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Chapter 2

Field-breeding birds on organic and conventional arable farms in the Netherlands

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The author carrying out a breeding bird survey

Abstract

In this study territory densities of field-breeding farmland birds were compared on pairwise-selected organic and conventional arable farms for two years. Differences in territory densities between the two farm types were explained examining the effects of three factors on territory densities: (1) non-crop habitats, (2) crop types and (3) within-crop factors. In both years, densities of most species did not differ between organic and conventional farms. Only skylark and lapwing were more abundant on organic farms, but only skylarks showed a consistent pattern over both years. Differences in crop types grown between the two systems were the only explaining factor for differences in densities of skylark. For lapwing, the difference was only partly due to differences in crop type, but differences in within-crop factors (probably as a result of crop management) were likely to have had an effect as well. There were no significant differences in abundance of non-crop habitats between the two farming systems, so this could not explain differences in territory densities.

Key words: Organic farming; Farmland birds; Habitat preference; Non-crop habitats; Crops; Landscape composition

Introduction

Populations of characteristic farmland birds are under severe pressure in north-west Europe (BirdLife International, 2004), with agricultural intensification cited as the main force behind this decline, i.e. increased usage of agrochemicals (pesticides, artificial fertilizers), removal of non-crop habitats and farm specialisation (Chamberlain *et al.*, 2000; Donald *et al.*, 2001, 2006). Organic farming is mentioned as one possible way of enhancing farmland bird populations (Christensen *et al.*, 1996; Lokemoen and Beiser, 1997; Chamberlain *et al.*, 1999; Freemark and Kirk, 2001; Beecher *et al.*, 2002; Belfrage *et al.*, 2005).

Organic farming systems differ from conventional systems in several aspects. In the first place, no artificial pesticides or fertilizers are used on organic farms, leading to greater food availability in terms of both invertebrates and plant matter (reviewed by Bengtsson *et al.*, 2005; Hole *et al.*, 2005). Secondly, organic arable farms generally have a wider crop rotation scheme, resulting in greater crop diversity (McCann *et al.*, 1997; Levin, 2007). A more diverse cropping pattern may provide multi-brooded ground-breeding birds with more suitable nesting sites throughout the breeding season (Wilson *et al.*, 1997). Finally, organic farms generally have larger areas of non-crop habitats (Gibson *et al.*, 2007; Levin, 2007). As non-crop habitats are used as foraging and nesting sites by many bird species (Sparks *et al.*, 1996; Vickery and Fuller, 1998), this is likely to have beneficial effects on bird densities as well.

Although several studies compared bird territory densities on organic and conventional farms, deeper analyses of the causal mechanisms behind observed differences are scarce (e.g. Chamberlain *et al.*, 1999; Freemark and Kirk, 2001). To explore opportunities for enhancing farmland bird populations, it is not enough just to know *whether* organic farming benefits farmland birds, but also *how* it does so. As birds use species-specific cues to select territories,

differences between organic and conventional arable farms may give rise to species-specific differences in territory densities (Cody, 1985). Therefore, more detailed analyses at species level should be carried out. The present study aims to compare bird territory densities on organic and conventional arable farms. Furthermore, it aims at species-specific explanations for observed differences. These explanations are related to three different factors: (1) differences in non-crop habitats, (2) differences in crop type and (3) differences in within-crop factors.

Materials and methods

Study area

This study was carried out in two neighbouring large-scale arable farming areas of the Netherlands: Oostelijk Flevoland and Noordoostpolder. Both are young polders (reclaimed during the 1950s and 1930s, respectively) with a clay soil of marine origin. Both polders have a similar homogenous landscape which is characterised by rectangular parcels of approximately 22 (Noordoostpolder) and 30 (Oostelijk Flevoland) ha. Most parcels are bordered by ditches and larger waterways. The only tree lines are along roads. At several locations there are operational wind turbines. The dominant crops are potatoes, winter cereals, sugar beet and onions. Set-aside fields are very rare in the area and in most cases they do not have grassy or regenerated vegetation, but are tilled frequently, in order to minimize weed populations. Fields are generally ploughed in autumn, with no stubble being left in winter. Pesticide use by farmers is comparable to other Dutch arable regions (de Snoo and de Jong, 1999).

In the study a total of 40 arable farms were selected in a pairwise set-up, each pair consisting of one organic and one conventional farm. Farms were

paired with respect to surrounding landscape elements such as woodlots, tree lines, roads, power lines and wind turbines, with soil type and groundwater levels the same on both. On average, the conventional farms were slightly larger than the organic, but this difference was not significant (organic: 36 ha.; conventional: 40 ha.; Paired-Samples T-test, $t = 1.062$, $df = 19$, NS). There was only little variation in surrounding landscape between farm pairs. On-farm habitat factors such as crops and non-crop habitats were not included in the pairing protocol, these constituting essential differences between the two farming systems and are a result of farm management. All organic farms were managed organically for at least five years and are certified by SKAL, the certification body for organic food production in the Netherlands (www.skal.nl). According to the SKAL guidelines, use of non-biological agrochemicals and artificial fertilizers is prohibited.

Data collection

The study was carried out in 2004 and 2005. In 2004 20 farms (10 organic and 10 conventional) were included, while in 2005 the study was extended to 40 farms (20 organic and 20 conventional). All farms involved in 2004 participated in 2005 as well. During field visits, crops and non-crop habitats were mapped and acreages of each determined by measuring the dimensions (length and width). In the case of woody elements the tree crown projection was defined as the area. On each visit, crop height (cm) and ground cover (visual estimate) were determined at three fixed points in the fields.

To assess bird territory densities, the standard method of the Dutch Breeding Bird Monitoring Project was employed (van Dijk, 2004). Farms were visited five times between April and July. Visits were carried out from 30 min. before sunrise till three h. after sunrise. Both of the farms in each pair were investigated on the same morning, but the order in which they were visited was

alternated during the field period. Birds were mapped while walking transects along the field edges. Only the territories of field-breeding species were surveyed, thus excluding farmyard and hedgerow species. Species that breed almost exclusively in reed-beds were also not included in this study, as reed-beds were managed by the water board, although owned by the farmers.

Data analysis

Non-crop habitats were assigned to one of four categories: (1) grassy (including field margins and ditch banks), (2) ditches, (3) reed and (4) woody and the percentage area in each category calculated for each farm. Rotational leys, present on just two organic farms, were not included in grassy non-crop habitats but were considered as crops. Ditches were dry during the majority of the breeding season. Reed was mainly present alongside larger waterways owned by the water board and was cut every two years. Hedgerows, shrubs and trees were considered as woody habitat elements. The relative abundance of crops on each farm was likewise calculated as a percentage of farm area. In addition, crop diversity was calculated and expressed as the Shannon-Wiener index H' . Differences in abundance of non-crop habitats, crops and crop diversity between the two farm types were tested using Wilcoxon matched pair tests.

To analyse differences in territory densities between both farming types General Linear Mixed Models (GLMM) with Poisson error and logarithm link function were used. Therefore, territory densities per farm were $\log(x+1)$ transformed. Farm type (organic/conventional) and interaction between farm type and polder (Oostelijk Flevoland/Noordoostpolder) were included as fixed terms. Farm pair was included as random factor. The analyses were carried out in Genstat 10.1. Because effects of organic farming on territory densities are probably independent between species, a correction method for multiple testing (e.g. Bonferroni) was not required (Sokal and Rohlf, 2000).

To investigate crop preference, bird territory densities were compared between the six main crops: potatoes, sugar beet, onions, spring cereals, winter cereals and carrots. Analyses were carried out using the Kruskal-Wallis test (SPSS 12.0), followed by a testing procedure analogous to the Bonferroni pairwise comparison procedure as described in Neter *et al.* (1996).

Territory densities on organically and conventionally managed crops were compared in order to assess the effects of factors at crop level. Because in most cases the analysed crop was not grown on both farms of a pair a paired test could not be applied and Mann-Whitney U-test was used instead. In this case, test results per species are probably not independent between different crops, so the Dunn-Šidak method (Sokal and Rohlf, 2000) was applied to correct for this. In order to see whether differences in crop height or ground cover appeared between organic and conventional crop types these variables were compared at five moments during the breeding season using a Mann-Whitney U-test.

Results

On average, about 3-4% of the farm area consisted of non-crop habitats. Grassy, semi-natural elements were far more dominant than ditches, reed or woody elements. Grassy elements comprised grassy field margins and ditch banks. Woody elements consisted mainly of solitary trees and scrub, though some farms had a small hedgerow. Organic farms had slightly more non-crop habitat than conventional farms (2004: 3.7 % vs. 3.1%; 2005: 4.4% vs. 3.6%), although in both years differences were not significant (2004: Wilcoxon, $Z = 1.682$, NS, 2005: Wilcoxon, $Z = 1.717$, NS). When differences were analysed per habitat type only in 2005 more woody habitat elements were found on organic farms (Wilcoxon, $Z = 2.666$, $P < 0.01$), although the absolute difference was small.

The dominant crops were potatoes, spring cereals, onions, sugar beet and winter cereals, though most farms had some vegetable crops, too. There

were several major differences in crop type between the two farming systems (Table 2). On conventional farms relatively more potatoes, sugar beet and winter cereals were grown. On organic farms more spring cereals were grown. Furthermore, crop diversity was generally higher on the organic farms.

Table 2 Differences in crop type between organic and conventional arable farms, showing mean relative farm area (\pm SD) with each crop and percentage of farmers growing the crop. Crop diversity is expressed as the Shannon-Wiener index. N = number of farms. *** = $P < 0.001$, ** = $P < 0.005$, * = $P < 0.05$, NS = $P > 0.05$.

Year	2004					2005				
	Organic (N=10)		Conventional (N=10)		Sig	Organic (N=20)		Conventional (N=20)		Sig
Farm type	Area (%)	Farms (%)	Area (%)	Farms (%)		Area (%)	Farms (%)	Area (%)	Farms (%)	
Potatoes	19 \pm 4	100	28 \pm 6	100	*	16 \pm 9	85	27 \pm 8	95	**
Spring cereals	28 \pm 8	100	4 \pm 6	30	**	27 \pm 11	100	5 \pm 9	30	**
Onions	11 \pm 7	70	11 \pm 9	70	NS	11 \pm 7	75	11 \pm 10	65	NS
Sugar beet	5 \pm 11	20	16 \pm 9	80	*	2 \pm 5	15	15 \pm 10	80	**
Winter cereals	0 \pm 0	0	15 \pm 11	70	*	0	0	12 \pm 14	50	*
Carrots	7 \pm 8	50	4 \pm 5	40	NS	7 \pm 8	55	4 \pm 6	35	NS
Belgian endive	1 \pm 3	10	6 \pm 8	40	NS	3 \pm 6	25	8 \pm 11	45	NS
Beans	5 \pm 7	40	3 \pm 11	10	NS	5 \pm 6	50	3 \pm 8	15	NS
Peas	3 \pm 8	20	0 \pm 0	0	NS	6 \pm 8	40	1 \pm 4	15	*
Other crops	21 \pm 17	90	12 \pm 16	60	*	23 \pm 15	85	14 \pm 17	45	NS
Crop diversity	2.5 \pm 0.3		2.3 \pm 0.3		NS	2.6 \pm 0.5		2.2 \pm 0.4		*

Table 3 shows mean bird territory densities per 100 ha. on organic and conventional farms. There were no significant differences in total territory density of field-breeding species between the two types of farm. At the species level, only skylark (in 2004 and 2005) and lapwing (only 2004) were

significantly more abundant on organic farms. Although territory densities of other species did not differ significantly between farm type, each species had a consistent pattern of farm preference in both years. For example, territory densities of common quail (*Coturnix coturnix*) were higher on organic farms in both years. Of the investigated species, four were more abundant on organic farms in both years, while for three species the opposite was true.

As an extra check to see whether results were repeatable between years bird territory densities of 2005 were analysed using the subset of farm that took part in the study in 2004 as well. As in 2004, skylark reached higher densities on organic farms (GLMM, $F = 6.84$, $P < 0.05$). Lapwing reached again higher densities as well, although the difference approached significance (GLMM, $F = 4.29$, $P = 0.053$). Territory densities of all other species did not differ.

As there were no differences in the abundance of non-crop habitats between organic and conventional farms this could not have caused differences in bird territory densities. Therefore, possible effects of non-crop habitats on bird abundance were not further analysed.

Skylarks showed a consistent crop preference in both years (Figure 1). Skylark densities were relatively high in spring cereals compared with other crops. So, the larger areas of spring cereals on organic farms are probably enhancing skylark territory densities here. For lapwings, crop preferences were less clear, although in both years winter cereals were completely avoided. In 2005 lapwing territory densities were highest in onions, but in 2004 no crop type was clearly preferred. Winter cereals were exclusively grown by conventional farmers, but there were no differences in relative areas of onions between the two management types. The larger areas of winter cereals grown on conventional farms seem to have a negative effect on breeding lapwing densities. Of the species that did not differ between the two farm types yellow wagtail, common quail and meadow pipit showed a crop preference. These species preferred spring and winter cereals, potatoes (only yellow wagtail) and

carrots (only meadow pipit). However, the total area of these crops did not differ between farm types.

Table 3 Mean bird territory densities (per 100 ha. \pm SD) on organic and conventional arable farms. Total bird territory density and bird diversity are also shown. ** = $P < 0.01$, * = $P < 0.05$, NS = $P > 0.05$.

Year <i>Farm type</i>	2004 (10 farm pairs)			2005 (20 farm pairs)		
	<i>Organic</i>	<i>Conventional</i>	<i>P</i>	<i>Organic</i>	<i>Conventional</i>	<i>P</i>
Common Quail <i>Coturnix coturnix</i>	1.4 \pm 1.6	1.0 \pm 1.9	NS	1.2 \pm 1.6	1.0 \pm 2.1	NS
Oystercatcher <i>Haematopus ostralegus</i>	1.2 \pm 2.0	1.5 \pm 3.1	NS	1.3 \pm 1.8	1.6 \pm 2.6	NS
Lapwing <i>Vanellus vanellus</i>	13.1 \pm 7.3	5.7 \pm 6.7	*	12.6 \pm 9.8	8.0 \pm 6.6	NS
Skylark <i>Alauda arvensis</i>	8.8 \pm 4.3	2.3 \pm 2.8	*	7.7 \pm 4.6	3.3 \pm 3.1	*
Meadow Pipit <i>Anthus pratensis</i>	6.0 \pm 4.3	8.1 \pm 5.7	NS	9.5 \pm 10.7	9.6 \pm 6.7	NS
Yellow Wagtail <i>Motacilla flava flava</i>	17.5 \pm 10.4	20.1 \pm 11.4	NS	9.7 \pm 8.3	14.1 \pm 12.6	NS
Ringed Plover <i>Charadrius hiaticula</i>	0.3 \pm 1.0	0.0 \pm 0.0	NS	0.7 \pm 2.9	0.1 \pm 0.5	NS
Redshank <i>Tringa totanus</i>	--	--	NA	0.0 \pm 0.0	0.2 \pm 0.8	NS
Black-tailed Godwit <i>Limosa limosa</i>	--	--	NA	0.0 \pm 0.0	0.5 \pm 2.1	NS
Total density	48.1 \pm 20.3	38.7 \pm 18.3	NS	42.6 \pm 28.4	38.4 \pm 27.1	NS

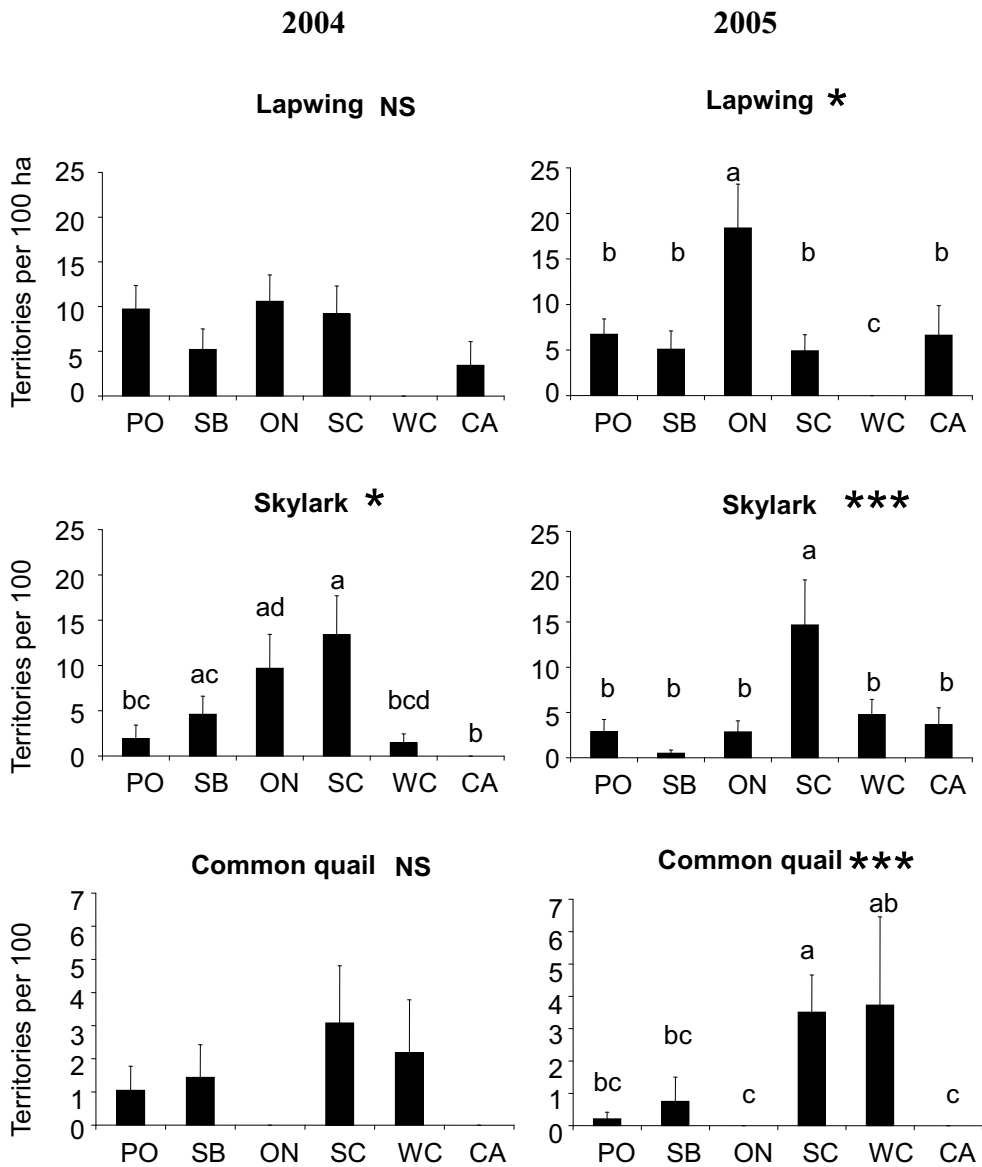


Figure 1 Territory densities (mean/100 ha. ± SE, vertical axis) of lapwing and skylark in six main crops in 2004 and 2005. PO = potatoes, SB = sugar beet, ON = onions, SC = spring cereals, WC = winter cereals, CA = carrots. Kruskal-Wallis test: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$, NS = $P > 0.05$. Letters above bars indicate inter-crop differences.

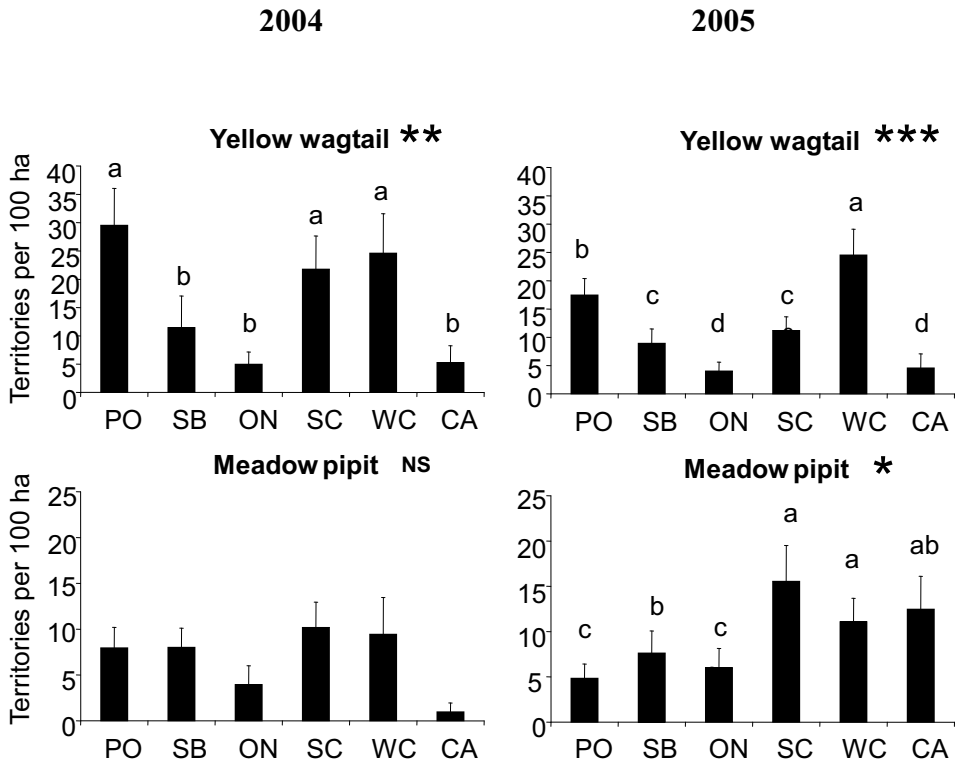


Figure 1 Continued.

To investigate whether differences in bird territory densities were caused by within-crop factors, comparisons were carried out within crops grown by at least six organic and six conventional farmers: potatoes (2004 and 2005), onions (2004 and 2005), spring cereals (2005) and carrots (2005). In both years lapwing densities were higher on organically managed onion fields compared to conventionally managed fields, but only in 2004 the difference was significant. Densities of other species did not differ between organic and conventional crop types. There was no difference in the growth rate of organic and conventional onions (all Mann-Whitney *U*-tests, $P > 0.05$). Therefore, the difference in lapwing densities was likely to be due to other within-crop factors.

Discussion

This study showed that the effects of organic arable farming on field-breeding birds are limited. Total densities did not differ between the two farming types and at the species level only skylark and lapwing reached higher territory densities on organic farms. This latter is in line with findings of previous studies (Christensen *et al.*, 1996; Wilson *et al.*, 1997; Chamberlain *et al.*, 1999). However, higher densities of lapwings were only found in 2004 when only ten pairs of farms were included in the study. Larger areas of spring cereals on organic farms seemed to be the only cause for higher skylark densities. For lapwings, larger areas of winter cereals on conventional farms and organic crop management (onions) are likely to have resulted in higher densities on organic farms. Territory densities of other species did not differ between the two farm types. This is probably a result of the fact that these species do not have a preference for a crop type which is grown in larger areas on one of the farm types.

In general, abundance of non-crop habitats did not differ significantly between organic and conventional farms, which is in contrast with other studies (Gibson *et al.*, 2007; Levin, 2007). Only in 2005 woody elements were more abundant on organic farms. The birds investigated in this study all prefer open landscapes and presence of trees had a negative effect on densities of these species (e.g. Wilson *et al.*, 1997). Despite higher abundance of trees, skylark density was higher on organic farms in 2005. This indicated that the difference in farm area with woody elements between the two farming types was probably too small.

Cropping regime differed in many aspects between the two farming types. The proportion of farm area occupied by spring cereals was higher on organic farms. The opposite was true for winter cereals, potatoes and sugar beet. Furthermore, crop diversity was higher on organic farms. Several studies

showed that spring cereals were more attractive to skylarks compared to most other crop types (e.g. Schläpfer, 1988; Wilson *et al.*, 1997; Kragten *et al.*, 2008). The avoidance of winter cereals by lapwing probably contributed to the lower lapwing densities on conventional farms.

Only for lapwing indications were found that actual organic management resulted in higher densities. In most cases however, territory densities did not differ between fields with the same crop type but different management (organic/conventional). This indicated that most species did not use cues related to crop management for territory selection. When the preferred crops are grown in equal proportions on both farm types, differences in territory densities between the two farm types are less likely to occur.

In order to get a complete picture of the effects of organic farming on breeding birds, reproductive output should be compared in order to conclude whether organic farming really enhances farmland bird populations. On organic farms, clutch survival of ground-nesting birds can be reduced because of usage of mechanical weeding methods instead of herbicides (Kragten and de Snoo, 2007). At the same time, though, breeding success might be enhanced by higher food availability (invertebrates, seeds) on such farms.

Further promotion of organic farming might further increase the area of organically managed farmland. Because arable farmers will change their crop rotation scheme when converting to organic farm management, the area of winter cereals will be reduced and the area of spring cereals will possibly grow. This can have positive effects on both skylark and lapwing. On the other hand, almost no differences were found in territory densities between organically and conventionally managed fields with the same crop type. This indicates that increasing the areas of preferred crop on conventional farms might help farmland bird populations as well.

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