Osnabrücker Naturwissenschaftliche Mitteilungen
Band 32, S. 191 – 198, 2006

Meadow birds on organic and conventional arable farms in the Netherlands: abundance and nest success

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Zusammenfassung: Als eine der Hauptursachen für den Rückgang der Wiesenvögel in westeuropäischen Grünland- und Ackerbaugebieten wird die Intensivierung der Landwirtschaft gesehen. Es stellt sich deshalb die Frage, ob eine weniger intensive Bewirtschaftung, z.B. in Form des ökologischen Landbaus, diese Abnahmen stoppen oder sogar wieder umkehren kann. Die hier präsentierte Studie beschäftigt sich vergleichend (1) mit den Siedlungsdichten von Wiesenvögeln auf konventionell und ökologisch bewirtschafteten Ackerflächen, sowie (2) mit dem Schlupferfolg von Kiebitzgelegen auf diesen Standorten.

Die Studie wurde in zwei Poldergebieten (Oostelijk Flevoland, Noordoostpolder) durchgeführt, die erst in den 1950er bzw. den 1930er Jahren dem Meer abgerungen wurden. Beide Gebiete weisen homogene, großräumige Ackerflächen auf. Insgesamt wurden 20 „Hofpaare" ausgewählt, wobei jedes Paar aus einem ökologisch und einem konventionell bewirtschafteten Betrieb bestand. Die beiden Betriebe eines jeden Paares wurden so gewählt, dass sich ihre Betriebsflächen in Landschaftsstruktur und Bodenverhältnissen nicht unterschieden. Alle ökologisch geführten Betriebe produzierten seit mindestens 5 Jahren in dieser Weise. Während die konventionell wirtschaftenden Betriebe mehr Kartoffeln, Zuckerrüben und Wintergetreide anbauten, wiesen die ökologisch arbeitenden Betriebe ein größeres Spektrum an Anbaufrüchten und mehr Flächen mit Sommergetreide auf.

In 2004 und 2005 wurden die Brutvogeldichten auf Betriebsflächen von 10 bzw. 20 „Hofpaaren" ermittelt. Dabei wurden insgesamt 6 Arten in größerer Dichte festgestellt: Schafstelze (*Motacilla flava*), Kiebitz (*Vanellus vanellus*), Wiesenpieper (*Anthus pratensis*), Feldlerche (*Alauda arvensis*), Wachtel (*Coturnix coturnix*), und Austernfischer (*Haematopus ostralegus*). In beiden Jahren war die Feldlerche auf ökologisch bewirtschafteten Flächen häufiger vertreten. Kiebitze traten in solchen Flächen ebenfalls in höherer Dichte auf, wenn auch nur in 2004 statistisch signifikant. Die Schafstelze dagegen siedelte in 2005 auf konventionell bewirtschafteten Flächen in höherer Dichte. Für alle anderen Arten konnten keine Abundanzunterschiede zwischen beiden Bewirtschaftungstypen ermittelt werden. Flächenunterschiede im Fruchtanbau zwischen ökologisch und konventionell wirtschaftenden Betrieben scheinen für die Abundanzunterschiede bei Feldlerche und Schafstelze verantwortlich zu sein. Feldlerchenreviere fanden sich vor allem in Sommergetreide, das stärker von ökologisch arbeitenden Betrieben angebaut wird. Schafstelzen besiedelten dagegen vor allem Kartoffeläcker und Wintergetreideflächen. Diese Früchte werden häufiger auf konventionell bewirtschafteten Äckern angebaut. Ein Vergleich der Siedlungsdichte beider Vogelarten auf der Ebene einzelner Feldfrüchte (z.B. Öko-Kartoffelfläche vs. konventionell bewirtschafteter Kartoffelacker) ergab keine Unterschiede. Es zeigt aber, dass die Feldfrucht für die Habitatwahl wichtiger ist als die Bewirtschaftungsweise. Beim Kiebitz gehen die Abundanzunterschiede zwischen ökologisch und konventionell bewirtschafteten Flächen nicht auf Flächenunterschiede im Anbau einzelner Feldfrüchte zurück. Vielmehr scheinen Unterschiede in der Bewirtschaftung einzelner Feldfrüchte wesentlich entscheidender zu sein.

In 2005 wurde vergleichend der Schlupferfolg von Kiebitzgelegen auf ökologisch bewirtschafteten (n = 80 Gelege) und konventionell bewirtschafteten Ackerflächen (n = 45 Gelege) ermittelt. Die Überlebenswahrscheinlichkeit der Gelege war auf ökologisch bewirtschafteten Flächen deutlich niedriger. Ursächlich war der höhere Maschineneinsatz sowohl bei der Feldbestellung als auch beim Jäten der Flächen.

Summary: Intensification of agriculture is mentioned to be the key drive behind the decline of farmland birds on grassland and on arable land. This raises the question whether a less intensive system, such as organic, can stop or reverse these declines. The present study compares (1) the territory densities of meadow birds on organic and conventional arable farms, and (2) the nesting success of Lapwings (*Vanellus vanellus*) on both farm types.

The study was carried out in Oostelijk Flevoland and Noordoostpolder, two polders reclaimed during the 1950s and 1930s respectively. Both areas are homogenous, large-scale, and mainly arable areas. In total 20 pairs of arable farms were selected, each pair consisting of one organic and one conventional farm. Both farms of a pair were selected in such a way that landscape features and soil type were equal for both. All organic farms have been managed organically for at least 5 years. Conventional farms grew relatively more potatoes, sugar beet and winter cereals, whereas organic farms had a more diverse cropping pattern with larger areas of spring cereals.

In 2004 and 2005 territories were mapped on respectively 10 and 20 pairs of farms. In total 6 meadow bird species were found: Yellow Wagtail (*Motacilla flava*), Lapwing, Meadow Pipit (*Anthus pratensis*), Skylark (*Alauda arvensis*), Common Quail (*Coturnix coturnix*), and Oystercatcher (*Haematopus ostralegus*). In both years Skylarks were more abundant on organic farms. The same held true for the Lapwing in 2004. In contrast Yellow Wagtails showed higher densities on conventional farms in 2005. For all other species no differences in abundances were found. Differences in crop rotation schemes between organic and conventional farms are likely to explain the differences in abundances of Skylark and Yellow Wagtail. The Skylark showed a preference for spring cereals that were more grown on organic farms. In contrast Yellow Wagtails reached highest densities in winter cereals and potatoes. These both crops are grown more on conventional farms. Comparisons on crop level (e.g. organic potatoes vs. conventional potatoes) showed no differences in abundances. This indicates that the crop itself is more important for territory establishment than crop management. For Lapwings differences in crop rotation scheme were unlikely to explain the differences in abundance in contrast to crop management. The latter might affect the densities of prey species, e.g. earthworms and ground-dwelling insects, of the Lapwing.

In 2005 the nesting success of Lapwings was determined for 80 nests on organic farms and 45 nests on conventional farms. The daily nest survival rates were almost significantly lower on organic farms as a result of higher farming activities, notably tilling of land and mechanical weeding.

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1 Introduction

In Western Europe, populations of several species of farmland birds have been in decline since the last decades as a result of agricultural intensification (Donald et al. 2001, 2006). These declines have resulted in the presence of some of these species on the Red List in different countries (BirdLife International 2004, van Beusekom et al. 2006).

Meadow bird species like Lapwing (*Vanellus vanellus*), Skylark (*Alauda arvensis*) and Yellow Wagtail (*Motacilla flava*) do not only breed in grasslands, but also on arable fields (e.g. Anthes et al. 2001, Sheldon 2002, Donald 2004). Several studies showed that organically managed arable farms hold higher territory densities of some of these species (Christensen et al. 1996, Wilson et al. 1997, Chamberlain et al. 1999) and therefore organic farming is said to be a possibility to enhance farmland bird populations.

So far it is not well understood why specific species reach higher densities on organic farms compared to conventional farms. Organic and conventional arable farms differ in several aspects from each other. First of all organically managed farms do not use agrochemicals such as pesticides and artificial fertilizers. Second, crop diversity is higher on organic farms (McCann et al. 1997), and organic farmers grow different crop types. Finally, there are indications that organic farms have more semi-natural habitats compared to conventional farms (Manhoudt 2006). Since birds use species-specific cues for territory selection differences between organic and conventional farms might have species-specific affects as well.

Although most studies comparing breeding bird populations between organic and conventional farms focussed on territory densities, breeding success might be a better indicator for estimating the effects of organic farming on farmland birds. Differences in crop management might result in differences in breeding success. The use of pesticides results in lower chick food abundance and this can result in lower breeding success (Boatman et al. 2004, Hart et al. 2006). On the other hand, the use of agrochemicals is prohibited on organic farms and therefore organic farmers use non-chemical methods to suppress weeds (Bond & Grundy 2001). These methods are potential threats for nests of ground-breeding birds such as Lapwings.

In order to obtain a more complete picture of the effects of organic farming on birds and to get better understanding of the underlying mechanisms, a study was designed that focussed at two aims. First of all, territory densities of meadow birds were compared between organic and conventional arable farms. The effects of differences in crop rotation schemes on bird abundance will be examined. The second goal was to compare nest success of Lapwings between organic and conventional arable farms. The results of this study can provide information that is useful in designing new, species-specific conservation programs.

2 Methods

2.1 Study area

This study was carried out in 2004 and 2005 in two large scale arable areas in the Netherlands: Oostelijk Flevoland and Noordoostpolder. Both areas are relatively young polders (reclaimed in the 1950s and 1930 respectively) with a clay soil of marine origin. The landscape is very open and has an allocation of rectangular parcels of approximately 300 by 900 metres. On every parcel several different crop types are grown. Most parcels are bordered by ditches, larger waterways and roads. Tree lines occur mainly along the roads and at some locations there are operational wind turbines.

In total 20 organic and 20 conventional arable farms were selected for this study using a pairwise set-up. Farms were paired with respect to the surrounding landscape. This means that the presence of certain landscape elements (e.g. woodlots, trees, roads, power lines and wind turbines) around the farm was equal for both farms within a pair. In addition, soil-type and groundwater levels were equal as well. On-farm habitats such as crop partition and presence of non-crop habitats were not included in the pairing procedure, since these are results of differences between organic and conventional farm management.

The conventional farms (40 ha) were on average slightly larger than the organic farms (36 ha), but the difference was not significant (Paired Samples T-test, t = 1.062, df 19, ns). All organic farms have been managed organically for at least five years and meet the requirements of SKAL, the Dutch control body for organic food production. All organic farms lacked the use of agrochemicals. In stead they applied mechanical weeding methods and organic manure. All conventional farms used chemical pesticides and fertilizers.

2.2 Data collection: Bird territories

In 2004 bird territories were investigated on 10 farm pairs, in 2005 this was done on 20 pairs. All farms involved in the study in 2004 were involved in 2005 as well. All farms were visited 5 times between April and July. All visits took place in the morning and both farms of a pair were visited during the same morning. Territory densities were established by using the standard method of the Dutch Breeding Bird Monitoring Project (Van Dijk 2004). During the field visits, crops and non-crop habitats were mapped and acreages were determined. Furthermore, crop height and ground cover were determined at three randomly placed but fixed points.

2.3 Data collection: Nest success Lapwings

In 2005 Lapwing nest surveys were carried out on all 40 farms and all farms were visited once a week. Nests were located by looking for breeding indicating behaviour, such as incubating females, guarding males and anti-predator behaviour. When a nest was found the location was saved using a GPS device. The nest was not marked in order to avoid farmers to adapt their management.

All nests were visited once a week and at each visit the nest was recorded to be incubated, hatched or failed. Nests were said to be incubated when small remnants of egg shell were found at the bottom. For all lost nests the cause of nest loss was determined. In case a nest was completely empty with no small remnants of egg shell on the bottom the nest was said to be predated. Farming activities were identified as cause of nest loss when relatively large remnants of the nest or eggs were found and there were signs of recently carried out agricultural operations. When eggs were still present but cold, the nest was said to be abandoned. A later visit was made to verify this.

2.4 Data analysis: Bird territories

Relative abundance of dominant crops was calculated and crop diversity was calculated and expressed as the Shannon-Wiener Index H'. Differences between organic and conventional farms were analysed using a Wilcoxon's signed rank test (SPSS 12.0).

Bird territory densities were calculated and compared between both farm types using Wilcoxon's signed rank test (SPSS 12.0). For species with different abundances on both types of farms territory densities of birds were calculated at the crop level for six dominant crops: potatoes, sugar beet, onions, spring cereals, winter cereals and carrots. Densities are compared between crops, but also for the same crop between farm management (organic vs. conventional).

2.5 Data analysis: Nest success Lapwings

Nest success was analysed by calculating daily nest survival rates (Mayfield 1961, 1975). For this purpose the nesting period was set at 32 days. Nest success was compared between organic and conventional farms using a likelihood-ratio test (Aebischer 1999). Nest loss as result of a particular cause (e.g. farming activities, predation) were analysed and compared between the two farming systems as well.

3 Results

3.1 Crops

There were some major differences between crop rotation schemes of organic and conventional farms (Tab. 1). Conventional farms grew relatively more potatoes, sugar beet and winter cereals. On the other hand, relative areas of spring sown cereals were larger on organic farms. Furthermore, organic farms had a more diverse cropping pattern.

3.2 Bird territories

Six species defined as meadow birds (Beintema et al. 1995) were found in high enough numbers to be included in the analyses: (1) Common Quail (*Coturnix coturnix*), (2) Oystercatcher (*Haematopus ostralegus*), (3) Lapwing, (4) Skylark, (5) Meadow Pipit (*Anthus pratensis*) and (6) Yellow Wagtail. In both years Skylarks were more abundant on organic farms compared to conventional farms (Tab. 2). Lapwings were more abundant on organic farms in only one year (2004). On the other hand, in 2005 Yellow Wagtails reached higher densities on conventional farms. For the other species no significant differences were found.

Skylark and Yellow Wagtail showed a crop preference that was consistent for both years (Fig. 1). Skylarks reached highest densities in spring sown cereals. Because spring cereals were mainly grown on organic farms this is likely to be an explanation for the difference in Skylark densities between organic and conventional farms. Yellow Wagtails reached highest densities in winter cereals and potatoes. These two crops are grown in relatively larger areas on conventional farms (Tab. 1), and therefore this could explain the higher densities of Yellow Wagtails on these farms. Lapwings only showed a preference for onions in 2005, but in 2004 no clear preference was observed. However, in both years lapwing completely avoided winter cereals, a crop only grown by conventional farmers.

Analyses at the crop level revealed that in both years Lapwings reached higher densities in organically managed onions compared to conventionally managed onions (2004: 18.5 ± 8.2 (organic), 2.7 ± 7.2 (conventional), Mann-Whitney test, $Z = 2.730$, $p = 0.007$, 2005: 26.8 ± 28.6 (or-

Tab. 1: Differences in crop rotation schemes between organic and conventional arable farms, showing mean relative farm area (± SD) with each crop and percentage of farmers growing the crop. Crop diversity is expressed as the Shannon-Wiener index (H'). *** = P < 0.001, ** = P < 0.005, * = P < 0.05, (*) = P < 0.10, NS = P > 0.10.

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

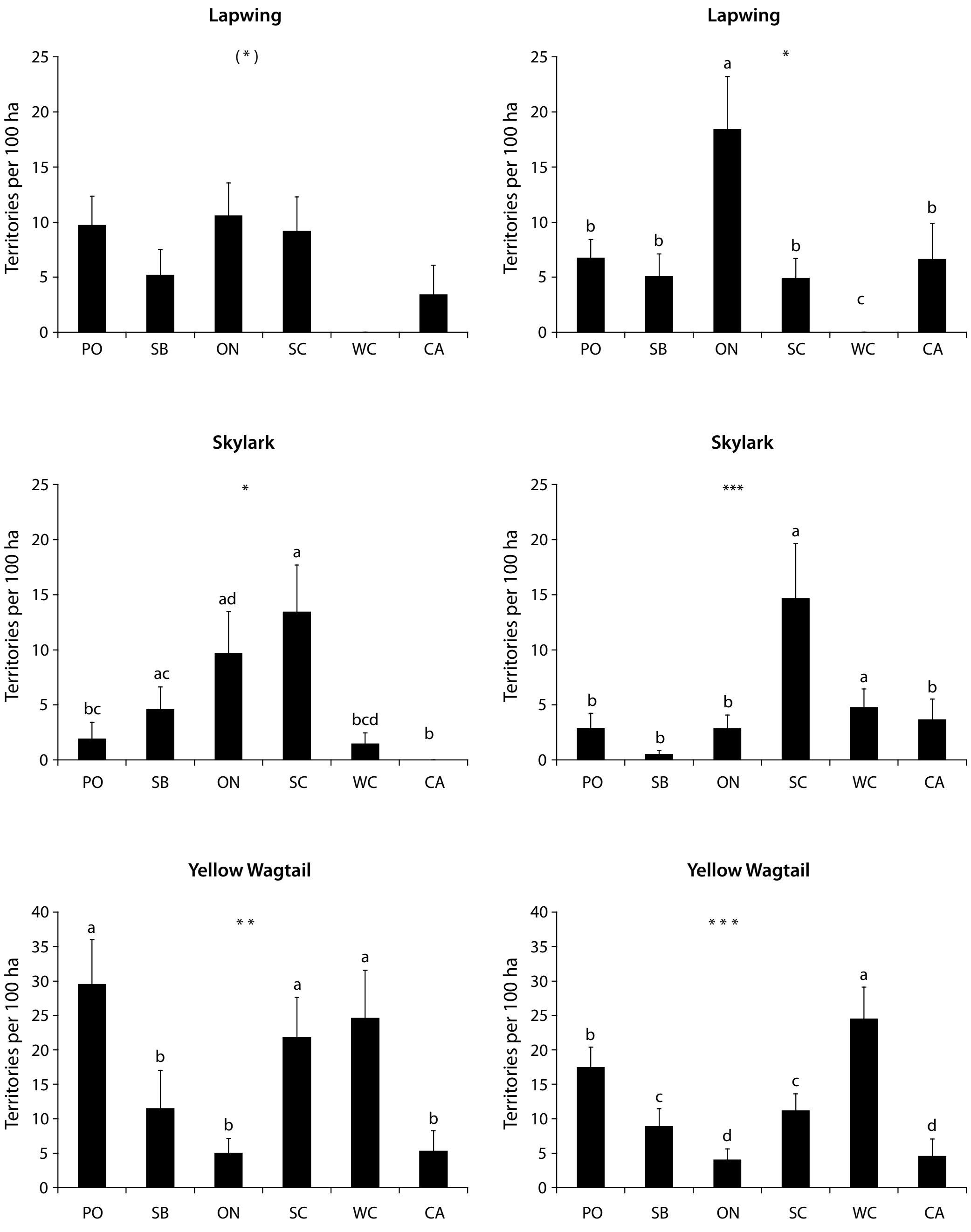

Fig. 1: Territory densities (mean/100 ha, ± SE) of selected bird species in 6 main crops in 2004 and 2005. PO = potatoes, SB = sugar beet, ON = onions, SC = spring cereals, WC = winter cereals, CA = carrots. Asterisks under species names signify the result of a Kruskal-Wallis test: * = P < 0.05, ** = P < 0.01, = P < 0.005, (*) = P < 0.10. Letters above bars indicate inter-crop differences.

Tab. 2: Mean bird territory densities (± SD) per 100 hectares on organic and conventional arable farms in 2004 and 2005. ** = P < 0.01, * = P < 0.05, NS = P > 0.05.

Year	2004 (10 farm pairs)			2005 (20 farm pairs)		
Field species / Farm type	Organic	Conventional		Organic	Conventional	
Common Quail *Coturnix coturnix*	1.4 ± 1.6	1.0 ± 1.9	NS	1.2 ± 1.6	1.0 ± 2.1	NS
Oystercatcher *Haematopus ostralegus*	1.2 ± 2.0	1.5 ± 3.1	NS	1.3 ± 1.8	1.6 ± 2.6	NS
Lapwing *Vanellus vanellus*	13.1 ± 7.3	5.7 ± 6.7	*	12.6 ± 9.8	8.0 ± 6.6	NS
Skylark *Alauda arvensis*	8.8 ± 4.3	2.3 ± 2.8	**	7.7 ± 4.6	3.3 ± 3.1	**
Meadow Pipit *Anthus pratensis*	6.0 ± 4.3	8.1 ± 5.7	NS	9.5 ± 10.7	9.6 ± 6.7	NS
Yellow Wagtail *Motacilla f.flava*	17.5 ± 10.4	20.1 ± 11.4	NS	9.7 ± 8.3	14.1 ± 12.6	*

ganic), 8.7 ± 17.8 (conventional), Mann-Whitney test, $Z = 2.183$, $p = 0.037$). This is an indication that differences in Lapwing densities between organic and conventional farms are caused by within-crop factors such as food abundance. For Skylark and Yellow Wagtail no differences were found. This supports the idea that differences in abundance of these two species are more likely to be caused by a difference in the relative area of a crop in stead of the crop management.

3.3 Nest success Lapwings

A total of 135 Lapwing nests were found of which 87 were on organic farms and 48 on conventional farms. Although the nest density on organic farms was almost twice as high the difference was not significant (11.9 ± 16.1 (organic), 6.0 ± 7.6 (conventional), $Z = 1.489$, $p = 0.136$).

Calculations of daily nest survival rates were based on 125 nests of which 80 were on organic and 45 on conventionally managed fields. There was a trend towards a higher daily nest survival rate on conventional farms (Tab. 3). This trend was mainly caused by more nest losses as a result of farming operations on organic sites. There was no difference in predation rates of nest between organic and conventional farms.

Tab. 3: Nest success of Lapwings on organic and conventional arable farms and nest losses as a result of farming activities and predation.
S = Daily nest survival rate.

	Type	S	P
Total	Organic	0.961 ± 0.006	0.071
	Conventional	0.976 ± 0.006	
Farming activities	Organic	0.974 ± 0.005	0.008
	Conventional	0.991 ± 0.003	
Predation	Organic	0.989 ± 0.003	0.957
	Conventional	0.988 ± 0.004	

4 Discussion

The results of this study show that organic arable farms attract higher numbers of Lapwing and Skylark, but Yellow Wagtail seems to prefer conventionally managed farms. However, this study also showed that organic arable farms hold certain risks for ground-breeding birds. Because of farming operations more Lapwing nests failed on organic farms and as a result total nest success seems to be lower as well.

For Skylark and Yellow Wagtail strong indications were found that differences in territory densities are mainly caused by differences in crops grown by the farmers. Because for these species no differences in densities were found between organically and conventionally managed fields with the same crop, it is likely that other factors, such as food abundance, are of less importance in the stage of territory settlement. In both years Lapwings avoided winter cereals completely. Although winter cereals were only grown on conventional farms it is unlikely that this is the only cause of the difference in Lapwing territory density. On average, between 12 and 15% of the area of conventional farms was grown by winter cereals, while Lapwing densities were more or less twice as high on organic farms. Considering that Lapwings reached higher densities in organically managed onion fields compared to conventionally managed fields, it is likely that for this species other factors than crop are of importance as well.

Foraging sites are important cues in the habitat selection by Lapwings (Berg 1993). In the prelaying stage, Lapwing predominantly feed on earthworms (Lumbricidae), but in later stages of the breeding cycle beetles (Coleoptera) become more important as prey items (Baines 1990). Several studies have investigated the abundance of earthworms and beetles on organic and conventional managed farmland, and the majority of them concluded that both earthworms and beetles are more common on organically managed sites (Hole et al. 2005). The higher abundances of earthworms and beetles on organic sites are possibly a result of the more extensive management, including no input of agrochemicals, and appliance of organic manure. This could mean that differences in Lapwing densities are indirect related to differences in crop management.

Although Lapwings were more abundant on organic farms in one year, the nest success seemed to be lower. This lower nest success was caused by more nest losses due to farming operations. The fact that territory densities are higher, but nest success is lower indicates that organic farms might act as ecological traps for Lapwings. However, in order to determine whether this is the case more information is necessary. This information includes chick survival, and adult survival. Besides, it could be that reproductive success on conventional farms is too low to maintain the population as well. This would mean that both farm types act as ecological traps, only organic being a stronger one.

This study explains for different species why they are more abundant on organic or conventional farms. This information can be used in designing new species-specific agri-environment schemes, which are in general more effective than schemes aimed at multiple species or taxonomic groups (Kleijn & Sutherland 2003). Secondly, this study showed that organic farming might attract higher numbers of birds, but that nest success of ground-breeding birds such as Lapwings might be lower. Lapwing populations are in decline as a result of an insufficient breeding success (Peach et al. 1994). This means that organic farming will not enhance Lapwing populations if no extra measures will be taken. One of these extra measures could be nest protection by volunteers. In Dutch meadow areas this has been shown to improve breeding success and enhance breeding populations of meadow birds (Teunissen & Willems 2004).

Acknowledgements. I would like to thank all the farmers for cooperating within this project. Cathy Wiersema, Erik Gertenaar, Erwin Reinstra, Wouter Bol and Bart Goosen helped collecting data. Geert de Snoo helped improving the manuscript.

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