring linseed declined markedly after the project but it has recently increased again.

15. Soya

HGCA funded a project (2002-2004) led by Sarah Cook, ADAS to provide soya seed samples to generate residue data in support of an application for SOLA – Specific Off-Label Approval. Five herbicide treatments were evaluated. As a result of the project a SOLA was approved for fomesafen (Flex)[41].

ROTATIONS

16. Integrated systems

The IFS (Integrated Farming Systems) LINK project (1990s) led by Sue Ogilvy was a major field-scale comparison of 'integrated' and 'conventional' arable rotations over five years and six sites. All management aspects were considered, including weed control, and many measures of environmental impact were taken. Pesticide use was reduced across most crops (30% less cost, 18% less active ingredient) in IFS fields but differences in environmental impact of the two systems were generally small. IFS was as economically viable as the conventional system overall[42].

The main message highlighted by the project was the need to question the basis of all management decisions and crop inputs from both economic and environmental viewpoints. Aspects of management specific to weed control included targeted and selective herbicide use based on the use of thresholds and rotational weed control, but cannot be presented as an 'integrated blueprint'.

Results of the IFS project were summarised in Project Progress 1[43] and in Topic Sheet 32[44]. The Topic Sheet listed a number of approaches to weed control as part of an integrated system, including for example the use of stale seedbeds and of comb weeders in conjunction with low doses.

Arable cropping and the environment – a guide (2002) which became required reading for ACCS membership, presented messages from the IFS project as well as from several other MAFF and commercially-funded projects in more detail[45].

The SAFFIE (Sustainable Arable Farming For an Improved Environment) LINK project led by James Clarke and for some time by Sue Ogilvy, and now by Jeremy Wiltshire, is also a field-scale experiment with specific aims to enhance biodiversity and environment and maximise profitability. The use of widely-spaced rows to allow access to skylarks and of skylark 'patches' within the crop were tested. The latter were found to be most effective in increasing skylark breeding and are now part of Environmental Stewardship, with increased allocation of points. Other aims include favouring 'desirable' non-aggressive weeds and examining suitable species for uncropped margins[46].

A new project led by Jim Orson starting in 2006) aims to quantify the environmental benefits of enhancing management of non-cropped land on farms so that it delivers greater benefits to the farmed ecosystem. The proposed management strategies are based on a number of preceding LINK projects, such as 3-D farming[47].

A new LINK project (2004-2008) in collaboration with Advanta, Agrovista, Banks Cargill, BASF, Farmlink, RAGT, Unilever, and United Agri-Products and led by Rosemary Bayles, NIAB is examining a sustainable whole-farm approach to ergot control. The aims are to evaluate grass margins as a source of ergot infection for wheat crops. It may be possible to reduce risk by identifying low-risk grass species and margin management regimes, and to identify wheat varieties with resistance to ergot. Findings could possibly have implications for grass weed management, notably of black-grass, couch and hybrid fescue[48].

17. Rotational management of GMHT crops

The rotational implications of the production of GMHT and conventional oilseed rape and sugar beet in four-year rotations were studied in the BRIGHT project (LINK) led by Jeremy Sweet, NIAB and Peter Lutman, Rothamsted Research. Herbicide-resistant GM oilseed rape (glyphosate or glufosinate) and non-GM imidazolinone-resistant rape were grown in comparison to conventional rape in different rotations including cereals, sugar beet and set-aside. GM varieties and/or herbicides were provided by BASF, Bayer and Monsanto. Weed control in GMHT oilseed rape was equivalent or slightly better then that on the conventional treatment. The weed control regimes used to control GM herbicide-resistant oilseed rape in cereals were effective and flexible and overall the impact of the HT crops was no worse from a biodiversity perspective than conventional weed control[49]. The project also included further studies on volunteer rape persistence (see references 34 and 35). The project provides a good basis for management advice for commercial HT crops - assuming in the future that such crops are grown in the UK.

18. Weed management – improving decisions

Agronomic decisions made in one crop, e.g. establishment method or herbicide used, often have an impact, not only on weed control in that crop, but also on following crops. These effects are being studied in the LINK WMSS (Weed Management Support System) project initially led by James Clarke, and then by Lynn Tatnell, ADAS. Co-funders were Bayer, BASF, Dow, DuPont and Syngenta. A computer program has been developed that aims to help farmers plan cost-effective weed control within a single season (for winter wheat only) and over the course of a rotation[50]. This project has utilized much of the biological data on weeds generated in previous projects on weed competition, population dynamics and herbicide resistance and is a component of the overall DSS project, Arable DS. A CD is now available via www.wmss.net and the final report will be published in January 2006.

19. Cereals and oilseed rape for biofuel

Dave Turley, CSL reviewed the environmental impact of growing wheat and oilseed rape for food use and for biofuel and considered the impact of all inputs, including herbicides in 2005. No savings were identified in herbicide costs on either crop[51]. A summary document of the review's findings was published[52].

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