Density, structure and management of landscape elements on Danish organic farms

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Abstract
Density and management of landscape elements on organic farms were investigated for 345 organic farms in Denmark in 2001, representing approximately 10% of the total number of organic farms. The density of hedgerows, area habitats and ponds was estimated and related to various aspects of farm character, such as size, type and lifestyle/part time/full time farms, as well as region and biophysical context. A large variation in the densities was found, the highest densities were found on the smallest farms. Farm size was the farm parameter that was closest related to the density of landscape elements as well as landscape structural variables. Farm size was related to the other farm characteristics.

Keywords: landscape elements, farm character, hedgerows, ponds, farm management

Introduction

Organic agriculture represents a whole-farm approach to natural resource management, aiming at an integration of production goals, environmental goals and goals for nature management and protection. A common goal is that biodiversity in farmland and adjacent areas must not be compromised (IFOAM, 2002). Unlike in UK (Soil Association, 2002) concrete and measurable objectives have not been linked to this goal in Denmark, but standards related to the density of uncultivated areas on the farm have been discussed. The ways the aspirations for protecting farmland biodiversity manifest themselves in the practice of organic farming in different socio-economic and biophysical contexts are not well known.

In an intensively cultivated country as Denmark (62% of the total land area is agriculture, of which only 7% is permanent grassland and the rest is in rotation) the potential for biodiversity is to a large extent related to the agricultural land use and management. Landscape heterogeneity at farm scale has been shown to be positively correlated to species richness (Weibull et al., 2003) and structural adjustment with increasing farm sizes, larger fields and fewer crops is expected to influence biodiversity negatively (Hole et al., 2005). In the absence of larger uncultivated areas, landscape elements (hedgerows, woodlots, ponds, etc.) and extensively managed grassland often constitute important biotopes for biodiversity, and preservation and restoration of these elements are vital for preservation of farmland biodiversity (Aude et al., 2003, Bengstsson et al., 2005). It has been shown that the organic farming system increases species richness by approximately 30% compared to conventional farming, especially in intensively cultivated areas (Bengtsson et al., 2005). In these areas it is to be expected that the farmer's short and long term management of owned and rented land is important to the development of quality landscape elements, and thus to biodiversity. Management is both in terms of non-removal, securing elements with a long continuity, and in terms of new planting, adding to the total area of elements and increasing density.

The aim of this study was to investigate the variation in the density and management of landscape elements as well as landscape structure related to field size and crop diversity on organic farms in Denmark. Moreover we investigated if this variation was related to aspects of farm character such as type, size and workload (lifestyle, part time or full time farming) as well as biophysical and regional context.

Material and Methods

Data on crop distribution and field size were retrieved from the registry on land use of organic farmers (Plant Directorate, 2001). These were complemented with a quantitative survey consisting of personal interviews with 345 organic farmers constituting approximately 10% of the Danish organic farms. The interviews included questions concerning the farm enterprise, time spend in farming, management of permanent grassland and fields in rotation, location and age of uncultivated areas on the farm and land use changes within the last five years. Farmers were located in eleven case areas all over the country, covering main landscape types of Denmark and all with a relatively high density of organic farms. All the organic farmers in the case areas (35-40 farms pr area) were approached for an interview, and the response rate was 75%. The resulting sample of farms represents the national distribution of organic farm types.

The interviewed farmers were asked to identify landscape elements on their farm on a copy of an aerial photo covering the farm area (used for applications for agricultural subsidies). Density of landscape elements was calculated for 1) linear landscape elements (hedgerows and dikes), 2) area habitats (woodlots and small uncultivated areas), and 3) ponds. Hedgerow areas were estimated based on length and information on number of rows. Area habitats were estimated directly from the photo. Ponds were all assigned an area of 400m2 (national mean densities of ponds in the farmland was estimated to 390m2/ha in 1996, (Holmes et al., 1998)). The density of landscape elements was calculated based on total field area rather than farm area, aiming at a description of farmland density. Landscape elements were assigned to age classes: less than 5 years old, 5-15 years old, 15-30 years old, more than 30 years old.

In the analysis we tested if farm characteristics (lifestyle-, part time- and full time farms, farm type and farm size) and biophysical setting (dominating soil type, flat or undulating topography and region), could explain landscape structural elements (density of different types of landscape elements, the existence of young and old landscape elements, average field size and crop diversity). Undulating topography was defined as farms where more than 5% of the farm area is sloping more than 5%). Relationships between farm character and biophysical variables and landscape structural elements were analysed with non-parametric analysis of scores.

Results and discussion

Landscape elements constituted on average 3,6 % of the total field area on the farm, with a range of 0 to 34%. A large variation within farms was found for all elements, but with a skewed distribution dominated by low densities. The area of linear landscape elements made up 44% of the total area of landscape elements, while area habitats contributed with 51% and ponds 5% of the total area. Mean on-farm densities of landscape elements are seen in Table 1. 7% of the organic farms had no hedgerows, 30% no area habitats and 33% no ponds, but only two farms had no landscape elements at all, indicating that the different types of landscape elements were located at different farms.

Table 1 Length, number and area of types of landscape elements on 345 organic farms

Landscape elements	N *)	Mean length / number / area per farm	Mean density: length / number / area per ha	Mean estimated area density, m2/ha
Linear (hedgerows, banks)	333	1966 m	59 m/ha	150 m^2/ha
Point (ponds)	333	1,4	0,06/ha	24 m^2/ha
Area (woodlots etc.) <1ha	333	5923 m^2	188 m^2 /ha	188m^2/ha

*) Missing values for 12 farms

The three types of landscape elements differed in age distribution. Linear landscape elements were represented in all four age groups, albeit less in the youngest. Their presence in the middle age groups is to a large extent due to the subsidies for hedgerow planting that was initiated in the 1980's. The class representing more than 30 years old elements made up the largest share of the area habitats and the ponds, indicating that these landscape elements may constitute an important target for nature conservation as habitats with a long continuity. The lack of medium age ponds and the high frequency of young ponds (23% of total number of ponds) indicate a change in approach to management of the small habitats. Removal of landscape elements during the last 5 years has been insignificant, according to farmers.

For all types of landscape elements, farms with old elements were most frequent among large dairy farms. Hedgerows were also established with higher frequency on large dairy farms, while establishment of area habitats was most frequent on mixed farms of medium size, predominantly in moraine landscapes. Ponds were established with higher frequency on medium sized arable farms.

Analyses of the relationships between farm character variables and landscape elements showed statistically significant relationships among several variables as shown in Table 2.

Table 2: Relationship between farm characteristics and density of landscape elements

	hedgerows/ banks	area habitats	Ponds	av. field size	N of crops
N	333	333	333	340	340
Farm type	**	ns	**	***	***
Lifestyle/part time/full time	ns	ns	*	***	***
Soil type	***	ns	**	***	ns
Topography	**	**	**	ns	ns
Region	***	*	***	***	ns
Size class	***	ns	**	***	***

(Significance levels: $p<0.05$ **, $p<0.001$ ***)

Farm size was a good descriptor of several aspects of landscape structure, as most landscape parameters – except area habitats – were significantly related to farm size. This is not so surprising, as boundaries between farms often carry physical structures such as hedgerows. Furthermore, as farm size and average field size is positively correlated ($r=-0.29$, $p<0.0001$), small farms and thus lifestyle- and part time farms usually has a smaller scaled mosaic, with smaller fields and more field divides. Especially the very small farms (< 10 ha) tended to have high densities for ponds and area habitats. Further inspection revealed that for small farm

sizes a dual pattern of density exist: most farms have either no landscape elements at all or they have a high density. For larger farm sizes (above 30- 50 ha) the relationship between farm density and farm size is less significant. When the analysis of relationships were repeated including only farms with presence of the respective landscape elements, the significance of the test increased for almost all relationships, and also area habitats were then significantly related to all farm character variables, except the soil type.

High hedgerow densities were found on small, arable or meat farms and on the sandy soils on the outwash plains in West Denmark, as they are still to some extent established due to the need for wind protection. High densities of area habitats were found in regions with more undulating topography like river valleys and moraine deposits, probably partly due to farm optimisation. Ponds were found to have a strong regional attachment, as high densities were predominantly found on smaller lifestyle farms of different types in the moraine area in Eastern Denmark. Here amenity values may play a prominent role for the establishment. While average field sizes were correlated to farm size, they were also linked to the status of farms as full time, part time or lifestyle farms. Number of crops increased with farm sizes up to 30 ha, above which it tended to be alike.

Conclusion

There is a large variation in presence and density of landscape elements on organic farms in Denmark, but few farms have no landscape elements at all. The presence of hedgerows, area habitats and ponds follow different patterns. Smaller farms, which are most often part time or lifestyle farms, have higher densities of all elements in general. Regional variation is found for all landscape element types, but the presence of the different types vary in different landscapes. The frequency of farms with old and young elements also differ according to element type, but large farms seem to have a high frequency of both young and old hedgerows. Given that size enlargement is taking place among organic farms, similar to that in conventional agriculture, it is uncertain whether size changes will result in a continued decrease in landscape elements on organic farms or whether goals related to landscape protection weaken this development on larger organic farms in the future.

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