Comparing the benefits to wintering birds of oil-seed rape establishment by broadcast and non-inversion tillage at Grange Farm, Cambridgeshire, England

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SUMMARY

There is extensive and compelling evidence that suggests changes in farmland bird abundance have been driven by changes in agricultural practice. Among these, the wide-scale change from spring to autumn cropping has consequences for the amount of food available to farmland birds over winter and associated survival rates. Oil-seed rape (OSR) *Brassica napus* is one crop that is primarily established in the autumn. While the leaves provide a valuable source of food for a few species, e.g. woodpigeon *Columba palumbus*, and may provide cover and micro-climates for invertebrate food for others, e.g. thrushes, there has been concern that autumn sowing of crops such as OSR removes the need to leave land fallow during the winter months. Fallow land in the form of over-winter crop stubble is a key foraging habitat for many birds, particularly granivorous species. It has been hypothesised that the recent wide-scale adoption of the broadcast method of establishment for OSR crops may have benefits for some species reliant on over-winter stubbles, as the crop is established into existing cereal stubble.

However, our study indicates that bird densities are similar on broadcast OSR fields compared to non-inversion tillage OSR, and that densities in the broadcast OSR were lower than in many studies of bird use of over-winter cereal stubbles. This may perhaps be due to the rapid growth of OSR in the autumn, shading out the stubble and thus making it an unsuitable feeding habitat for many birds for much of the winter. As the available evidence suggests that cereal stubbles broadcast with OSR are unlikely to provide the benefits to farmland birds of traditional over-wintered stubbles, the decision on method of establishment for oilseed rape crops should be based on agronomic considerations.

BACKGROUND

The decline of many farmland bird species since the 1970's has been well publicised with many species suffering very considerable reductions in abundance and range (Gibbons& Reid 1993, Risely *et al.* 2008). This has been linked to multivariate intensification of farming; amongst which has been a change from predominantly spring sowing to autumn sowing (Chamberlain *et al.* 2000, Newton 2004). There has been a considerable reduction in the area of spring cereal tillage (mainly spring barley), taken as a proxy for over-winter cereal, from c. 770,000 ha in 1983 to c. 258,000 ha in 2007 (DEFRA 2007). Spring cropping allows one of the main food sources for farmland birds during the winter to persist: the over-winter cereal stubble, some of which can be rich in spilt grain and seeding arable weeds that are not available in the majority of cropped areas established during the autumn (Henderson *et al.* 2004, Moorcroft *et al.* 2002, Robinson & Sutherland 1999). Many cereal stubbles currently left over-winter may also be of low suitability as sources of food for birds, with grain and weed seed abundance related to harvesting techniques and the level of herbicide application during crop growth and pre- and post- harvest (Bradbury *et al.* 2008). A combination of these factors has led to considerably reduced food availability for birds during the winter, which has consequently led to reduced over-winter survival for many species such as reed bunting *Emberiza schoeniclus* and yellowhammer *Emberiza citrinella* (Siriwardena *et al.* 2008). It has been postulated that this reduced over-winter survival gives the best explanation for the declines of many farmland bird species, particularly those considered farmland specialists (Peach *et al*. 1999, Siriwardena *et al*. 2000). However, for skylark *Alauda arvensis* and yellowhammer, it has been shown that populations recover in areas with approximately 10-20 ha of cereal stubble per 100 ha of farmed land, compared to continuing decline with less than this threshold (Gillings *et al.* 2005).

The decline of farmland birds is clearly inextricably linked to developments in the agricultural industry. This industry is continually striving to be efficient, both in terms of production output (yield) and agri-chemical inputs. The economics behind crop production are continually being assessed with novel techniques of crop establishment or husbandry being sought to reduce costs, occasionally with unintended biodiversity benefits. OSR has become a widely used break crop with approximately 600,000 ha in 2007 (DEFRA 2007). Two techniques that are currently widely deployed during the establishment of winter OSR are broadcasting the seed onto cereal stubble during harvesting and non-inversion tillage. Approximately 10% of OSR is established using broadcast methods and 25% by non-inversion or minimum tillage methods, although there may be considerable regional and annual variation (James Clark pers. com.). Both substantially reduce costs of establishment to the farming industry as no, or little, soil tillage is required and the number of in-field operations is reduced, thereby substantially reducing fuel costs and potentially increasing the financial return per hectare to the farmer (Anon. 2002). The number of applications of slug control pellets is generally increased compared to conventional OSR establishment. The control of grass weeds in OSR is generally more important than the control of broad-leaved weeds. With non-inversion tillage or broadcast methods, grass weeds tend to predominate, since broad-leaved weeds only tend to be encouraged where soil has been disturbed. These methods allow more consistent control of the pernicious weed black grass *Alopecurus myosuroides*, as their roots grow closer to the surface. Whilst the primary aims within the agriculture industry for this method of establishment are cost reduction and pernicious weed control, a further unintended biodiversity benefit may be the increased area of over-winter cereal stubble available. It is hypothesised that this may increase the level of food available to farmland birds, thus allowing over-winter survival rates to increase. However, as few quantitative data had been collected, we undertook a novel investigation of the bird use, over two winters, of OSR that had been established by broadcasting and by non-inversion tillage.

ACTION

Study site: The trial took place at Grange Farm, Cambridgeshire (OS grid ref: TL3362). Grange Farm is an arable farm (181 ha) managed conventionally by the Royal Society for the Protection of Birds (RSPB), with a cropping rotation at present of winter wheat: winter OSR: winter wheat: spring beans. The soil at the trial site is Hanslope calcareous clay loam (Anon. 1985).

Methodology: The trial ran during the winters of 2006/07 and 2007/08; four fields (total area 50.34 ha) in 2006/07 and two fields (total area 44.37 ha) in 2007/08. In both winters, two of the fields were split with half the OSR established by broadcasting and half by non-inversion tillage. In 2006/07, one each of the remaining smaller fields was established wholly by broadcasting or non-inversion tillage. Non-inversion tillage covers a wide range of establishment techniques; at Grange Farm, the non-inversion tillage fields were cultivated with discs and tines to a depth of approximately 5cm before sowing. The broadcast side of the fields were sown during wheat harvest in August 2006 and 2007 at 6.45 kg/ha and 6.0 kg/ha respectively, while the non-inversion side of the fields were sown in September 2006 and 2007 at 6.16 kg/ha and 8.0 kg/ha respectively. The agri-chemical inputs added to each field were as advised by the farm agronomist and contractor, Appendix 1.

Two bird surveys were made in each field per month between September and March during each winter, using the whole-area search method with each fieldworker ensuring that they walked to within 25 m of each point of the field (Atkinson 2006). The locations of all birds encountered were plotted accurately on maps. The number of birds of individual species and of various conservation-status related species guilds or feeding preference related groupings using each establishment type were then calculated for each survey.

The species guilds and feeding preference related groupings were: ***Farmland Bird Index* (FBI) species:** kestrel *Falco tinnunculus*, grey partridge *Perdix perdix*, lapwing *Vanellus vanellus*, skylark *Alauda arvensis*, jackdaw *Corvus monedula*, rook *C.frugilegus*, starling *Sturnus vulgaris*, stock dove *Columba oenas*, woodpigeon *C. palumbus*, linnet *Carduelis cannabina*, reed bunting *Emberiza schoeniclus*, yellowhammer *E.citrinella* and corn bunting *Milaria calandra*; ***Granivores*:** chaffinch *Fringilla coelebs*, goldfinch *Carduelis carduelis*, greenfinch *C.chloris*, linnet, reed bunting, yellowhammer and corn bunting; ***Probers*:** common snipe *Gallinago gallinago*, blackbird *Turdus merula*, song thrush *T.philomelos*, rook, jackdaw and starling.

Statistical analysis: Analyses were performed using General Linear Modelling in SAS (SAS Institute Inc.), using procedure Genmod. Data were modelled with Poisson errors and a log link function, using a repeated measures procedure to account for multiple data collection from the same fields. All models were constructed with 'field' identity included as a fixed blocking factor. Other terms included in all models were date, winter (2006/07 v 2007/08) and treatment (broadcasting v non-inversion tillage). The interaction term treatment*date was also included to check for differential bird use between treatments between early and late winter. Field size (ha) was included as an offset to give a model output in densities (birds/ha). A number of different response variables were tested, each of which corresponded to an individual species (skylark, meadow pipit *Anthus pratensis*, common snipe and woodpigeon were sufficiently abundant to analyse at the species level), or a group of species based on feeding preferences (granivores, probers) or conservation status (Farmland Bird Index species). Over-dispersion in the datasets was automatically corrected by SAS procedures. All results are presented are from the full models; although step-down procedure, in which the least statistically non-significant variable dropped from the model after each iteration) to establish the minimum adequate model (MAM), was also performed to check the robustness of the results from the full models. Terms that were significant (P<0.05) in the full models did not differ from those in the minimum adequate models. A t-test was also used to check if the mean field sizes for each treatment significantly differed.

CONSEQUENCES

Analysis of the data collected during the two winters showed few significant trends, Table 1. The Farmland Bird Index (FBI) group of species did show a small but significant effect of treatment, with greater densities on the broadcast areas of the fields than the non-inversion tillage areas, Figure 1 (X^2 = 4.41, D.F. = 1, P = 0.04). Other species and guilds did not show any significant effect of treatment, Table 1.

There was a highly significant difference in densities for the Farmland Bird Index group of species, Figure 2 (X^2 = 7.11, D.F. = 1, P = 0.008) and a significant difference for skylark (X^2 = 3.86, D.F. = 1, P = 0.05), woodpigeon (X^2 = 6.59, D.F. = 1, P = 0.01) and the 'probing' group of species (X^2 = 3.99, D.F. = 1, P = 0.05) between winters, with the second winter holding consistently higher densities than the first winter. There was no significant interaction between treatment and period, with both treatments showing similar trends in densities between the early and late winter periods.

There was no significant difference between the mean field size of both establishment methods (t = 0.13, D.F. = 8, P = 0.90).

Table 1. Trends of field use by selected bird species and feeding preference related groups during the winters of 2006/07 and 2007/08.

	Snipe	**Skylark**	**Meadow pipit**	**Woodpigeon**	**FBI sp.**	**Granivores**	**Probers**
Treatment	*ns*	*ns*	*ns*	*ns*	*	*ns*	*ns*
Winter	*ns*	*	*ns*	*	**	*ns*	*
Date	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
Treatment*Date	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Note: ns – not significant, * - P<0.05, ** - P<0.01

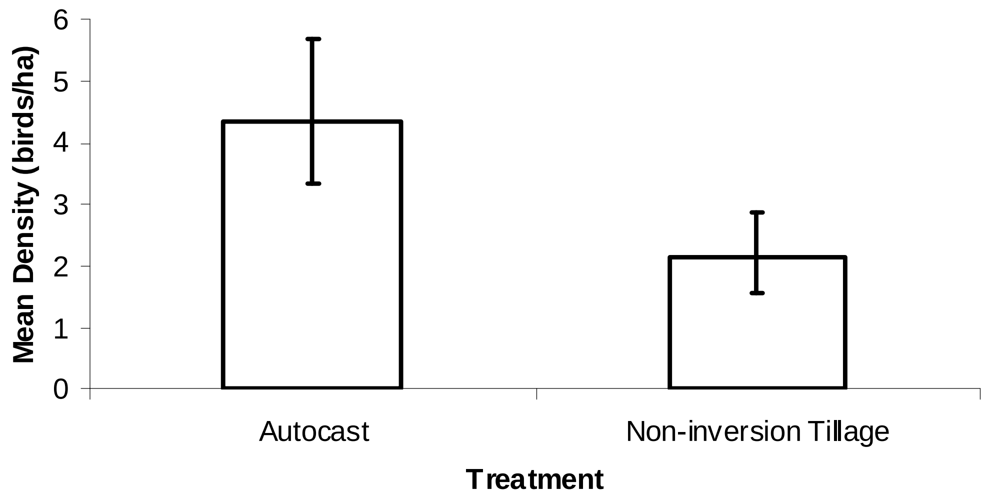

Figure 1. Mean densities of farmland bird index species using OSR fields established by broadcast and non-inversion tillage. 95% confidence limits are also shown.

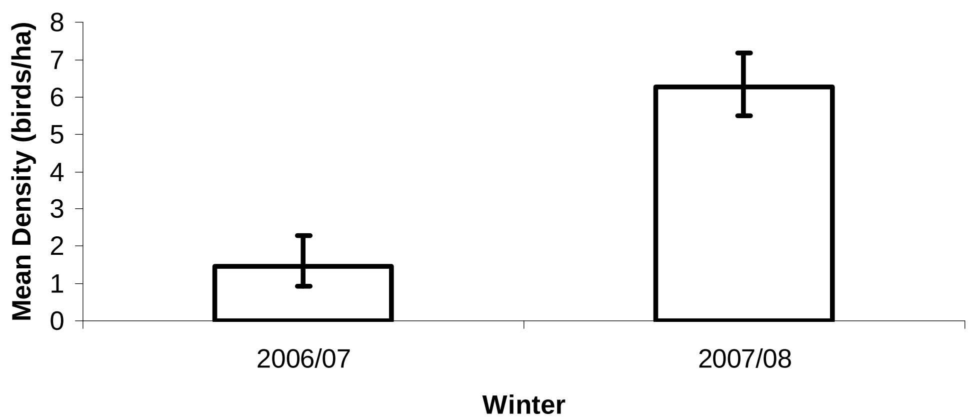

Figure 2. Mean densities (with 95% confidence limits) of farmland bird index species using OSR fields established in winter 2006/07 and 2007/08.

Conclusions and discussion: Analysis of the data has shown that in most cases densities of birds (number of birds/ha) did not differ significantly between the differing methods of crop establishment, either at a species level or in the various species groupings tested. The exception being the rather diverse Farmland Bird Index group, which includes species with a wide range of feeding requirements – omnivores, carnivores (i.e. kestrel), insectivores and granivores. This group was found in significantly higher densities on the areas established with broadcasting than those established by non-inversion tillage, although densities on both treatments were low relative to some other agricultural habitats (e.g. over-winter cereal stubbles, root crops, wild bird seed mixtures).

It is perhaps surprising that granivores did not show a greater response to the availability of these broadcast fields compared to the non-inversion tillage fields. High densities of granivores using cereal stubbles in winter have been reported from several other studies (Moorcroft *et al.* 2002, Hancock & Wilson 2003, Bradbury *et al*. 2004, 2008) utilising both spilt grain and seeds from germinated arable plants (Wilson *et al.* 1999). For a food source to be utilised it, firstly, has to be recognised as such and, secondly, easy access to the food source is required (Wilson *et al.* 2005). A likely explanation for birds not selecting the broadcast treatment may be that the rate of growth of the OSR during the autumn is such that it rapidly shades out the cereal stubble. Typically, plants have reached BBCH principal growth stage 2 by November (Fig. 3), with further development towards growth stage 3 by February (Lancashire *et al.* 1991, authors pers. obs.), although in both winters the development of the OSR on the non-inversion tillage fields lagged behind that on the broadcast fields principally due to a later establishment date (Appendix 1). This effectively makes much of the cereal stubble unrecognisable as such, inaccessible and may prevent birds from ensuring effective predator surveillance whilst feeding on the stubble (Butler *et al.* 2005, Whittingham *et al.* 2006). It has also been shown that birds may alter their pattern of usage of a food source if its ability to maintain effective predator vigilance is impaired (Whittingham *et al*. 2004).

Figure 3. Broadcast oil-seed rape (BBCH principal growth stage 2) at Grange Farm, November 2008.

The densities of birds found using the non-inversion fields was higher than expected considering there was little more than the OSR plants growing over the sparse straw left from the establishment. However, non-inversion tillage is likely to leave spilt oil-seed grains and other seeds close to the soil surface and therefore exploitable by birds. The difference in bird densities using either establishment method investigated are unlikely to be as great compared to conventionally established OSR, which would leave very little split grain and other near surface seeds from the harvest and pre-cultivation germinated arable plants, although quantitative data are lacking on this. It is also known that species such as woodpigeons and skylarks will forage on the plant leaves of OSR (Inglis *et al*. 1990, Donald *et al*. 2001, Gillings & Fuller 1991); indeed the exploitation of OSR in winter has been postulated to explain the rapid increase in woodpigeon abundance in England (Gibbons & Reid 1993). It is unlikely though that the establishment method will influence the choice of where to feed for these species.

It is also possible that the micro-climate under the OSR plants, once they have reached BBCH growth stage 2, is such that it allows invertebrates to better survive the winter climate providing a food source for species which prefer to forage in dense cover such as song thrush, dunnock *Prunella modularis* and wren *Troglodytes troglodytes*. As with the omnivorous species, it is unlikely the establishment method will have a significant effect on which field they choose to forage in, although virtually all species were recorded at (non-significantly) higher densities in the broadcast fields compared to the non-inversion tillage fields.

Densities of woodpigeon, skylark and the 'probers' and FBI groupings, were found to be significantly higher in the second winter of the trial than the first. It is unclear whether this between-winter effect was attributable to differences in the weather, or due to unmeasured variables, such as topography, boundary features or surrounding habitat.

Recommendations: This trial was carried out on only one farm, and a wider-scale trial may be needed to provide evidence of impacts throughout the wider countryside. However, at present the decision on method of establishment for oilseed rape crops should be based on agronomic and economic considerations, as for birds, there is no clear and consistent evidence that suggests one technique is more beneficial than the other. At Grange Farm, we continue to use the broadcast method for establishment of OSR for the agronomic and economic reasons discussed above. Crucially, until evidence is available to contradict this study, cereal stubble with oil-seed broadcast on it should not count towards the overall area on a farm delivering good quality winter food resources for birds.

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Appendix 1. Applications and cultivations on the non-inversion tilled and broadcast oilseed rape fields at Grange Farm.

Winter 2006/07

Date	Cultivations	Broadcast			Non-inversion		
		A	B	C	A	B	D
05/08/2006	seed	✓	✓	✓			
05/08/2006	fertiliser	✓	✓	✓			
07/08/2006	molluscicides	✓	✓	✓			
25/08/2006	herbicides	✓	✓				
31/08/2006	molluscicides	✓	✓				
05/09/2006	herbicides						✓
06/09/2006	herbicides	✓	✓	✓			
06/09/2006	insecticdes	✓	✓	✓			
06/09/2006	adjuvants	✓	✓	✓			
06/09/2006	seed				✓	✓	✓
08/09/2006	herbicides				✓	✓	✓
03/10/2006	molluscicides				✓	✓	✓
11/10/2006	molluscicides				✓		
15/10/2006	fungicides	✓	✓	✓			✓
15/10/2006	herbicides	✓	✓	✓			✓
15/10/2006	trace elements	✓	✓	✓			✓
15/10/2006	insecticdes				✓	✓	
02/11/2006	herbicides	✓	✓	✓	✓	✓	✓
30/11/2006	herbicides	✓	✓	✓	✓	✓	✓
30/11/2006	fungicides	✓	✓	✓	✓	✓	✓
01/02/2007	herbicides	✓			✓		
13/03/2007	fertiliser	✓	✓	✓	✓	✓	✓
28/03/2007	fertiliser	✓	✓	✓	✓	✓	✓
28/03/2007	insecticdes	✓	✓	✓	✓	✓	✓
28/03/2007	trace elements	✓	✓	✓	✓	✓	✓
28/03/2007	growth regulators	✓	✓	✓	✓	✓	✓

Winter 2007/08

Date	Cultivations	Broadcast	Minimum tillage
27/08/2007	seed	✓	
28/08/2007	molluscides	✓	
13/09/2007	insecticides	✓	
14/09/2007	seed		✓
15/09/2007	mollusicides		✓
01/10/2007	herbicides	✓	
01/10/2007	insecticides	✓	
04/10/2007	mollusicides		✓
20/10/2007	herbicides		✓
20/10/2007	insecticides		✓
26/10/2007	herbicides	✓	
26/10/2007	fungicides	✓	
26/10/2007	insecticides	✓	
01/11/2007	herbicides	✓	
01/11/2007	fungicides	✓	
27/11/2007	herbicides	✓	✓
27/11/2007	fungicides	✓	✓
11/02/2008	fertilser	✓	✓
12/02/2008	herbicides	✓	
12/02/2008	adjuvants	✓	
19/02/2008	fertilser	✓	✓
31/03/2008	fertilser	✓	✓
31/03/2008	trace elements	✓	✓