HGCA

RESEARCH REVIEW No. OS8

ESTABLISHMENT OF OILSEED RAPE IN THE PRESENCE OF CEREAL STRAW

OCTOBER 1990

Price FREE

HGCA OILSEEDS RESEARCH REVIEW

ESTABLISHMENT OF OILSEED RAPE IN THE PRESENCE OF CEREAL STRAW

by

P BOWERMAN, R DARBY and B DAVIES.

OCTOBER 1990

CONTENTS

ESTABLISHMENT OF OILSEED RAPE IN THE PRESENCE OF CEREAL STRAW

PAUL BOWERMAN

Agricultural Development and Advisory Service, Boxworth Experimental Husbandry Farm, Boxworth Cambridge CB3 8NN.

With Contributions from
RICHARD DARBY,
Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Herts. AL5 2JQ.

and

BRYAN DAVIES,
Soil Science Department, Agricultural Development and Advisory Service, Brooklands Avenue, Cambridge CB2 2DR.

ABSTRACT

A ban on straw and stubble burning is proposed by the Government to come into effect after the 1992 harvest.

There is a need to develop more suitable techniques for establishing rape in the presence of chopped straw, particularly after wheat on the heavier soils. The short interval between wheat harvest and rape sowing precludes the use of all except shallow cultivations on most of these soils. Light loams present few problems following ploughing. Medium loams are more suited than clays to ploughing before rape but the better option in dry conditions is often cultivation rather than ploughing.

Techniques of establishing oilseed rape by broadcasting seed into the standing cereal crop were investigated at Boxworth (clay) and at Rothamsted (silty clay loam with flint) in harvest years 1986-89. In both series, the effects of baling and removing straw and leaving chopped straw on the surface were tested, and at Boxworth the chopped and spread straw was also incorporated; treatments were modified slightly each year. Some systems

gave good results in some years. Further work is required to assist in improving the consistency of a system requiring the minimum of cultivation.

Variable results were found in ADAS surveys of 24 fields in which crops were established by broadcasting seed into standing wheat crops. However the farmers considered the advantages of reduced cultivation costs and timeliness of sowing to be important.

In the few comparisons of ploughing and tine cultivation for straw incorporation prior to drilling rape, the former treatment usually gave the higher yield but the trials were not on the very heavy or difficult soils.

In 1990 six farmers were interviewed about their method of rape establishment where straw had not been burnt. The systems adopted were to a large extent influenced by soil texture. All of the farmers considered it critical to do the primary cultivation as soon as possible after the cereal harvest and to conserve moisture by using a roll or landpacker immediately.

It is recommended that support be given for further work on developing methods of establishment of rape where straw has not been burnt, particularly on heavy soils, and for studies of the interaction of the presence of straw upon nitrogen requirement and slug damage.

This review, completed in October 1990 and with 36 pages in the full document, was funded by the HOME GROWN CEREALS AUTHORITY, Hamlyn House, Highgate Hill, London N19 5PR, from whom copies may be obtained at a price of £5.00 each (postage and packing included).

INTRODUCTION

The area of straw and stubble burnt prior to oilseed rape establishment is not known but general observation suggests it is likely to be a substantial proportion, and certainly more than 50 per cent. The Government is proposing to ban straw and stubble burning after the 1992 harvest. The ban would be brought into effect in a new Bill to control pollution and waste and there would be provision to enable the Minister to grant exemptions in special circumstances.

Farmers have three seasons in which to develop alternative methods of straw disposal such that oilseed rape can be successfully established. This is unlikely to be a problem on lighter soils.

The choice of alternative break crops on heavy soils is limited. Therefore, the consequence of failing to develop methods of establishing rape where straw had not been removed would be an increase in the area of cereals grown and a reduction in break crops in the rotation on these soils. This could result in reduced income to the farmers and a greater dependence upon the use of pesticides in cereals, particularly for the control of diseases such as eyespot and yellow rust (ADAS, 1988) and weeds, particularly the grass weeds.

The area of oilseed rape grown in the United Kingdom expanded rapidly in the 1980s. As the area increased from 91,800 ha in 1980 to 345,700 ha in 1988 the greatest spread of the crop occurred in north east England and Scotland. Oilseed rape is now the third largest arable crop (in area) in England and Wales after wheat and barley and forms an important part of the economics on the 11,575 holdings on which it is grown (MAFF, 1989).

Place in the rotation

Oilseed rape is grown on many soil types and in a wide range of crop rotations. Surveys on crops in England and Scotland in 1987 and 1988 (Semundo) and 1989 (United Oilseeds Marketing Limited) provide information on 166 fields of rape (Table 1).

Table 1. Percentage of fields in surveys during 1987-89 sown to rape following various crops.

Previous crop	Soil type	
	Clay	Others
Barley	25	39
Wheat	19	11
Others	2	4

Nearly half the crops were on clay soil, and although barley was the previous crop in just over half of these fields, most of the remainder followed wheat. A higher proportion of the crops grown on other soil types followed barley. The other crops that preceded rape were grass, peas, broad beans and in one case, oilseed rape.

Based upon an arbitrary line between Nottingham and Lincoln, the proportions of rape crops in these surveys following various crops in the north of England and Scotland compared with the south of England are shown in Table 2.

Table 2. Percentage of fields in surveys during 1987-89 sown to rape following various crops in the north and south of UK.

Previous crop	North	South
Barley	34	29
Wheat	6	24
Others	4	3

The proportions of the crops after barley in the north and south were 77 per cent and 53 per cent respectively. In the south, wheat preceded nearly the same proportion of the rape crops as barley but in the north few crops followed wheat.

The later cereal harvest and the need to sow oilseed rape earlier in the north explain the dominance of barley as the choice of crop to be grown prior to oilseed rape. Where climatic conditions permit, the substitution of wheat for barley often results in an increase in farm income because of the higher price for wheat grain and on many farms the yield of wheat (usually a second or third cereal crop) would be superior to spring or winter barley crops. In addition, volunteer barley could influence the value of the grain of the wheat crops following oilseed rape which had been preceded by a barley crop. However, by growing wheat, the interval between harvest and sowing at the optimum date for rape (late August to early September in the south) is often reduced to a few days (ADAS 1986).

Soil types and oilseed rape production

Although rape is grown throughout Britain, Figure 1 illustrates the major importance assumed by the crop in Eastern England, the East Midlands and to a lesser extent in Eastern Scotland. In the most dense rape growing areas, shown black in Figure 1, between 6 and 17 per cent of areas were occupied by the crop in 1987. Table 3 shows the relationship between soil texture and density of rape growing.

Table 3. Soil Type and Frequency of Rape Growing

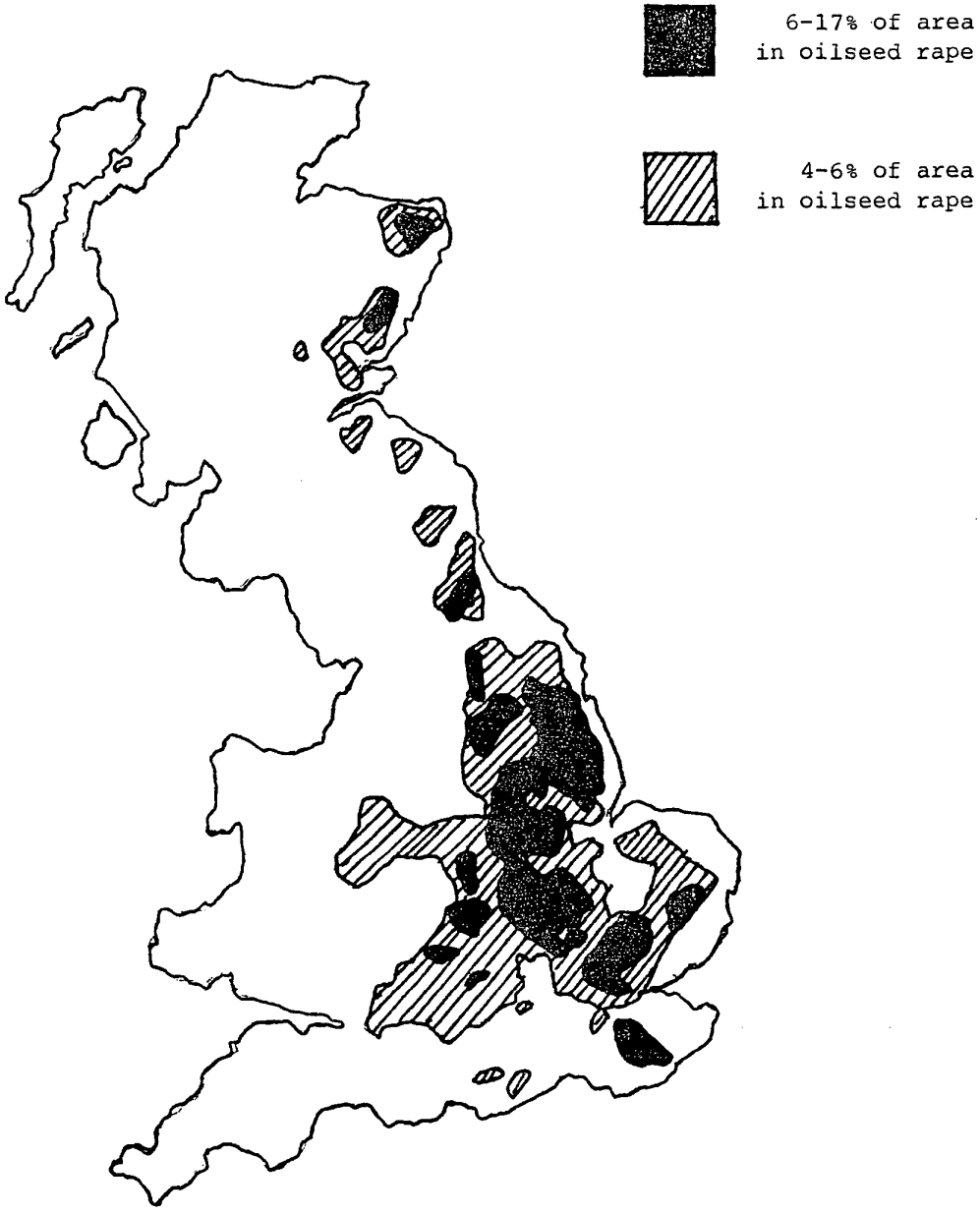
The proportion of rape grown at high density (600-1700 ha per 10,000 ha); or lower density (400-600 ha rape per 10,000 ha) on differing soil types.

Topsoil Texture	Area of rape (per cent)	
	High density cropping	Low density cropping
Sands and light loams	16	28
Medium loams	30	37
Clays	54	35

Figure 1. Distribution of rape for oilseed in Great Britain, 1987.

Produced and distributed by
ESRC Regional Research Laboratory for Scotland & Edinburgh University Data Library

Derived from the Agricultural Census carried out by Department of Agriculture and Fisheries for Scotland & Ministry of Agriculture, Fisheries & Food



It is clear from this table that the crop is concentrated on clays and to a lesser extent medium loams, rather than on lighter soils.

Although clay soils exhibit a common and characteristic behaviour, there is a wide range of workability within the clay group. An important distinction can be made between the Stagnogley clays and the Pelosol clays. The typical Stagnogley type has a higher water table overwinter, due to very low subsoil permeability, and weaker stability in the topsoil due to naturally low calcium carbonate content. This weak stability is frequently accentuated by high silt content. Typical examples are Denchworth and Windsor clays which are vale soils commonly found on the Oxford and London Clay formations. Pelosols generally have lower water tables during winter and better structured and more highly fissured subsoils. In addition their topsoils are more stable and faster draining. Typical examples are Hanslope clay formed in chalky clay till and Evesham clay found on lime rich valley clay formations in several parts of England.

Choice of cultivation for autumn seedbed preparation is strongly influenced by topsoil clay content. Light loams with maximum clay contents of 18 per cent, present few problems following ploughing. These soils are friable over a wide moisture range and any clods readily break up to give good quality seedbeds. In contrast, clays which contain a minimum of 35 per cent clay particles, are only friable over a narrow moisture range. Drying gives rise to strong clods which require energetic cultivation and a period of weathering before satisfactory seedbeds can be produced. After ploughing clays it is usually not possible to produce rape seedbeds unless weather conditions are exceptionally favourable. However, British clays tend to develop a fine surface tilth during the summer months as cyclical wetting and drying leaves a fine seedbed between 2 and 5 cm deep. This weather tilth tends to be less stable on Stagnogley clays and may be lost during heavy rain and by compaction when the land is wet.

Conventional seedbed preparation on clay soils is to burn the straw or less commonly to bale it - followed by shallow disc or tine cultivation and rolling. This system takes advantage of the natural tilth and largely avoids clod problems. In addition, it conserves moisture and so provides the best opportunity for regular and rapid establishment of small seeded crops such as rape. Deeper loosening to ensure free drainage and deep rooting is best done a year prior to rape to avoid raising clods to the

surface and losing moisture. Medium loams are generally more suited than clays to ploughing before rape but in dry summers cultivation rather than ploughing is often the best option. The best soil management option on clayland prior to rape has been straw burning. The next best is shallow cultivation after baling straw, but this is only feasible where is there is an outlet for the straw. Where there is no market, which is the case for many clay farmers, there are several options for establishment but none of them provides the same reliability as burning coupled with shallow tillage.

The options are:

a) Broadcasting seed before or after straw spreading, followed by shallow cultivation and rolling. These methods are not reliable under all conditions and often result in patchy establishment where straw is thicker.
b) Incorporation with heavy discs and tines before drilling requires a minimum of 10 cm cultivation compared with only 5 cm after burning. Consequently there is a risk of more moisture loss and cloddier seedbeds. Heavy rolls play an important part in this option but still reliability is not yet 100 per cent, particularly in dry seasons.
c) Ploughing is only a viable option in moist seasons and then only on a limited area. On the heavier and more difficult clays this is a high risk option.
d) Specialist implements are available which either loosen, incorporate and drill in one operation, or lift the straw and broadcast seed before the straw falls back to the ground. Both systems have worked well in field experiments and commercially but the high capital cost rules out these options on many farms.

Economics of systems

Losses in income would be incurred if the system adopted resulted in delayed drilling as this frequently produces reduced yields in rape.
The interval between cereal harvest and sowing rape can be extended by preceding rape with winter barley rather than wheat but this can reduce the farm income. Changing to a plough system could increase cultivation costs considerably (£40-£70/ha) but could save up to £20/ha on herbicides as early competition from grass weeds and volunteer cereals are much reduced.

FIELD EXPERIMENTS

Straw incorporation by plough or fairly deep cultivation on light and medium soils does not cause major problems in producing a suitable seedbed for oilseed rape. However, as discussed in the previous section, difficulties are often encountered on clay soils.

A research programme was started at Rothamsted in autumn 1985 to investigate the effects of cereal straw on the establishment of rape with two series of trials. ADAS started a trial series at Boxworth EHF in the same year to compare broadcasting rape seed into the standing wheat crop with various straw incorporation treatments. Four of the ADAS long-term straw incorporation trials where various straw incorporation treatments had been maintained for a number of years were cropped in rape.

The following summary gives a brief outline of the major findings from these trials (full reports of the Rothamsted and ADAS trials are given in Appendices I and II respectively).

Broadcasting into standing wheat

Satisfactory establishment and yield were achieved in ideal conditions. There were problems if the interval between broadcasting of seed and harvest of wheat was extended beyond 2 or 3 days.

Difficulties in establishment in very dry and very wet autumns and in weedy wheat crops were encountered.

Shallow incorporation of straw and seed usually produced more consistent results.

Chop length and spread of straw from current combine-mounted choppers are adequate for cereal establishment (Prew and Smith, 1988) and this applies equally before establishing rape. Even distribution is more important for non-plough incorporation and the use of chaff spreaders on combines with very wide cutter bars is probably more desirable before rape than another cereal.

Seed rate probably needs to be increased slightly compared with drilling after burning straw and stubble from 6 kg to 7-9 kg/ha.

No problems with slug grazing were encountered but monitoring by means of traps was necessary.

Establishment with straw incorporation

Conservation of moisture is critical.

Broadcasting rapeseed on top of chopped straw followed by shallow incorporation and single pass machines that incorporate some of the straw and sow rape seed, have both shown promising results.

The results from one of the long-term straw incorporation sites showed a benefit in yield where the straw had been incorporated over a number of years compared to where it had been burnt.

Ploughing on some sites had proved a satisfactory method of straw incorporation but sites on very heavy soils were not included in the trials.

ADAS SURVEYS OF BROADCASTING SEED

Oilseed rape crops which were established by broadcasting the seed into standing cereal crops were monitored (Paynter, 1987; and Hague, 1988). Over the two seasons 24 fields or part-fields in Cambridgeshire, Bedfordshire and Northamptonshire were monitored (Appendix III). All the crops were on heavy soil and the seed/straw was not incorporated. Four of the five farms in the second survey had participated in the first survey.

All the farmers in the first year's survey were satisfied with the technique. Most of them tried it again in the less favourable conditions in the next year and some were covered by the second survey.

Most of the farmers in the second survey were again satisfied with the crop establishment and yield and they considered the benefits of reduced cultivation costs and timeliness of sowing to be important advantages over conventional drilling. The authors of both surveys stressed the importance of achieving a good spread of chopped straw and broadcasting the rape seed within a few days of the cereal harvest.

CASE STUDIES

Six farmers were interviewed in June 1990 about their method of rape establishment without burning straw. There was variation in the systems adopted which to a large extent were influenced by soil texture. In most of the cases the previous crop was wheat and with the earlier harvest in 1989 there was an extended period between harvest and sowing rape. The individual farmers' systems are given in Appendix IV.

Seed rates for rape were all in the range of 7-9 kg/ha. Most of the farmers grew all or part of their acreage following winter wheat. Neither of the farmers on silty clay (Messrs. Schweir and Woodhead) considered it possible to produce a seedbed if the straw was incorporated with a plough even if a landpacker was available to consolidate afterwards. The three farmers (Messrs. Dillon-Robinson, Burling and Ward) on the slightly less heavy soils (silty clay loam) had each adopted different methods of dealing with straw. Mr. Dillon-Robinson used a plough, Mr. Burling used discs and Mr. Ward grew barley to allow himself time to bale the straw before ploughing. The sixth farmer (Mr. Pearce) ploughed in straw on his lighter soil (silt loam). All the farmers stressed the importance of doing the primary cultivation as soon as possible after the harvest of the previous cereal crop and to follow immediately with a roll or landpacker.

Most farmers were satisfied with the chop and spread of the straw from equipment mounted on combines. One farmer had a chaff spreader and the others did not consider one to be necessary. Only one farmer used autumn nitrogen and he was not certain it was beneficial to the crop. Slug control following the various methods of straw disposal was considered necessary by Mr. Woodhead only and he applied slug pellets with the seed.

All the farmers except one used a graminicide to control volunteer cereals and most followed it with Kerb. Mr. Dillon-Robinson used Kerb alone on one field and no herbicides on the remainder. Mr. Schweir applied a sequence of Fusilade and Kerb but felt the latter failed to control brome grass adequately. This was the reason he decided to burn straw in 1989.

Most of the farmers considered it more expensive to produce a seedbed after incorporating straw than following burning. A few expressed reservations about their straw incorporation and seedbed preparation procedure in very wet or dry conditions.

RECOMMENDATIONS FOR FUTURE WORK

The amount of work on heavy soils at Rothamsted, Boxworth and other ADAS sites on the establishment of winter oilseed rape in the presence of straw has been small. The results of the trials and farmers experiences in tackling the problem have been variable and areas requiring further study are set out below:-

Broadcasting into wheat crops

Factors limiting the success of this system of establishment need to be identified.
Seedrate requirement, particularly in adverse conditions such as a badly lodged wheat crop requires further investigation.
Use of pelleted seed might improve the penetration of the seed through the crop.
Use of stripper header on wheat crop would leave a long stubble which could act as a deterrent to pigeons but the effect upon the rape crop of being shaded by the straw needs to be assessed.

Straw incorporation

Feasibility of ploughing in straw on heavy and the most difficult soils.
Test single pass incorporation and seeding implements.
Evaluation of new equipment and techniques for straw incorporation and sowing.
Evaluate the system of broadcasting the rape seed on top of chopped and spread straw prior to both straw and seed being cultivated to a very shallow depth.

Supplementary studies

To assess soil mineral nitrogen and plant nitrogen content.
To test autumn nitrogen requirement which might be different in the presence of straw.
To obtain an understanding of the relationship between slug populations and damage in presence of straw, and improved forecasting.
To monitor effects of long-term straw incorporation upon establishment of rape.

To measure changes in efficiency of conversion of absorbed radiation for the canopy, nitrogen uptake and mobilisation by growth analysis.

Economics of systems

Obtain data on economics and management problems from a wide range of farms.

ACKNOWLEDGEMENTS

I wish to thank Bryan Davies and Richard Darby for their valuable contributions and Bob Prew (Rothamsted Experimental Station) for his guidance in the production of this report.

My thanks also to the farmers who participated in the case studies and who so patiently answered my questions.

REFERENCES

1. ADAS, 1986 - Oilseed Rape. ADAS Pamphlet P2278 p.1.
2. ADAS, 1988 - Survey of winter wheat diseases in England and Wales.
3. Hague, M.C., 1988 - Broadcasting winter oilseed rape into a standing crop of winter wheat, ADAS
4. MAFF, 1989 - Agricultural Census Results for the United Kingdom, 1989.
5. Paynter, Ruth, 1987 - Straw incorporation or broadcasting seed into a standing cereal crop, ADAS.
6. Prew, R.D. and Smith, B.D., 1988 - Changing Straw Disposal Practices. HGCA Review No 11 p.48.
7. Semundo - Ariana Surveys 1987 and 1988.
8. United Oilseeds Marketing Limited - Crop Survey, 1989 Crop.

Appendix I. RESULTS OF ROTHAMSTED EXPERIMENTS

From 1985 to 1989 two series of experiments investigating the effects of cereal straw on the establishment of winter rape were made at Rothamsted Experimental Station. The soil at Rothamsted is silty clay loam over clay-with-flints (Batcombe series) which is generally free draining.

Straw disposal before Winter Rape

This series of experiments was designed to investigate the effects of cereal straw disposal and seedbed cultivation methods on the establishment and yield of rape.

Winter rape was sown early (3rd week in August) or later (2nd week in September) at 8 kg/ha in plots where the preceding cereal straw had either been burnt, or chopped and spread, or baled and removed. Seedbeds were prepared either by ploughing down the residue or incorporation by tined cultivation. In the first experiment in 1986 (experiment year refers to year of harvest) the treatment combination of baling straw followed by ploughing was not tested, but rapeseed was direct drilled after straw burning and ash incorporation. The effect of 50 kg N applied to the seedbed was also tested in each season. All plots received a spring top-dressing of 200 kg N/ha in mid-February 1986-88, but in 1989 only 150 kg N/ha was applied.

Crop establishment and winter losses

The autumn of 1985 was very dry. Early sown ploughed treatments could not be sown on 22 August so all were sown at the later sowing date (9 September) after forcing a seed bed. Both conventional and direct drilled plots emerged well when sown early (mean 123 plants/m^2) but continuing dry conditions delayed emergence of the later sown crop with the majority emerging only after rainfall on 7 October. However by 31 October the later sown crop had 111 plants/m^2 but many were small. This prolonged period of emergence delayed the application of herbicide to control cereal volunteers. Where emergence had been rapid and more uniform following the early sowing, winter losses were small, and on average 112 plants/m^2 remained, but after later sowing, delayed emergence and a very cold February, frost heave caused severe winter losses amounting to 92% where

straw had been chopped and incorporated by tine cultivation. Of the later sown treatments, plots which were ploughed retained the largest plant population (68 plant/m^2). Applying 50 kg N/ha to the seed-bed had no effect on the number of plants established or lost over winter. However, the plants were generally larger where seedbed N had been applied.

Weather conditions at crop establishment in the remaining 3 years, 1987-9, were generally conducive to rapid and even germination. The effects of straw disposal and cultivation treatments varied between seasons. In 1987 incorporation by ploughing resulted in a small improvement in plant population, and in 1988 and 1989 later sowing also increased the number of plants. However, the numbers of plants established were more than adequate in all seasons, exceeding 80 plants/m^2 in 1987 and 1988 and 140 plants/m^2 in 1989. Winter losses were not consistently affected by straw disposal or cultivation treatment, and averaged 12.7% from 1987-89. Again seed-bed N had no effect on the number of plants established or on winter survival but plants were larger and more sturdy where it had been applied.

Seed yield and oil content

In the first year of the experiment (1986) yields were large where the rape was sown early, exceeding 4 t/ha except where chopped straw was incorporated by tine cultivation. Where rape was sown later, yields were significantly smaller (Table 4). The application of seed-bed N resulted in a small non-significant increase in yield of 0.14 t/ha averaged over both sowing dates. Oil content of the early sown rape was not affected by straw disposal or cultivation treatments, averaging 44.6% oil at 90% DM. However oil content was significantly lower in later sown crops in which there was over 73% winter kill in widely spaced highly branched plants with a broad spread of maturity. Where straw had either been baled or chopped and incorporated by tine cultivation oil content was 40.8 and 36.5% respectively when later sown.

Table 4 The effect of sowing date, straw disposal and incorporation method on yield of oilseed rape (t/ha 90% DM) in 1986.

Disposal and incorporation method	Sowing date	
	22 Aug	9 Sept
Burn, direct drill	4.00	2.91
Burn, tine cultivate	4.05	3.27
Burn, plough	-	3.90
Chop, tine cultivate	3.88	1.19
Chop, plough	-	2.80
Bale, tine cultivate	4.04	2.03
Mean	3.99	2.68

In the remaining three experiments in which plant population was adequate, differences in yield were less likely to be associated with the prevailing weather conditions during establishment. In 1987 yields were at a good average level and early sown rape significantly outyielded later sown rape (3.82 vs 3.55 t/ha). However, in 1988 and 1989, this effect was reversed, the largest yields being obtained from the later sown crop (2.78 vs 3.65 and 1.90 vs 2.27 t/ha respectively). In general, seed yield was disappointingly low in 1989 despite the largest surviving plant population (130 plants/m^2).

The mean effects of straw disposal and incorporation methods are shown in Table 5. Ploughing gave consistently larger yields than incorporation by tine cultivation, and disposal of straw by baling was better than by burning although there was little difference in rape yield after burning or chopping straw before ploughing. Although there were no differences in the number of plants present in plots where straw was chopped and incorporated by tine cultivation, in general these plots were noticeably poorer throughout the winter, and gave the lowest yield. Although showing no benefit in number of plants, seed-bed N significantly increased yield in 1987 and 1989 (3.58 vs 3.79 and 1.99 vs 2.18 t/ha respectively), but not in 1988, an effect noted in other experiments that year.

Table 5. The effects of straw disposal and incorporation method on yield of oilseed rape (t/ha 90% DM) mean of 3 years 1987-89.

Disposal method	Incorporation method		
	Tine cultivate	Plough	Mean
Burn	2.91	3.05	2.98
Chop	2.80	3.04	2.92
Bale	3.06	3.12	3.09
Mean	2.92	3.07	

Differences in oil content due to straw disposal and cultivation treatments were generally small and tended to compensate for observed differences in seed yield.

Broadcasting rape seed into standing wheat 1987-89

The second series of experiments was designed to compare conventionally sown rape with a crop established by broadcasting into standing wheat.

Winter oilseed rape was broadcast into standing wheat immediately before harvest. After the wheat was combine harvested, straw was either baled and removed or chopped and left as a mulch. These broadcast treatments were compared with rape drilled conventionally into a seed-bed prepared after harvest by ploughing and rolling, followed by rotary harrow and drill in 1987, or by rotary grubbing, followed by rotary harrow and drill in 1988 and 1989.

Crop establishment and winter losses

The number of plants established by conventional cultivations and drilling were 115 plants/m^2 from 8 kg seed/ha in 1987, 116 vs 245 and 209 vs 328 from 8 vs 16 kg seed/ha in 1988 and 1989 respectively. Where seed was broadcast significantly fewer plants established. Plant stands tended to be uneven and numbers recorded variable; however there were on average 44 plants/m^2 from 8 kg seed/ha and 88 from 16 kg seed/ha. Chopping the straw or removal by baling had no effect on the number of plants established but some increase in plant population was observed in 1987 and in 1989 at the higher seed rate from the application of 50 kg N/ha to the seed-bed.

Winter losses from 8 kg/ha drilled seed were large in 1987 (35%) and small in 1988 and 1989 (4 and -1%), however losses from 16 kg/ha drilled seed were much greater in 1988 and 1989 (19% and 15% respectively). By contrast, winter losses from broadcast seed were never very large ranging from between 3 and 10 plants/m^2 (6-15%) in the three seasons, possibly because earlier establishment and smaller population density resulted in robust plants which were able to withstand the winter. Neither seed-bed N nor straw disposal treatments had any effect on winter losses except in 1988/9 when chopping straw increased winter loss to 27%.

Seed yield and oil content

Despite the smaller plant population from broadcast seed, yields were often larger from these treatments than where it had been drilled (Table 6). On average, broadcasting the seed and baling the straw gave the largest yield although not significantly so. Straw as a mulch tended to smother the small rape plants. In 1988, yields were generally smaller where 16 kg seed/ha had been sown than where 8 kg had been used, but in 1989 the reverse was true. The application of seed-bed N increased yield by 0.44 and 0.69 t/ha in 1987 and 1989 respectively, but not in 1988 when yield was reduced by 0.32 t/ha, an effect observed elsewhere.

Oil content was lower in 1986/7 than in the two subsequent years (38.6, 43.2 and 42.6% in 90% DM respectively). Oil content was decreased in rapeseed from plots on which straw had been chopped in 1987 and 1989 and also where 8 kg seed had been sown in 1989.

Table 6 The effects of broadcasting rape seed into standing wheat then chopping or baling the wheat straw after harvest, compared with conventional sowing on yield of rape (t/ha 90% DM).

(a) 1986/87					
Seedbed N (kg/ha)		50	-	-	
Spring N timing		Feb/Mar	Feb/Mar	Feb	
Straw disposal	Sowing method				Mean
Plough	Drilled	3.51	3.22	3.28	3.34
Baled	Broadcast	3.61	3.38	3.51	3.50
Chopped	Broadcast	3.47	2.66	2.86	3.00
	Mean	3.53	3.09	3.22	

(b) 1987/88				
Seed rate (kg/ha)		8	16	Mean
Cultivated	Drilled	3.49	3.13	3.31
Baled	Broadcast	3.52	3.18	3.35
Chopped	Broadcast	3.37	3.34	3.36
	Mean	3.46	3.22	

(c) 1988/89				
Seed rate (kg/ha)		8	16	Mean
Cultivated	Drilled	1.04	1.33	1.18
Baled	Broadcast	1.83	1.79	1.81
Chopped	Broadcast	0.91	1.41	1.16
	Mean	1.26	1.51	

Appendix II. RESULTS OF ADAS EXPERIMENTS

Techniques of establishing rape by broadcasting seed into a standing cereal crop were investigated at Boxworth Experimental Husbandry Farm (clay, Hanslope series). In addition, four of the ADAS long term straw incorporation trials on heavy soils were sown to rape in that period and the results are presented also.

Broadcasting rape seed

In the trial series at Boxworth, where seed was broadcast into the standing wheat crop, the effects of baling and removing straw were compared with chopping and spreading straw which was incorporated with a rotary harrow or left on the surface; treatments were modified slightly each year. The very dry autumn in 1985 led to poor seedbeds and slow, uneven crop emergence. Very cold spells in late December, February and early March resulted in very slow growth and considerable plant losses so the trial was abandoned.

In the much more favourable conditions in 1986/87 good seedbeds were obtained and the rape grew well. Most of the treatments gave good establishment (Table 7) and satisfactory yields (Table 8). The low plant population and yield where rape seed was broadcast into the standing wheat crop 28 days before harvest emphasised the risk of sowing prematurely, especially when the weather was unsettled.

In the three treatments where rape was broadcast and straw chopped and spread, or chopped, spread and incorporated, or baled, the yields were greater than on the burnt treatment.

Table 7. Establishment of oilseed rape, Boxworth EHF. Plant populations in spring at 7kg seedrate, 1987-1989.

	Plants per square metre		
	1987	1988	1989
Straw burnt, shallow cultivation, drilled	73	43	66
Seed broadcast onto chopped straw and incorporated	-	-	39
Seed and chopped straw incorporated by single pass machine	-	51	-
Seed broadcast into wheat crop 15-28 days before harvest	9	Failed	-
Seed broadcast into wheat crop on day of harvest:			
Straw chopped/spread only	36	Failed	8
Straw chopped, spread, incorporated	51	34	8
Straw baled	42	Failed	15

Table 8. Establishment of oilseed rape, Boxworth EHF. Yield t/ha at 91% DM, at 7kg seedrate.

	Yield t/ha		
	1987	1988	1989
Straw burnt, shallow cultivation, drilled	3.10	4.21	3.12
Seed broadcast onto chopped straw and incorporated	-	-	2.82
Seed and chopped straw incorporated by single pass machine	-	3.93	-
Seed broadcast into wheat crop 15-28 days before harvest	1.96	Failed	-
Seed broadcast into wheat crop on day of harvest:			
Straw chopped/spread only	3.37	Failed	1.06
Straw chopped/spread, incorporated	3.70	4.28	1.73
Straw baled	3.53	Failed	2.40

Wet conditions in June and July 1987 led to a prolific growth of chickweed on the trial site which may well have contributed to the poor results of treatments without incorporation. The problem of delaying harvest of the wheat crop because of weather conditions was encountered again with the early broadcast treatment.

The interval between broadcasting and harvest was intended to be 10 days but was extended to 15 days.

The long-term straw disposal trial was in a neighbouring field in the same year but was free of weed problems. After broadcasting rape seed into the wheat the effect of incorporation by rotary harrow after straw chopping was tested. On plots which had been either tined and ploughed or tined to 5 cms for the previous four seasons there were no yield differences between incorporation or non-incorporation of the chopped straw (Table 9.).

Table 9. Broadcasting seed with or without incorporation on the long-term disposal trial, Boxworth 1987/88.

	Spring plant populations & yields (t/ha at 91% DM)			
Treatments applied autumns 1983-86	Broadcast into wheat on day of harvest, 1987			
	With incorporation		Without incorporation	
	pl/m²	t/ha	pl/m²	t/ha
Straw chopped/spread:				
Tines to 5cm	56	3.86	66	3.61
Tines to 15cm and ploughed	56	3.78	56	3.78

Heavy rain over the period of cereal harvest in 1988 again highlighted the problems associated with sowing rape seed into standing wheat (Tables 7 and 8) as there was a six day interval between harvest and incorporation of straw and seed. The most likely explanation for poor establishment from these treatments is that the seed rotted under the wet straw. A higher proportion of the seed broadcast on to the chopped straw survived and this seed would have been lying on or close to the surface of the straw during the wet period. Sowing into the wheat crop and baling the straw (7 day interval) resulted in a low plant population and a moderate yield. Although straw burning followed by cultivation and drilling was delayed for nine days after wheat harvest this treatment gave the best plant population and yield. The yields of straw and chaff of the previous wheat crop were measured from hand-harvested areas and the yields were 5.15 t/ha, 9.5 t/ha and 9.0 t/ha prior to 1987, 1988 and 1989 rape crops respectively.

Seedrate

The above treatments were tested at seedrates of 7kg and 14 kg/ha each year. Plant populations were larger at the higher seedrate but they rarely increased yield.

Autumn nitrogen

The effect of an additional 40kg N/ha applied in October was evaluated in 1986/7 but there was no yield benefit in combination with any other treatment.

Long term straw incorporation

The long-term straw incorporation trial at Boxworth was cropped with oilseed rape in 1987/88 on plots where various treatments for incorporating straw had been maintained on the same plots for the previous four wheat crops (left-hand column of Table 10). For the rape crop each plot was divided so that on half seed was broadcast into the standing wheat crop on the day of harvest and on the other half the incorporation treatment continued as in previous years. The straw of the wheat crop into which rape seed had been broadcast was chopped, spread and incorporated with a rotary harrow. Following the various cultivations on the remaining half of each plot, rape was drilled into seedbeds prepared by rotary harrow. As in the other trials a roll was used after drilling or the final incorporation.

Table 10. Spring plant populations and yields (t/ha at 91% DM) on the long-term straw disposal trial, Boxworth 1987/88.

Treatments applied Autumns 1983-86	Broadcast into wheat on day of harvest 1987		Cultivated in 1987 according to treatment and drilled	
	pl/m²	t/ha	pl/m²	t/ha
Straw burnt, tines to 5cm	104	3.12	97	3.42
Straw burnt, ploughed	62	3.51	40	3.30
Seed and chopped straw incorporated by single-pass machine	55	4.01	61	3.96
Straw chopped/spread;				
Tines to 10cm	54	3.64	59	3.38
Tines to 15cm	53	3.63	63	3.58
Ploughed to 20cm	50	3.83	32	3.49

Rape establishment was good whether achieved by the broadcast technique or by drilling following various cultivation methods to incorporate straw. After ploughing in 1987 followed by two passes with a rotary harrow the seedbed remained unsatisfactory; drilling was delayed by a week in these cobbly and dry seedbeds with the result that emergence was late and plant population and size were very small going into the winter. Desiccation was delayed by 11 days and harvest delayed by five days but the yield was similar to the best treatments.

Yields of rape were greater after broadcasting the seed into the standing crop where straw had been incorporated in the previous years than where straw had been regularly burnt followed by 5cm tines. This yield benefit in a rather wet and mild season might have been the result of improved soil structure, the presence of straw residues assisting drainage and/or a nitrogen mineralisation effect from the breakdown of accumulated straw residues.

Other sites with long-term straw incorporation

Three sites in the ADAS long-term straw incorporation trial series on heavy soils have been cropped with oilseed rape; Otley on sandy clay loam, Beccles series, Sproatley on clay, Holderness series, and Terrington EHF on silty clay loam on Agney series (Table 11).

Table 11. Long-term straw disposal trials at Otley, Sproatley and Terrington EHF

	Yields t/ha at 91 per cent DM.		
Site	Otley	Sproatley	Terrington
Harvest year	1987	1988	1989
No. of years same treatment applied previously	3	3	6
Straw burnt:			
Tines to 15cm	3.58	3.22	3.20
Ploughed	3.58	3.67	-
Straw chopped and spread:			
Tines to 10cm	2.18	1.71	3.47
Tines to 15cm	1.90	-	-
Ploughed to 20cm	3.01	3.67	3.04
Pre-mix and ploughed to 20cm	3.11	3.61	2.93

Yields at Otley were reduced by the various straw incorporation methods particularly following the shallow-tined treatments. Ploughing where the straw was burnt or chopped gave yield increases over straw burning followed by tine cultivation at Sproatley. The reduction in yield by chopping straw and tined cultivation was associated with a weed infestation and poor establishment. There were no yield differences between the treatments at Terrington, and no benefit from pre-mixing the straw before ploughing at any site.

Appendix III. RESULTS OF ADAS SURVEYS ON BROADCASTING RAPE INTO STANDING WHEAT

	Farm	Previous crop	Straw treatment	Seedrate kg/ha	No. days broadcast-harvest	Spring pl/m²	Approx. t/ha
1986/87							
1.	A	Wheat	Spread	13.5	6	98	3.1
2.	B	Wheat	Spread	9.9	25	40	4.4
3.	C	Wheat	Spread	9.8	22	74	3.9
4.	C	Wheat	Spread	10.4	7	62	4.0
5.	D	Wheat	Baled	11.2	21	104	4.1
6.	D	Barley	Baled	11.2	10	68	2.5
7.	E	Wheat	Baled	11.2	4	53	4.1
8.	F	Wheat	Baled	13.5	12	136	4.2
9.	G	Wheat	Spread	15.7	21	78	3.8
1987/88							
10.	B	Wheat	Spread	10.0	26	50	3.1
11.	B	Wheat	Spread	10.0	25	26	1.8
12.	B	Wheat	Spread	10.0	33	30	2.7
13.	B	Wheat	Spread	10.0	5	55	3.1
14.	C	Wheat	Spread	11.2	9	52	2.9
15.	C	Wheat	Baled	7.5	9	42	
16.	C	Wheat	Spread	16.6	9	67	3.9
17.	C	Wheat	Baled	10.0	9	49	3.9
18.	D	Wheat	Spread	11.2	8	70	3.3
19.	D	Wheat	Spread	9.0	8	117	2.8
20.	E	Wheat	Baled	11.2	3	65	3.0
21.	E	Wheat	Baled	11.2	5	58	3.0
22.	E	Wheat	Baled	11.2	6	45	3.0
23.	H	Wheat	Spread	11.2	0	100	2.7
24.	H	Wheat	Spread	11.2	0	60	3.0

Appendix IV. FARMERS' SYSTEMS IN CASE STUDIES

1. Mr. M. Schweir, Hungary Hall Farm, Oldhurst, Cambridge.

	Silty clay.
	Straw incorporated before rape in 1988/89 only.
Previous crop:	wheat (1988).
Width of combine cut:	5.3 metres.
Type of straw chopper and spreader:	Record.
Adequacy of straw chop:	good.
Effectiveness of straw spread:	good.
Chaff spreader:	no.
Primary cultivations:	Dynadrive to a depth of 20cm followed by roll.
Secondary cultivations:	only drill and roll.
Autumn nitrogen:	nil.
Critical features:	conservation of moisture; not to bring up clods.
Problems:	poor control of sterile brome with Kerb.
Number of years system used for rape:	only this one year.
Further comments:	Mr. Schweir has been incorporating straw before wheat by ploughing for four years on most of the farm but would not plough before rape even with a landpacker because of the fear of drying out the soil. He considered it important to roll the field after each pass with an implement.

2. Mr. A. Woodhead, Dammerwick Farm, Burnham-on-Crouch, Essex.

	Silty clay.
Previous crop:	wheat.
Width of combine cut:	5.2 metres.
Type of straw chopper and spreader:	on New Holland and Claas combines.
Adequacy of straw chop:	poor.
Effectiveness of straw spread:	poor behind New Holland.
Chaff spreader:	on New Holland only.
Primary cultivations:	twice with Simba heavy discs to a depth of 7cm followed each time by a roll.
Secondary cultivations:	mole drain, roll, rotary harrow, roll, rotary harrow, roll, Wilder harrow, roll, drill, roll.
Autumn nitrogen:	40 kg N per hectare.
Critical features:	disc as soon as possible after harvest but avoiding going too deep which would result in large clods and loss of moisture.
Problems:	some difficulty resulting from poor spread of straw.
Further comments:	Mr. Woodhead does not alter the system in dry or wet seasons and he would never plough before rape. He is doubtful whether there is a benefit from the autumn nitrogen. He considered it important to use a heavy roll after each cultivation. For rape grown after barley the same treatments are applied following baling of the straw.

3. J. Dillon-Robinson, Priors Hall Farms Ltd, Widdington, Saffron Walden, Essex.

	Silty clay loam.
Previous crop:	barley and wheat.
Width of combine cut:	5.2 metres.
Type of straw chopper and spreader:	on Claas 106.
Adequacy of straw chop:	good.
Effectiveness of straw spread:	medium-good.
Chaff spreader:	no.
Primary cultivations:	plough with skimmers to 15-20cms followed as soon as possible by Simba Landpacker.
Secondary cultivations:	rotary harrow, roll, drill, roll.
Autumn nitrogen:	nil.
Critical features:	timing of landpacker and subsequent cultivations problems: volunteer cereals because of ploughing every year.
Number of years system used for rape:	three (first two on lighter soils).
Further comments:	Mr Dillon-Robinson stressed the need to press down the bottom of the furrow with the landpacker to reduce slug activity. He thought the system of establishment would be difficult in excessively wet or dry conditions.Straw had been incorporated over the whole farm since 1984 and it is thought that "workability" of the soil had improved.

4. T. Henshaw, manager for B. Burling, Chain Farm, Over, Cambridge.

	Silty clay loam.
Previous crop:	wheat.
Width of combine cut:	3.0 metres.
Type of straw chopper:	Votex topper on to previously spread unchopped straw.
Adequacy of straw chop:	poor.
Effectiveness of straw spread:	poor.
Chaff spreader:	no.
Primary cultivations:	discs twice to a depth of 5cm followed by roll.
Secondary cultivations:	rotary harrow once, roll, drill, roll.
Autumn nitrogen:	nil.
Critical features:	discing as soon as possible after wheat harvest, rolling after each cultivation.
Problems:	rain falling between discing and rolling.
Number of years system used for rape:	two.
Further comments:	Mr. Henshaw will use a combine with 7.3 metre cut with chopper and spreader plus a chaff spreader in 1990. He emphasised the importance of rolling after discing and using the power harrow. He did not wish to contemplate using a plough even in sequence with a heavy roll or landpacker.

5. Mr. M.W. Ward, Brook End Farm, Keysoe, Bedford.

	Silty clay loam.
Previous crop:	barley.
Width of combine cut:	6.1 metres.
Straw treatment:	baled.
Primary cultivations:	plough with trash boards to a depth of 20cms.
Secondary cultivations:	discs followed immediately by a Dynadrive and roll, drill, roll.
Autumn nitrogen:	nil.
Critical features:	Mr. Ward tries to plough as quickly as possible after combining so that the seedbed is three quarters prepared. Then he waits for rain and drills only when the moisture content of the soil is right.
Comments:	He does not find it necessary to use a rotary harrow and prefers to avoid using one if he can. He is concerned that this is an expensive system. He has incorporated straw for 3-10 years and for rape after wheat he has used a Soil Saver followed by power harrow, drill and roll. Mr. Ward feels that this system after wheat would be difficult in a late, wet season.

6. Mr. F. Pearce, Rivenhall Hall, Witham, Essex.

	Silt loam.
Previous crop:	wheat.
Width of combine cut:	5.2 metres.
Type of straw chopper and spreader:	on Claas combine.
Adequacy of straw chop:	very good.
Effectiveness of straw spread:	good.
Chaff spreader:	no.
Primary cultivations:	plough with skimmers to 15-20cm as quickly as possible after harvest.
Secondary cultivations:	heavy flat roll, Cousins Dutch harrows once or twice to 7cm just before drilling, roll.
Autumn nitrogen:	nil.
Critical feature:s	use of heavy roll after ploughing before soil dries out.
Problems:	none.
Further comments:	Mr. Pearce does sometimes grow barley before rape but he is growing an early ripening wheat variety (Camp Remy) in 1990 to try to extend the period in which to prepare the rape seedbed.