Breeding birds on organic and conventional arable farms

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Chapter 5

Breeding skylarks (*Alauda arvensis*) on organic and conventional arable farms in the Netherlands

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A rare thing: skylark nest in a conventional winter wheat crop

Abstract

The aim of this study was to analyse the effects of differences in cropping pattern between organic and conventional arable farms on the breeding activity of skylarks and to assess the effects of arable crop management on skylark nest survival. Skylark nest density was seven times higher on organic farms than on conventional farms (0.63 vs. 0.09 nest per 10 ha.). Skylarks showed a strong preference for spring cereals, lucerne and grass leys, all of which were mainly or exclusively grown on organic farms. On organic farms nests were initiated during the entire breeding season, but on conventional farms no nesting activity was found during the peak of the season (early May to early June). On organic farms 27% of all nests was successful. Increasing the availability of suitable breeding habitat during the peak of the breeding season on conventional farms might provide one means of enhancing breeding skylark populations. On organic farms, crop management should focus on reducing nest loss due to farming operations.

Keywords: Organic farming; *Alauda arvensis*; Habitat preference; Arable crops; Reproductive success; Mechanical weeding

Introduction

Once a very common bird in European agricultural landscapes, skylark *Alauda arvensis* populations in most western European countries are now under great pressure. Since the 1970s, declines of over 50% have been reported in several countries, such as the UK, the Netherlands, France and Sweden (Boutin *et al.*, 2003; Gregory *et al.*, 2004; Hustings *et al.*, 2004; Wretenberg *et al.*, 2006). As a result of these declines the skylark has been put on Red Lists in several countries (e.g. van Beusekom *et al.*, 2004; Gärdenfors, 2005).

As with other farmland bird species, skylark population declines have been associated with agricultural intensification. In particular, changes in cropping patterns are said to have affected skylark populations (Chamberlain *et al.*, 1999a). First of all, there has been a change from spring-sown to autumn-sown cereals (Chamberlain *et al.*, 2000). Even early in the breeding season, autumn-sown cereals are already unsuitable as a breeding habitat for skylarks, becoming too tall and dense (e.g. Chamberlain *et al.*, 1999a). Secondly, lower crop diversity is associated with lower skylark densities (Chamberlain *et al.*, 1999a; Browne *et al.*, 2000), possibly because this reduces opportunities for producing multiple nests (Wilson *et al.*, 1997).

On organic farms, crop diversity and the area of spring-sown cereals are generally larger than on conventional farms (e.g. Hole *et al.*, 2005; Levin, 2007) and several studies found higher skylark densities on organically managed farms (e.g. Wilson *et al.*, 1997; Chamberlain *et al.*, 1999b). Additionally, the absence of pesticide use on organic farms may have an indirect positive effect on skylark breeding success through higher food availability (Odderskær *et al.*, 1997; Boatman *et al.*, 2004), although the evidence is equivocal (Donald, 2004). On the other hand, organic farmers use mechanical methods of weed control, which might result in direct nest failure of ground-breeding birds (e.g. Kragten and de Snoo, 2007).

This study aimed at analysing breeding activity and breeding success of skylarks on organic and conventional arable farms. First of all, the effects of differences in cropping patterns on breeding activity were assessed. Secondly, the effect of crop management on skylark nest survival was investigated.

Materials and methods

Study area

The study was carried out from April to July 2006 in two arable areas in the centre of the Netherlands: Oostelijk Flevoland (approximate location 52°32'N, 05°43'E) and Noordoostpolder (approximate location 52°44'N, 05°46'E). Both areas are polders, reclaimed during the 1950s and 1930s, respectively, and are adjacent to each other. Both polders have a similar landscape: very open with few vertical landscape structures such as tree lines, wind turbines and power lines. In both areas the predominant crops are winter cereals, potatoes, sugar beet and onions.

A total of 36 arable farms (18 organic and 18 conventional), comprising 663 ha. organically managed and 764 ha. conventionally managed farmland, were selected in a pairwise set-up. All farms had one or more parcels of approximately 25 ha. These parcels were divided into several fields, but fields were not separated from each other by boundary structures. Vertical landscape elements are, if present, only at the edges of these parcels. To limit the bias caused by surrounding landscape elements, the pairing procedure was based on keeping these surrounding landscape elements (e.g. roads, forests, power lines, wind turbines) as similar as possible for both farms of a pair. All organic farms had been managed organically for at least seven years. The relative on-farm abundance of non-cropped habitats (e.g. field margins, hedgerows) was slightly higher on organic than on conventional farms (4.3 vs. 3.7% of total farm area), but no effect on skylark abundance was found (Kragten and de Snoo, 2008).

Data collection

Information about cropping pattern and crop management (type and timing of farming operations) was gathered by interviewing the farmers. All farms were visited at least once a week in order to observe skylark territory display or breeding activity, such as nest-building and chick-feeding. When a nest was found, its location was saved using a GPS device (Garmin Geko 201). In a few cases, nests were inconspicuously marked with a small piece of red tape approximately 15 m. from the nest. For all nests the type of crop, clutch size and number of hatchlings were recorded. All nests were visited every four days and on each visit the status of the nest was recorded (incubated, chicks present, failed, successful). Nests were defined as successful when at least one chick fledged. Skylark chicks normally leave the nest when they are eight days old (Donald, 2004). To be able to conclude whether a nest was successful, chick age needed to be known. Therefore, chick age was determined based on dates for the first egg-laying or hatching. If this was not possible, chick age was estimated by comparing feather development with that of chicks of known age. For all failed nests the cause of nest failure was determined. If a nest was found empty before the chicks had reached nest-leaving age, the nest was considered as failed due to predation. If there were signs of recent farming operations and the nest was damaged but still contained egg remnants, the nest was recorded as failed due to farming operations. In order to make sure that these nests had not been predated eggshells were checked for traces of predators (e.g. bitemarks). Nests with dead chicks in the near vicinity were defined as failed due to starvation. Also the dead chick bodies were checked on bitemarks in order to rule out predation as a cause of failure.

Data analysis

Skylark nest density (seasonal total) on conventional and organic farms was compared using a Wilcoxon Signed Ranks Test (SPSS 12.0). Most crops used by skylarks as breeding habitat were only available on some of the farms. Therefore, we considered all farms with a certain management (organic or conventional) as one study area in which the birds could select their breeding habitat. Then, a Chi-square test with the observed number of skylark nests per crop being compared with the expected value based on a uniform distribution of nests over different crops was used to analyse breeding habitat preference on both farm types. Based on first egg-laying dates, we analysed whether there was a shift in crops used as breeding habitat by skylarks as the season progressed. First egg-laying dates were calculated back from chick age, or from the number of eggs when nests were found during the egg-laying stage, assuming production of one egg per day (Donald, 2004).

In order to investigate the effects of differences in cropping patterns between organic and conventional farms on skylark breeding activity, two approaches were used. First, the relative abundance of crops used by skylarks as breeding habitat (based on nests) was compared between the two farming systems, using a Wilcoxon Signed Rank Test. Secondly, the availability of suitable breeding habitat was monitored throughout the breeding season. Suitable skylark breeding habitat was defined as a crop with a height of 20-50 cm. (e.g. Wilson *et al.*, 1997). In 2005, crop height and ground cover were measured for all crops on all farms on five occasions between mid April and mid-July. Each crop was measured at three randomly placed fixed points. Crop height was measured using a measuring stick, while ground cover was determined by visual estimation. Based on these data, polynomial crop growth curves were modelled and used to estimate the period in which the crop had a height of 20-50 cm. To correct for variation in sowing dates, growth curves were calculated for fields that were sowed within half-monthly intervals. The availability of suitable breeding habitat on organic versus conventional farms was compared per day, using Wilcoxon Signed Rank Tests. To gain more insight into the effects of crop density on breeding skylarks we estimated the crop density at the moment of nest initiation. For this purpose, polynomial growth curves were applied based on ground cover data collected in 2005 as well.

As ample size (n =7) was too small on conventional farms, skylark nest survival was only calculated for organic farms according to Mayfield (1975). A total nest period of 23 days was applied (including egg laying). Relative nest loss due to farming operations, predation and starvation was calculated using a technique similar to a baseline hazard approach (Kleinbaum, 1996). In this approach, only nests that failed due to a specific cause are considered as failed. Differences between nest failure rates due to different causes were then analysed using a likelihood-ratio test, as described by Aebischer (1999).

Results

A total of 49 nests were found, 42 of them on organic farms and seven on conventional farms. Nests were found on 11 organic and five conventional farms. Nest density was significantly higher on organic farms (0.63 vs. 0.09 nest per 10 ha.; Wilcoxon Signed Ranks Test, Z = 2.668, P = 0.008). On conventional farms the nests were found in winter cereals, spring cereals and peas (Table 8). On organic farms the nests were found in spring cereals, lucerne, grass leys, carrots, peas, oregano, potatoes, winter cereals and onions. Table 8 shows the percentage of nests found in a specific crop type compared to the expected percentage of nests in case of a uniform distribution of nest over crop types. On conventional farms, winter cereals in particular were preferred as a breeding habitat On organic farms especially in spring cereals, lucerne and grass leys more nests were found than expected. Areas of most crops preferred by skylarks (spring cereals, lucerne and grass leys) were larger on organic farms (Table 9).

For 37 nests the initiation date could be determined. There was a clear shift in crop preference as the breeding season progressed. In Table 1 nest initiation dates of the first and last nest built in a crop type are shown. Early in the breeding season most nests were found in winter cereals (mainly on conventional farms), regenerated lucerne and grass leys (on organic farms). During the peak of the breeding season (May – early June) the majority of the nests found were in spring cereals (mainly on organic farms). With one exception, nests were not initiated in spring cereals after the first half of June, but other crops like lucerne, carrots and potatoes were used instead.

Of all nests, 88% were initiated (first egg) when the crop was 20-50 cm. high. However, the crop density (percentage ground-cover) at the moment of initiation showed major variation between crops: spring cereals (65-100% ground cover), winter cereals (80-95%), lucerne (90-100%), grass leys (90-100%), peas (15-55%), carrots (30-50%) and potatoes (40-45%).

In five of the seven nests found on conventional farms, the first egg-laying date was between April 12 and May 8. This was followed by a period of approximately one month without any nesting on conventional farms. The two other nests were initiated on June 4 and June 9, respectively. On organic farms, breeding activity was observed throughout the whole breeding season (first nest April 6, last nest July 13), with no periods without breeding activity (Figure 5).

Table 8 Number of skylark nests (N) found per crop type on organic and conventional farms. "Observed nests" (Obs.) is expressed as percentage of the number of nest found per farm type. "Expected nests" (Exp.) is the percentage of nests that should be expected based on a uniform distribution of nest over all crop types. Nest initiation dates are given for the first and last nest initiated.

	Organic			Conventional			Nest initiation dates	
Crop type	N	Obs.	Exp.	N	Obs.	Exp.	First nest	Last nest
Spring cereals	18	42.9	22.3	1	14.3	7.2	May 7	June 27
Lucerne	7	16.7	4.4	--	--	--	April 6	July 3
Grass leys	4	9.5	2.7	--	--	--	May 6	May 14
Carrots	4	9.5	8.4	0	0	5.8	June 21	July 13
Peas	3	7.1	6.7	1	14.3		May 24	June 4
Oregano	2	4.8	0.3	--	--	--	April 26	May 28
Potatoes	2	4.8	16.5	0	0	24.3	June 10	June 10
Winter cereals	1	2.4	1.0	5	71.4	14.3	April 12	May 8
Onions	1	2.4	10.6	0	0	12.3		

Table 9 Mean percentage of farm area (±SD) with crops in which skylark nests were found. N = number of farms on which the crop was grown. *P* represents the level of significance between organic and conventional farms where ** < 0.01, * < 0.05, NS > 0.05.

	Organic	N	Conventional	N	*P*
Potatoes	16 ± 10	15	26 ± 10	17	*
Spring cereals	22 ± 11	17	5 ± 11	4	**
Onions	11 ± 8	13	11 ± 8	13	NS
Winter cereals	1 ± 5	2	15 ± 13	11	**
Carrots	10 ± 9	12	6 ± 10	8	NS
Peas	6 ± 12	5	1 ± 4	2	NS
Lucerne	6 ± 10	6	0	0	*
Grass leys	3 ± 8	2	0	0	NS
Oregano	0.3 ± 1	1	0	0	NS

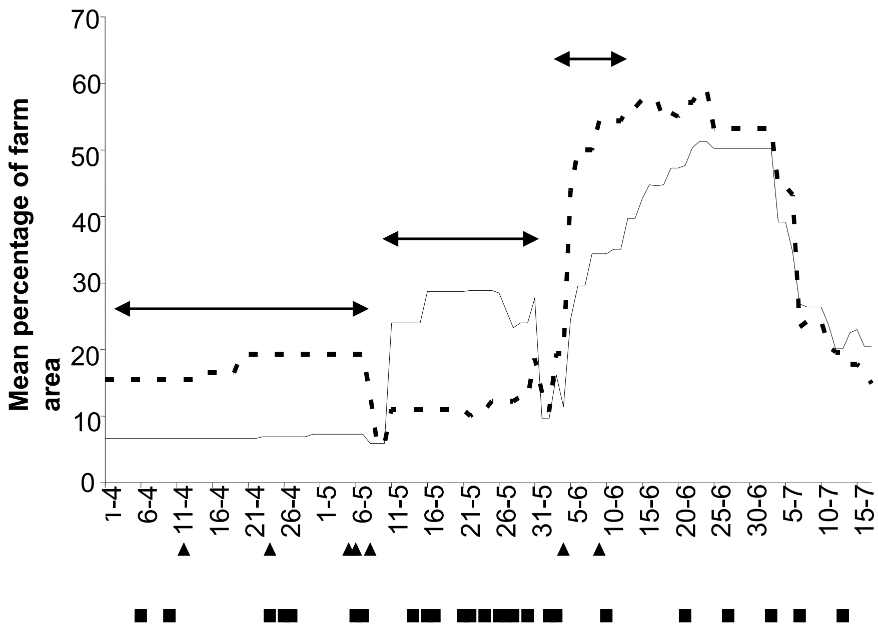

Figure 5 Mean percentage of farm area with suitable breeding habitat for skylarks in relation to skylark nest initiation. The solid line represents organic farms, the dashed line conventional farms. Arrows represent periods with a significant difference in the availability of suitable breeding habitat (Wilcoxon Signed Rank Test, *P* < 0.05) between organic and conventional farms. ▲ = nest initiated on conventional farm, ■ = nest initiated on organic farm.

On both farm types, the relative area with suitable breeding habitat for skylarks changed as the breeding season progressed (Figure 5). Based on these changes, the breeding season was divided into three periods. During the first period (until May 9) conventional farms had relatively more suitable habitat compared with organic farms (Wilcoxon Signed Ranks Test, $P < 0.05$), due mainly to the presence of winter cereals on the former, which were more suitable compared to spring-sown crops. The second period (May 10 - June 1) was characterised by higher breeding habitat availability on organic farms (Wilcoxon Signed Ranks Test, $P < 0.05$), owing to the presence of spring cereals. By then, winter cereals have become too tall (> 50 cm.), while especially spring cereals have reached a suitable height. During the third period (from June 2 onwards), finally, the availability of breeding habitat increased markedly on both types of farm. By this time, spring cereals have become too tall (> 50 cm.), but several vegetable crops (e.g. carrots, potatoes) are sufficiently high. There is consequently a substantial increase in the amount of suitable breeding habitat available on both farm types, with conventional farms having relatively more suitable habitat during the first days of this period (Wilcoxon Signed Ranks Test, $P < 0.05$).

The period without breeding activity on conventional farms (May 9 - June 3) corresponded well with the period (10 May - 1 June) in which suitable breeding habitat was limited on these farms (Figure 5). In contrast, on organic farms 19 nests (45% of the total) were initiated during this period and there was no shortage of suitable breeding habitat. During the peak of the breeding season there is thus a gap in the availability of breeding habitat on conventional farms, which is likely to limit breeding activity of skylarks.

Mayfield calculations for organic farms were based on 36 nests. Of these nests 21 were successful, ten failed due to farming operations, four were predated and the result of one nest was unknown. Daily skylark nest survival rate (± SE) on organic farms was 0.944 ± 0.015, which equals 27% of all nests being successful. On organic farms nest failure as a result of farming operations seemed to be higher than nest predation rates, but the difference was not significant (Likelihood ratio test, df 1, $D = 2.731$, NS). Of the nests failed due to farming operations, four failed due to mechanical weeding (spring cereals and onions), three due to cutting (grass), three due to ploughing (lucerne) and one due to ridging-up (carrots).

Discussion

In our study skylarks nest densities on organic farms were almost seven times higher than on conventional farms, which is in line with previous findings (e.g. Wilson *et al.*, 1997; Chamberlain *et al.*, 1999b). The strong preference for crops like spring cereals and lucerne (also found by Wilson *et al.*, 1997; Eraud and Boutin, 2002), plus the fact that these crops were grown over larger areas on organic farms, is probably an important factor behind the difference in nest density.

Besides larger areas of preferred breeding habitat, organic farms especially provide more suitable breeding habitat during the peak of the breeding season. This is likely to facilitate skylarks to produce multiple clutches on these farms. On conventional farms however, there seems to be a gap in the availability of suitable breeding habitat during the peak of the breeding season.

In this study suitable breeding habitat was defined as a crop with a height of 20-50 cm. The estimated nest initiation dates and data on crop development show that indeed most nests were initiated when the crop has reached this height, but ground-cover showed a large variation between crop types. Besides crop height, other factors that might have influenced breeding activity is the patchiness of a field (Daunicht, 1998) and food availability.

Breeding success on organic farms was at approximately the same level found earlier in the UK (Wilson *et al.*, 1997). However, in 2006 the total amount of precipitation was very high during the second half of May and mechanical weeding was consequently often impossible. In spring cereals, a crop strongly preferred by skylarks as breeding habitat during this period, far fewer farming operations were carried out compared with years with more average weather circumstances.

On conventional farms, the limited availability of suitable breeding habitat during the peak of the breeding season is probably one of the main reasons that skylark breeding activity was low and limits the possibility of production of multiple clutches. By increasing the areas of crops that are suitable as breeding habitat during the peak of the breeding season (e.g. spring-sown cereals and peas), skylarks will possibly be able to produce multiple clutches on these farms.

On organic farms, during the peak of the breeding season the availability of suitable breeding habitat is higher and nests were found during the entire season. However, organic crop management may have a markedly negative effect on breeding success. A reduction of farming operations in spring cereals, especially, for a certain period could enhance skylark breeding success.

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