

Effect of dairy farm management on Swallow *Hirundo rustica* abundance in The Netherlands

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Capsule Dairy farm management methods have no influence on numbers of Swallow breeding pairs.

Aim To identify differences in Swallow abundance between organically and conventionally managed dairy farms, by examining three factors: farm buildings, food availability and farmer attitudes to Swallows.

Methods Organic and conventional dairy farm holdings were compared in pairwise fashion. On visits to individual farms the number of occupied Swallow nests was counted, the number and type of farm buildings recorded, food availability assessed and the farmer's attitude gauged via a questionnaire.

Results No significant difference was found in the number of Swallows on organic and conventional farms. Nor was there any significant difference in food availability or farmer attitude between the two types of holding. On conventional farms there were significantly more buildings qualifying as preferential Swallow breeding sites, but this did not result in more Swallows on these holdings.

Conclusions Our results show that the adopted regime of dairy farm management (conventional versus organic) has no influence on the number of breeding pairs of Swallows.

Throughout Europe, certain species of farmland birds have been in decline for several decades (Burfield & Van Bommel 2004). One of these is the Barn Swallow, or Swallow *Hirundo rustica*, a semi-colonial, insectivorous, migratory species. In Europe as a whole, there was a 10–29% decline in the number of breeding pairs of Swallows between 1970 and 1990. Although the decline has subsequently dropped to 4% in the Netherlands, and has declined or even stabilized in several other countries, in much of northwestern Europe the number of breeding pairs has continued to decline, with a 1–9% decline in the overall European population since 1990 (Burfield & Van Bommel 2004). Earlier research had pointed to climatological changes in Africa as one possible cause of population decline (Saino *et al.* 2004). Within the species' breeding range, the ongoing intensification of agriculture, a decline in the number of (small) farm holdings and a loss of nesting opportunities have all been cited as contributing to the observed decline in Swallow abundance (Marchant *et al.* 1990, Møller 2003, Evans *et al.* 2003, Robinson *et al.* 2003).

In examining the impact of agricultural intensification, conventional farming is often compared with organic farming (Bengtsson *et al.* 2005, Hole *et al.* 2005). A number of studies have demonstrated that the latter has a positive impact on biodiversity, including bird diversity and the number of birds breeding on farm holdings (Bengtsson *et al.* 2005, Hole *et al.* 2005). Organic farming is based on a vision of the farm being embedded in natural processes and cycles, with external inputs of chemical fertilizers, herbicides and insecticides rejected, and use of veterinary drugs kept to a minimum (IFOAM 2005). We expected organic farm management to have a positive impact on the number of breeding pairs of Swallows, in light of the following three factors.

(1) *Buildings*. To close mineral cycles, organic farms are often managed as mixed holdings. Given the associated range of activities on the holding, we expected there to be a greater variety of farmyard buildings, with a potentially positive effect on Swallow numbers.

(2) *Food supply*. Because of their rejection of insecticides and use of organic fertilizers (i.e. manure), organic farms harbour more insect biomass than conventional farms (Bengtsson *et al.* 2005, Hole *et al.* 2005). This

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greater level of food availability is sometimes cited as a factor behind the generally greater numbers of birds found breeding on organic farms (Chamberlain *et al.* 1998). Swallows make use of this enhanced food supply, being seen foraging more frequently above organic than conventional cereal fields (Beecher *et al.* 2002).

(3) *Farmer attitude.* We expected organic farmers to have a more positive attitude towards Swallows than conventional farmers, respect for the environment, landscape and biodiversity, and conservation thereof, being central to the organic philosophy (IFOAM 2005). For these farmers, who do not use insecticides, Swallows also constitute an efficient form of insect control.

This study sought to answer two questions. (1) Is there any difference in the number of breeding pairs of Swallows found on Dutch dairy farms managed organically and conventionally? (2) If there is any difference between organic and conventional dairy farms in this respect, what factors can explain it?

To answer these questions we compared a number of organic and conventional dairy farms in the west of The Netherlands in pairwise fashion, examining the influence of three factors: buildings, food availability and farmer attitudes.

METHODS

The study took place in the 'peat meadow district' in the west of The Netherlands (51°49'N–52°11'N and 4°26'E–5°10'E). A total of 22 randomly selected organic farms were visited and pairwise comparison carried out with 22 conventional farms. Farms within each pair were about 2 km (0.5–5.3 km) apart. To exclude the influence of type of cattle shed (Van den Brink 2003, Ambrosini *et al.* 2002) and because the majority of Dutch conventional and organic dairy farmers today keep their cattle in loose barns, it was decided to restrict the study to holdings with this kind of barn.

Number of breeding pairs

All farms were visited once between 18 May and 18 June, when most Swallows have their first brood (Löhr & Gutscher 1973, Turner 1982). The aim was to visit each pair of farms on the same day, but when that proved impracticable (five times) the second farm was visited within three days. On each visit a count was made of the number of occupied Swallow nests, defined

as any nest with a brooding parent or nestlings. Nests to which birds were carrying nesting material or food, those with fresh excrement on their sides and those with eggshells on the ground below were also counted as occupied nests.

Farm buildings

Swallows usually make their nest within buildings, and once they have selected a breeding site they generally return to it each year. Presence of livestock, both at the present time and in the past, and the design of the building have an influence on Swallow numbers and distribution (Møller 1983, Ambrosini *et al.* 2002). On each holding, the number and type of buildings were recorded. Four types of building were distinguished, defined by two variables: presence or absence of cattle, and whether the building was 'closed' (four walls) or 'half-open' (one side open). In each building, Swallow occupancy and the number of nests were recorded.

Swallow food availability

Fledgling Swallows are fed mainly on Diptera, but their diet also includes Homoptera, Hymenoptera, Hemiptera and Coleoptera (Kozena 1983, Cramp 1980). Eighty per cent of these insects are between 1.5 and 5 mm in size, with a mean of 4.1 mm (Cramp 1980, Kozena 1983). On each holding, food availability was assessed in the week from 20 to 25 June 2005, the period when most Swallows have young. The insects were captured using 'sticky yellow traps' (25 × 10 cm, Pherobank) positioned 1.5 m above the ground, which is the foraging height of Swallows (Bryant & Turner 1982, Møller 2001, Evans 2003). Duplo traps were set at two locations, in the farmyard and 100 m away on nearby grassland; they were placed 5 m apart and left for three days. To exclude edge effects, the number of insects was counted in the middle of the traps (105 cm²). Three size classes were distinguished: 0 to ≤4 mm, >4 to ≤8 mm, and >8 mm. During the sampling period the mean temperature was 27°C (range 21–32°C), with an average wind speed of 2 on the Beaufort scale.

Farmer attitude

To gain an impression of farmer attitudes towards Swallows, all farmers were interviewed according to a standard format comprising four questions: (1) How do you feel about the presence of Swallows on your farm? (2) Are the Swallows breeding in places where they are

'unwanted'? (3) Do you regard Swallows as a beneficial species (i.e. as insectivores)? (4) Do you regard Swallows as a pest (i.e. as potential vectors of disease)?

Farmers could respond on a scale from 1 to 5, with 1 indicating complete agreement/very positive and 5 complete disagreement/very negative.

Statistical analysis

The differences between conventional and organic holdings in terms of Swallow breeding pair count, number of buildings, food availability and farmer attitude were analysed by means of a paired *t*-test. Because the data on building type showed a non-normal distribution, they were subjected to a Wilcoxon matched-pairs signed-rank test to identify any differences between the two kinds of farm management. Swallow preference for a particular type of building was assessed by calculating the number of occupied nests per building and applying ANOVA with type of building as factor.

For differences between insect trap locations we used a

paired *t*-test, with each farm regarded as a unit within which trap sites were then paired. Test statistics of paired *t*-tests were regarded as significant after the improved Bonferroni correction for $n = 13$ simultaneous tests (Haccou & Meelis 1994).

A regression analysis was performed of insect biomass against head of cattle per hectare. It was also assessed whether insect numbers might be an explanatory factor for the number of Swallows on a holding.

RESULTS

Basic farm data

No significant difference in size was found between organic and conventional holdings, nor in the number of livestock kept (Table 1). On conventional farms, however, the number of livestock per hectare was significantly higher than on organic holdings (2.2 ± 0.3 and 1.8 ± 0.4 , respectively). Conventional farmers also tended to put their cattle out to graze less (106.8 ± 26.7 versus 127.5 ± 39.4 hours per year).

Table 1. Basic farm data, number of Swallows and the three factors investigated on organic and conventional holdings.

	Organic farms	Conventional farms	Parameter tested	Adjusted critical value	P-value
Basic farm data					
Holding size (hectares)	43.1 ± 39.5	38.8 ± 26.8	$t_{1,20} = 1.474$	0.005	0.155
Herd size (head of cattle)	75.9 ± 25.6	86.7 ± 37.2	$t_{1,20} = -1.460$	0.005	0.159
Cattle per hectare	1.8 ± 0.4	2.2 ± 0.3	$t_{1,20} = -4.506$	0.000	0.000
Hours of grazing, per head, per year	127.5 ± 39.4	106.8 ± 26.7	$t_{1,20} = 1.944$	0.004	0.066
Swallows					
Number of nests per holding	4.0 ± 3.7	4.1 ± 3.8	$t_{1,21} = -0.047$	0.050	0.936
Buildings					
Total number of accessible buildings per holding	4.5 ± 1.7	4.6 ± 1.6	$t_{1,21} = 0.654$	0.010	0.520
Number of buildings of the type 'cattle, closed'	1.7	2.3	$z = -2.397$	–	0.017
Number of buildings of the type 'no cattle, closed'	1.2	1.1	$z = -0.131$	–	0.896
Number of buildings of the type 'no cattle, half-open'	1.1	1.1	$z = 0.000$	–	1.000
Number of buildings of the type 'cattle, half-open'	0.5	0.1	$z = -1.706$	–	0.088
Insects					
Total number of insects per trap per holding	68.9 ± 17.3	69.4 ± 15.1	$t_{1,21} = -0.113$	0.025	0.911
Number of insects per trap per holding: field	66.3 ± 16.0	69.4 ± 18.8	$t_{1,21} = 0.279$	0.017	0.783
Number of insects per trap per holding: farmyard	71.4 ± 31.5	69.3 ± 21.5	$t_{1,21} = 0.789$	0.008	0.439
Farmer attitude^a					
General Swallow presence	1.0 ± 0.2	1.1 ± 0.3	$t_{1,20} = -0.568$	0.013	0.533
Swallows breeding where they are 'unwanted'	3.6 ± 0.8	3.5 ± 0.9	$t_{1,20} = 0.972$	0.006	0.376
Swallows as a beneficial species (insect control)	1.6 ± 0.8	1.8 ± 0.7	$t_{1,20} = -1.451$	0.006	0.188
Swallows as a pest species (disease vector)	4.3 ± 0.6	4.1 ± 0.7	$t_{1,20} = 0.900$	0.007	0.382

All results are reported as average ± sd. Adjusted critical value as calculated after Bonferroni correction (Haccou & Meelis 1994). –, Missing value due to non-normal distribution (Wilcoxon matched-pairs signed-rank test). ^aFarmer attitude score: 1 = complete agreement/very positive, to 5 = complete disagreement/very negative.

Number of breeding pairs

Breeding Swallows were observed on 89% of all dairy farm holdings: 20 of the organic farms (90%) and 19 of the conventional farms (86%). In all, 179 occupied nests were found, with the number per holding varying from zero to a maximum of 15. There was no significant difference in the number of occupied nests between conventional and organic holdings (Table 1). No significant correlation was found with the period of time for which organic farms had been established ($P = 0.708$)

Farm buildings

Both types of holding had an average of four farm buildings (Table 1). In terms of building type, on conventional holdings there were more closed buildings serving as cattle sheds. As Table 2 shows, Swallows prefer to breed in closed buildings housing livestock, where percentage occupancy as well as average nest number are both highest.

Food availability

There was no significant difference in insect numbers (in particular Diptera) on the organic and conventional holdings. Neither was any significant difference found between the farmyard and grassland insect traps on either the organic or conventional holdings. Even when the data were broken down by size class there was still no difference between the two types of holding (0.1 to ≤ 4 mm: organic 57.8 ± 14.6 , conventional 57.59 ± 13.4 ; >4 to ≤ 8 mm: organic 10.9 ± 5.5 , conventional 10.7 ± 3.5 ; >8 mm: organic 1.1 ± 1.2 , conventional 1.0 ± 0.9). Small insects accounted for 82% of the total number.

The number of cattle per hectare was found to have no influence on the total amount of insects on the holding ($F_{1,41} = 2.738$; $P = 0.106$). There was a weak positive correlation, however, between head of cattle per hectare and the number of insects smaller than 4 mm ($75.82 + 19.37 * \text{cattle/ha}$, $F_{1,41} = 3.585$, $r^2 = 0.085$, $P = 0.059$). The presence or absence of Swallows on a holding does not depend on local insect abundance, for as many insects were found on Swallow-occupied (53.3 ± 20.9 , $n = 5$) as on unoccupied (58.3 ± 12.9 , $n = 39$, $P = 0.452$) holdings. The number of Swallow nests on these dairy farms showed no correlation with the number of insects on the holding ($F_{1,42} = 2.113$, $r^2 = 0.000$, $P = 0.887$), nor with any of the insect

Table 2. Occupancy rate and average number of nests per type of building.

Type of building	Occupancy rate (%)	Number of nests*
'Cattle, closed' ($n = 87$)	53	$1.4 \pm 2.2a$
'No cattle, closed' ($n = 51$)	49	$0.8 \pm 1.3a, b$
'No cattle, half-open' ($n = 48$)	15	$0.3 \pm 1.4a, b$
'Cattle, half-open' ($n = 13$)	25	$0.5 \pm 0.5b$

*Letters indicate different subsets, with more nests found in 'cattle, closed' than in 'cattle, half-open' buildings ($P = 0.002$).

size classes (small: $F_{1,42} = 3.207$, $r^2 = 0.001$, $P = 0.877$; medium: $F_{1,42} = 2.115$, $r^2 = 0.048$, $P = 0.153$; large $F_{1,42} = 0.231$, $r^2 = 0.005$, $P = 0.634$). Finally, the number of breeding Swallows showed no correlation with head of cattle per hectare ($F_{1,41} = 0.690$, $r^2 = 0.017$, $P = 0.411$), in contrast to the number of small insects.

Farmer attitude

In general, all the farmers had a very positive attitude to having Swallows on their holding (Table 1). Many of them make due allowance for Swallows by ensuring that doors and other entrances are left open. No difference in attitude was found between organic and conventional farmers. Most farmers agreed that the Swallows catch insects on and around the farm (organic 1.6 ± 0.8 , conventional 1.8 ± 0.7), while any risk of Swallows carrying disease was deemed unimportant (organic 4.3 ± 0.6 , conventional 4.1 ± 0.7). The farmers were neutral as to whether Swallows were breeding where they were 'unwanted' (organic 3.5 ± 0.9 , conventional 3.7 ± 0.9). If such is the case, it is often sufficient just to keep the building in question closed.

DISCUSSION

In contrast to prior expectations, our study revealed no difference in Swallow occupancy or number of breeding pairs on organic and conventional dairy farms in The Netherlands. In hindsight this is logical, given that the explanatory variables studied – number of farm buildings, Swallow food availability and farmer attitudes – did not differ significantly between the two categories of farm. What our results thus show is that Dutch conventional and organic dairy farms resemble one another more than one might think. One explanation for this is that virtually every organic holding was once conventionally managed. Although historical data of farming practice described current Swallow

abundance best (Ambrosini *et al.* 2002), we found no evidence in our study that Swallow abundance was influenced by the period of time that organic farms had been established. After the switch to organic farming – in this study, an average of 7.5 years ago – the organic farmers continued to use existing buildings. Following the switch they also specialized in dairy farming. Of all the organic farm holdings in The Netherlands, only 16% can be characterized as ‘mixed’ (CBS Statline 2005). On these holdings artificial fertilizers have been replaced by organic ones, artificial pesticides are rejected and livestock numbers are lower; however, this makes no difference to Swallow food availability on these holdings, whether in the farmyard or on adjacent grassland. A correlation was generally found, however, between the number of cattle and the number of small insects on the holding.

In this study Swallows were observed on almost every organic and conventional holding visited. This high occupancy rate indicates that Dutch dairy farms constitute important Swallow breeding sites. On each holding an average of four Swallow nests was found. This is in good agreement with data from Belgian cattle farms, where 3.5 nests were recorded on average (Windig & Florus 1997). However, over the past few decades there has been a marked decline in the number of cattle farms in Europe; in The Netherlands, for example, the number fell by 36% between 1993 and 2004 (CBS Statline 2005). Everywhere, cattle are seen less frequently and farm buildings are being turned into homes, or demolished. Given the findings of Møller (2003), who observed a decline in Swallow numbers as well as reproductive success following discontinuation of dairy farm operations, these trends are likely to lead to further loss of Swallows throughout Europe (Moore 2001). If the European population is to be stabilized, it would seem important to ensure the survival of dairy farms in rural areas. The results of the present study seem to indicate that it makes little difference whether these holdings are managed organically or conventionally. Our study did not, however, assess Swallow reproductive success on the two types of dairy farm as a function of building type or other parameters, and this is an issue requiring further study (Ambrosini 2003, Van den Brink 2003).

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