BIOLOGICAL MONITORING OF THE ORGANIC FARMING SCHEME IN NORTHERN IRELAND

Report to the Department of Agriculture and Rural Development

by

Agri-environment Monitoring Unit

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Agri-environment Monitoring Unit

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Co-ordinator	Dr. J. H. McAdam	(DARD)
Team members	Ms. M. Flexen	(QUB)
	Mr. R. J. Johnston	(QUB)
	Dr. A. Cameron	(QUB)

Address
Agri-environment Monitoring Unit
Department of Applied Plant Science
Queen's University of Belfast
Newforge Lane
Belfast BT9 5PX
Northern Ireland

Tel: 028 90255525
Fax: 028 90668372
Email: jim.mcadam@dardni.gov.uk
m.flexen@qub.ac.uk
r.j.johnston@qub.ac.uk

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SUMMARY

The Organic Farming Scheme (OFS) was established in Northern Ireland in 1999 by the Department of Agriculture and Rural Development (DARD) to aid farmers in converting to organic production. The scheme aims to encourage environmentally sensitive food production whilst helping to meet local consumer demand for organic produce. Participants enter into a five-year plan and receive payments to help them convert all or part of their land to organic farming. As well as farming organically farmers must manage their land in an environmentally beneficial way.

A study of eleven farms in Northern Ireland receiving payment under the OFS was carried out in summer 2002, in order to monitor the effects of organic farming on certain indicators of biodiversity. Plant and invertebrate communities were sampled from field boundaries and margins. In addition to the monitoring of farms under OFS agreement, similar surveys were also carried out on organic land at DARD's Greenmount Campus, where non-organic sites were sampled for comparison.

This report summarises the results of baseline biological monitoring of farms in the Organic Farming Scheme. Baseline surveys form a 'yardstick' in terms of biodiversity and it is not until a re-survey has been completed that the effects of any management practices can be determined. These farms have only been managed organically for a short period and it may take many years before any benefits for biodiversity to become apparent.

1. INTRODUCTION

1.1. The Organic Farming Scheme

The Organic Farming Scheme (OFS) was established in Northern Ireland in 1999 by the Department of Agriculture and Rural Development (DARD) under the Organic Farming Regulations (NI) 1999 (S.R. 1999 No.237). It has been incorporated into the Northern Ireland Rural Development Plan (NIRDP) 2000-2006 and is jointly funded by DARD and the European Union. The scheme aims to encourage environmentally sensitive food production whilst helping to meet local consumer demand for organic produce. It is open to farmers that have registered their land and developed a conversion plan with an approved organic sector body or UK Register of Organic Food Standards (UKROFS). Participants enter into a five-year plan and receive payments to help them convert all or part of their land to organic farming. Farmers can make more than one application to convert separate land parcels. There is no further financial support after conversion is completed but this may change in the future with the introduction of organic aid payments.

Organic farming uses methods designed to achieve sustainable production systems with limited use of external inputs. The use of artificial fertilisers and synthetic pesticides is avoided. Crop rotation is used to maintain soil fertility and control pests or diseases. Natural fertilisers such as animal manures are used. As well as farming organically farmers in the OFS must manage their land in an environmentally beneficial way (DANI, 1999). Environmental management prescriptions include the retention and protection of all semi-natural habitats, the maintenance of traditional field boundaries, and the retention of an uncultivated 1 metre wide strip adjacent to boundary features.

1.2. Scheme uptake

The initial uptake targets in the NIRDP (based on GB figures) were for 1000 farmers and 30,000ha of land to be under OFS agreement by 2006. These have been considerably revised with the target now 100 participants and 5500ha by March 2004 (DTZ Pieda Consulting, 2004). The figures for scheme uptake at end of 2003 were a total of 84 farms. There were also a further 16 supplementary agreements from participant farmers, i.e. for additional areas of land, giving a total of 100 agreements.

1.3. Biodiversity benefits of organic farming

A review of the environmental impacts of organic farming in the UK, including an assessment of the effects on biodiversity, has recently been carried out (Shepherd *et al*, 2003). As well as the benefits *per se,* increased biodiversity improves nutrient cycling, pest control and disease control. Several studies have been undertaken over the past few years to investigate the comparative biodiversity benefits of organic and conventional farming. These include studies on arable flora, birds and invertebrates. Most of the research has found greater levels of abundance and diversity of species on organic farms compared to non-organic farms, both in-field and on field boundaries or margins (Azeez, 2000). Many studies have been carried out on cereal crops (e.g. Norton, 2002) although there has also been some research on organic grassland (e.g. Younie & Armstrong, 1995).

Permanent pasture is important for its potential to provide stable and less disturbed environments, and to provide a refuge for biodiversity. Organic management of grassland has been shown to increase plant diversity due to reduced nutrient inputs, less intensive grazing, avoidance of pesticides and later cutting dates for mown swards.

Non-crop areas such as grass margins, hedges, ditch and bank habitats are intrinsic in organic regimes where their management is central to the philosophy (Stockdale *et al*, 2001). They play an important role for organic farming in providing habitats for predators of crop pests. The nature and extent of these habitats is the key to determining the overall biodiversity of agricultural areas, because they are the reservoirs for faunal and floral diversity (Gardner & Brown, 1998). Field margins and hedgerows on organic farms tend to have greater abundance and diversity of plants than equivalent areas on conventional farms (Critchley, 1994). Greater floral diversity has a positive impact on invertebrate diversity.

1.4. Current monitoring programme

A baseline study of eleven farms in Northern Ireland receiving payment under the Organic Farming Scheme was carried out in summer 2002, in order to monitor the effects of organic farming on certain indicators of biodiversity. The main focus of this monitoring is on plant and invertebrate communities, using methods based on other agri-environment scheme monitoring programmes (e.g. Hegarty *et al*, 1994). These have proved to be successful in determining the effectiveness of agri-environment schemes in maintaining or enhancing biodiversity. Changes in plant species composition have been widely used to examine long-term ecological changes such as the relationship between species diversity and agricultural management. Quantitative sampling of plant communities using quadrats was used to assess species diversity and composition. Ground beetles (Carabidae) and spiders (Araneae) were monitored as they are habitat specific, easily trapped in pitfall traps and are good indicators of biological change (Kirby, 1992). These groups of species are particularly useful in organic systems as they are important predators of agricultural pests.

Field boundaries and their associated margins were selected as the most suitable sites for sampling plants and invertebrates. These areas support higher levels of wildlife than in-field areas and as such they are most likely to see increases in species diversity over time. Field margins should also not be subject to disturbance by cultivation or application of slurry or manures. Soil sampling was carried out along field margins. Soil nutrient levels are expected to decrease over time due to organic farming practices.

In addition to the monitoring of farms under OFS agreement, similar surveys were also carried out on organic land at DARD's Greenmount Campus, where non-organic sites were also sampled for comparison. The Greenmount Organic Unit began organic conversion with the Soil Association in spring 2002.

2. METHODS

2.1. Sample selection

Baseline surveys were carried out on eleven farms, giving a 13% sample of farms under OFS agreement. These farms were randomly selected from a list of all OFS farms, to give an even sampling distribution over Northern Ireland. Three or four monitoring sites were located at each farm, giving a total of 40 sample sites. Four sites were randomly chosen from both organic and non-organic land at Greenmount Campus.

2.2. Botanical sampling

Plant data was recorded from transects randomly located along each field boundary in summer 2002. Tree and shrub species were recorded along a 10m length. The ground flora of the hedge base or bank was sampled using a 10m x 1m linear quadrat. The percentage cover of bare ground and bryophytes was also recorded. Plant species within the field margin were recorded from an adjacent 10m x 1m strip. Data from ditch vegetation was also collected if present. The management and structure of the field boundary was recorded along with the associated land-use. The location of sites was marked using a Global Positioning System (GPS).

2.3. Invertebrate sampling

Invertebrates were sampled using pitfall traps located on a sub-sample of the field margins. Ground beetles and spiders were sampled during three, four-week periods between April and October 2002. This was achieved at each site using five pitfall traps (polythene containers 9 cm wide and 20 cm deep) part filled with ethylene glycol to prevent the escape and deterioration of specimens before collection. Pitfall traps are the most efficient method of collecting invertebrate samples and produce more species than any other method (Coulson & Butterfield 1985). They also collect animals throughout the time they are in place and so are less labour intensive for the number of species trapped. At the end of each sampling period traps were emptied and removed. At the beginning of the next sampling period, traps were replaced and refilled with a fresh ethylene glycol solution. The contents from all 5 traps were pooled for each sampling site and frozen at -5^{o}C until sorting. All adult ground beetles taken in the traps were identified to species using Lindroth (1974). Species identifications were confirmed by Dr. Roy Anderson, (Agriculture and Environmental Science, Department of Agriculture and Rural Development). All adult spiders were identified to species using Roberts (1985). New species identifications were confirmed by Dr. Peter Merrett (British Arachnological Society).

2.4. Soil sampling

Ten soil samples of 10cm depth were taken from along each field margin using a 3cm diameter corer. These were mixed to give a composite sample for the site. They were then dried and subsequently chemical analysis was carried out to determine pH, phosphorus, potassium and magnesium levels (Allen, 1974).

2.5. Data handling

Plant data was recorded on standard record sheets and transferred to a database in MS Access 2000. Invertebrate data was collated and put onto an MS Access database. These records were also stored on the relational database Recorder 2002 and will be transferred to CEDaR (Centre for Environmental Data and Recording) at the Ulster Museum.

2.6. Data analysis

To monitor the success of the OFS scheme in maintaining or enhancing biodiversity, changes in plant and invertebrate species diversity, and also frequency and abundance of indicator species, will be analysed.

An indication of invertebrate species diversity at each site was given by alpha of the log series distribution of species abundance data. Alpha species diversity was calculated for ground beetles and spiders for each site. Alpha (α) was estimated by maximum likelihood in: $S = \alpha \ln (1 + N/\alpha)$

where: S is the species total and N is the total individuals of all species at each site (Southwood 1978).

Quality scores for each spider species based on rarity have been derived from all previous agri-environment monitoring data (Cameron *et al,* 2003). This allowed an overall spider biodiversity score to be calculated for each site.

3. BASELINE RESULTS

3.1. Botanical monitoring

Plant species diversity

The mean number of higher plant species (i.e. not including mosses, liverworts or lichens) for boundary components and field margins on OFS sites (including organic sites at Greenmount) was determined (Table 1). Species-richness of banks and field margins was highly variable between sites, ranging from 6 species to 35 and 28 species respectively.

Table 1. Plant species diversity of boundaries and field margins under organic management in 2002.

Boundary component	*n*	*Mean number of higher plant species per quadrat (se)*
Trees/shrubs	44	4.4 (0.3)
Hedge base/bank	44	20.1 (1.1)
Field margin	44	13.1 (0.7)
Ditch	4	9.5 (0.5)

The species-richness of banks and field margins on non-organic and organic sites at Greenmount was compared. Those sites in conventional fields had a higher mean number of plant species per quadrat, because they were situated in a less intensive part of the farm (Table 2).

Table 2. Plant species diversity on organic and non-organic Greenmount sites. (n=4)

Boundary component	*Mean number of higher plant species per quadrat (se)*	
	Organic	*Non-organic*
Hedge base/bank	10.0 (1.9)	16.5 (4.1)
Field margin	9.5 (0.9)	15.0 (1.1)

Plant species composition

The boundaries were not generally diverse in terms of numbers of tree and shrub species. Most of the hedges were dominated by hawthorn (*Crataegus monogyna*) with other frequent woody species being bramble (*Rubus fruticosus*), rose (*Rosa* sp.) and ivy (*Hedera helix*). Ash trees (*Fraxinus excelsior*) were present on 30% of sites. Gorse (*Ulex europaeus*) and blackthorn (*Prunus spinosa*) were also common.

The most frequently occurring species of the ground flora (i.e. hedge base or bank) were nettle (*Urtica dioica*), dandelion (*Taraxacum officinale*), cleavers (*Galium aparine*), red fescue (*Festuca rubra*), cocksfoot (*Dactylis glomerata*), creeping bent (*Agrostis stolonifera*), rough meadow-grass (*Poa trivialis*), yorkshire fog (*Holcus lanatus*) and creeping buttercup (*Ranunculus repens*). The most abundantly occurring herb species in terms of mean percentage cover were nettle, cow parsley (*Anthriscus sylvestris*) and cleavers, all indicators of high nutrient levels. The mean grass cover per quadrat was 51.4% and mean herb cover was 52.4%. Bare ground cover was generally low, with mean cover of 3.3%.

The field margins were generally species-poor improved grassland. Most abundant species in the margin were creeping bent (*Agrostis stolonifera*), perennial rye-grass (*Lolium perenne*), rough meadow-grass (*Poa trivialis*), yorkshire fog (*Holcus lanatus*) and creeping buttercup (*Ranunculus repens*). Grasses were dominant with mean cover per quadrat of 73%. Herb cover was usually low, with a mean cover of 17%. Field edges were often poached and trampled by cattle, leading to a mean bare ground cover of 12%.

Four seasonally wet ditches were recorded in the survey. These were species-poor and dominated by creeping bent, yorkshire fog and rough meadow-grass with abundant creeping buttercup and some soft rush (*Juncus effusus*). Under the scheme agreement ditch maintanance must be carried out in rotation and not between 1 March and 31 August.

Associated land use

The majority of the 44 organic sites were associated with improved grassland, 55% of fields were pasture and a further 41% were in silage. Only two sample sites were adjacent to arable fields, one under barley and the other potatoes. The four non-organic sites at Greenmount were all improved pasture.

Management of boundaries

Fourteen sites had recently managed hedges, either flailed or clipped. The other thirty sites had unmanaged boundaries, generally with overgrown or scattered shrubs. On farms under OFS agreement traditional field boundaries must be maintained. Hedge trimming is carried out in rotation, not between 1 March and 31 August.

3.2. Invertebrate monitoring

Ground beetles

A total of 10,226 individuals of 54 ground beetle species were captured from April to September 2002 on field margins of 26 sites on OFS farms (Appendix 1). The mean number of species captured per site was 18.3 (±0.9) and the mean number of individuals per site was 393.3(± 48.4).

The most abundant species by far was *Nebria brevicolis.* This species prefers drier, open habitats and has been found to be common on hedge restoration sites and cereal fields during baseline monitoring of the Countryside Management Scheme (CMS) (Flexen *et al*, 2004). Other frequent carabids recorded were *Pterostichus* species and *Agonum muelleri*, common species on agricultural land in Northern Ireland.

Comparison of organic and non-organic sites at Greenmount showed a higher mean number of individuals per site on the organic field margins and a similar mean number of species (Table 2).

Table 2. Invertebrate diversity on organic and non-organic field margins at Greenmount sites.

	Organic	*Non-organic*
Ground beetles		
Mean number of individuals per site	523	353
Mean number of species per site	16	15
Spiders		
Mean number of individuals per site	106	117
Mean number of species per site	10	11

Spiders

A total of 3337 spiders of 65 species were captured from April to September 2002 on field margins of 26 sites on OFS farms (Appendix 2). The mean number of individuals per site was 128.3 (±20.4) and the mean number of species was 12.8 (±1.1).

The most abundant species recorded were *Erigone atra*, a small money spider preferring an open vegetation structure and *Pardosa amentata*, a wolf spider previously found on undisturbed habitats.

Comparison of organic and non-organic sites at Greenmount showed a similar mean number of spider individuals per site and similar mean number of species (Table 2).

Spider species quality scores and alpha diversity have been calculated for OFS sites and are presented with equivalent scores for certain habitats under CMS agreement for comparison (Table 3). Alpha diversity of OFS sites is at present comparatively low but spider species quality scores are comparatively high. This is due to a small number of high scoring rare spider species recorded in the OFS sites.

Table 3. Spider species quality score and alpha diversity of OFS sites relative to scores for habitats from baseline CMS monitoring.

Habitat	*Ranked Spider Species Quality Score*	*Habitat*	*Ranked Alpha diversity*
Hedge restoration	148.5	Farm woodland	7.1
Field margin of OFS participant	**98.0**	Hedge restoration	6.8
Farm woodland	83.5	Farm scrub	6.3
Cereal field	82.8	**Field margin of OFS participant**	**4.1**
Farm scrub	44.8	Cereal field	3.1

3.3. Soil analysis

Results of soil analysis from field margins of organic sites are shown below (Table 4). Soil nutrient levels for each farm will be compared over time. Few sites had ‘excessive’ levels of soil nutrients, in terms of agricultural recommendations (Cruickshank, 1997). However levels were generally above that required for grassland or cereals.

Table 4. Mean soil pH and nutrient levels (n=44)

Soil attribute	*Mean level per site (se)*
pH	5.85 (0.07)
P (mg/l)	28.9 (3.5)
K (mg/l)	406.9 (57.2)
Mg (mg/l)	314.2 (47.9)

There were highly significant negative correlations between the soil levels of potassium, phosphorus and magnesium and the number of plant species recorded in the field margin. Correlation coefficients (r) were as follows:

P	$r = -0.486$	($p<0.001$)
K	$r = -0.367$	($p<0.02$)
Mg	$r = -0.342$	($p<0.02$)
pH	$r = 0.018$	(not significant)

4. DISCUSSION

This report summarises the results of a baseline survey of farms in the Organic Farming Scheme. Baseline surveys form a ‘yardstick’ in terms of biodiversity and it is not until a re-survey has been completed that the effects of any management practices can be determined. These farms have only been managed organically for a short period and it may take many years before any benefits for biodiversity to become apparent. After conversion it takes several years for soils to recover and build up levels of biological activity and structure. Wildlife populations are expected to build up over the years. The monitoring sample tended towards large, intensively managed farms (e.g. dairy farms) that usually support low populations of wildlife. However plant species diversity of field boundaries and margins is expected to increase over time through organic management.

Heavy applications of slurry may be leading to high nutrient levels on some sites. There is also likely to be high residual soil fertility on field margins due to previous non-organic farming practices. Studies have shown that this may take a long time period to decline. The negative correlation between plant species richness and soil nutrients indicates that expected decreases in soil fertility brought about by organic farming practises should gradually increase species diversity.

Ground beetles are the predominant group of soil surface invertebrate fauna in agro-ecosystems and are important predators. The more a ground beetle is typical of agricultural fields, the more it benefits from organic agriculture (Doring & Kromp, 2003). Several indicator species have been suggested such as *Amara* spp. that benefit from organic management generally preferring weedier, more open fields, and others such as *Pterostichus melanarius* that appear to prefer conventional farming. These indicator species may be useful in future monitoring of organic farms.

Agricultural intensification has been cited as causing a reduction in spider populations (Aebisher, 1991). Organic cereal fields have been shown to support a greater abundance and diversity of spiders (Feber *et al*, 1998). Certain spider species, for example *Erigone atra* and *Lepthyphantes tenius*, both abundant in the baseline survey of the OFS, have been found to be useful in controlling pest species (Bell *et al*, 2002).

In the absence of pesticides under organic management there is expected to be a greater supply of invertebrate prey items for ground beetles and spiders. Increases in all of these invertebrate groups will in turn provide an important food source for farmland birds. Changes in abundance and species composition of ground beetles and spiders will be used to determine any biodiversity enhancement due to organic farming.

Most studies have compared biodiversity between a paired sample of organic farms and conventional farms. The small study at Greenmount may give some indication of change in species diversity over time in organic compared with non-organic field margins and boundaries. In addition future results from this OFS monitoring programme could be compared with invertebrate data from non-organic hedgerows and field margins being monitored on farms under Countryside Management Scheme agreement. Comparison of baseline results from both schemes shows similar mean numbers of ground beetle and spider species recorded.

Longevity of organic management is likely to play a significant role in influencing biodiversity. Therefore long-term monitoring of farms that have continued to farm organically after Organic Farming Scheme agreements end will be necessary to determine any biodiversity benefits.

5. REFERENCES

Aebischer, N.J. (1991). *Twenty years of monitoring invertebrates and weeds in cereal fields in Sussex*. Blackwell Scientific, Oxford.

Allen, S.E. (1974). *Chemical analysis of ecological materials*. Blackwell Scientific Press, Oxford.

Azeez, G. (2000). *The Biodiversity Benefits of Organic Farming*. The Soil Association.

Bell, J.R., Johnson, P.J., Hambler, C., Haughton, A.J., Smith, H., Feber, R.E., Tattersall, F.H., Hart, B.H., Manley, W., & Macdonald, D.W. (2002). Manipulating the abundance of *Lepthyphantes tenuis* (Araneae: Linyphiidae) by field margin management. *Agriculture, Ecosystems & Environment*. **93**, 295-304.

Cameron, A., Johnston, R.J., & McAdam, J. (2004). Classification and evaluation of spider (Araneae). assemblages on environmentally sensitive areas in Northern Ireland. *Agriculture, Ecosystems & Environment*. **102**, 29-40.

Coulson, J.C. & Butterfield, J.E.L. (1985). The invertebrate communities of peat and upland grasslands in the North of England and some conservation implications. *Biological Conservation*, **34**, 197-225.

Critchley, C.N.R. (1994). Relationships between vegetation and site factors in uncropped wildlife strips in Breckland Environmentally Sensitive Area. *Field Margins: Integrating Agriculture and Conservation*. (ed N. Boatman). pp. 283-288. BCPC Monograph No. 58.

Cruickshank, J.G. (1997). *Soil and Environment: Northern Ireland*. AESD, Department of Agriculture for Northern Ireland and AESD, Queen's University Belfast. Belfast.

Doring, T.F. & Kromp, B. (2003). Which carabid species benefit from organic agriculture? - a review of comparative studies in winter cereals from Germany and Switzerland. Agriculture, Ecosystems & Environment, **98**, 153-161.

DTZ Pieda Consulting (2004). *Mid-term evaluation of measures funded by the EAGGF*. Final report to DARD.

Feber, R.E., Bell, J., Johnson, P.J., Firbank, L.G., & Macdonald, D.W.T. (1998). The effects of organic farming on surface-active spider (Araneae). assemblages in wheat in southern England, UK. *The Journal of Arachnology*, **26**, 190-202.

Flexen, M., Johnston, R.J., Cameron, A., & McAdam, J.H. (2004).. *Baseline Biological Monitoring of the Countryside Management Scheme in Northern Ireland, 2002-2003*. Queen's University of Belfast.

Gardner, S.M. & Brown, R.W. (1998). *Review of the comparative effects of organic farming on biodiversity*. Report to MAFF for project number OF0149.

Hegarty, C., McFerran, D., Cameron, A., Mulholland, F., & McAdam, J.H. (1994). *Environmentally Sensitive Areas in Northern Ireland. Biological Monitoring Report, Year One, 1993*. Queen's University of Belfast, Belfast.

Kirby, P. (1992). *Habitat management for invertebrates: a practical handbook*. Royal Society for the Protection of Birds, Bedfordshire.

Lindroth, C.H. (1974). *Coleoptera, Part 2, Carabidae.* Royal Entomological Society, London.

Norton, L.R. (2002). Factors influencing biodiversity with organic and conventional systems of arable farming - methodologies and preliminary results. *UK Organic Research 2002: Proceedings of the COR Conference*, (ed Powel *et al*), pp. 231-236, Aberystwyth.

Roberts, M.J. (1985). *The spiders of Great Britain and Ireland*. Harley Books, Colchester.

Shepherd, M., Pearce, B., Cormack, B., Philipps, L., Cuttle, S., Bhogal, A., Costigan, P., & Unwin, R. (2003). *An assessment of the environmental impacts of organic farming*. Report to DEFRA.

Southwood, T.R.E. (1978). *Ecological methods*, 2nd edn. Chapman and Hall, London.

Stockdale, E.A., Lampkin, N.H., Hovi, M., Keatinge, R., Lennartsson, E.K.M., Macdonald, D.W., Padel, S., Tattersall, F.H., Wolfe, M.S., & Watson, C.A. (2001). Agronomic and environmental implications for organic farming systems. *Advances in Agronomy*, **70**, 261-327.

Younie, D. & Armstrong, G. (1995). Botanical and invertebrate diversity in organic and intensively fertilised grassland. *Proceedings of the first ENOF workshop: Biodiversity and Land Use: The Role of Organic Farming*. Bonn.

APPENDICES

Appendix 1. Total number of individuals and percentage frequency of carabid beetle species recorded in 2002 on sites from OFS farms (n=26).
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Appendix 2. Total number of individuals and percentage frequency of spider species recorded in 2002 on sites from OFS farms (n=26).
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Appendix 1. Total number of individuals and percentage frequency of carabid beetle species recorded in 2002 on sites from OFS farms (n=26).

Species	Total indiv.	% Freq.
Nebria brevicollis	5741	100
Pterostichus melanarius	851	100
Pterostichus nigrita	724	100
Pterostichus strenuus	313	100
Agonum muelleri	529	96
Agonum dorsale	309	96
Pterostichus niger	276	96
Loricera pilicornis	197	96
Pterostichus vernalis	67	62
Abax parallelepipedus	143	58
Leistus fulvibarbis	38	58
Carabus granulatus	67	54
Bembidion lampros	73	50
Bembidion aeneum	48	46
Clivina fossor	35	46
Amara aenea	25	42
Pterostichus madidus	223	38
Leistus rufescens	15	38
Agonum assimile	36	31
Agonum obscurum	21	31
Cychrus caraboides	21	31
Elaphrus cupreus	11	31
Bembidion tetracolum	65	27
Calathus melanocephalus	28	27
Calathus piceus	22	27
Bembidion bruxellense	53	19
Amara plebeja	17	19
Amara ovata	14	19
Harpalus rufibarbis	14	19
Harpalus rufipes	14	19
Trechus quadristriatus	12	19
Amara communis	5	19
Pterostichus versicolor	12	15
Calathus fuscipes	10	15
Notiophilus biguttatus	7	15
Agonum fuliginosum	6	15
Pterostichus diligens	6	15
Badister bipustulatus	5	15
Bembidion mannerheimi	5	15
Carabus nemoralis	4	15
Amara aulica	10	12
Asaphidion curtum	7	12
Amara similata	3	12
Amara lunicollis	6	8
Agonum viduum	2	8

Species	Total indiv.	% Freq.
Olisthopus rotundatus	2	8
Agonum albipes	78	4
Nebria salina	46	4
Pterostichus anthracinus	8	4
Bembidion harpaloides	2	4
Agonum marginatum	1	4
Bradycellus harpalinus	1	4
Carabus arvensis	1	4
Pterostichus rhaeticus	1	4

Appendix 2. Total number of individuals and percentage frequency of spider species recorded in 2002 on sites from OFS farms (n=26).

Species	Total indiv.	% Freq.
Erigone atra	1088	100
Pardosa amentata	781	92
Erigone dentipalpis	310	92
Bathyphantes gracilis	306	96
Lepthyphantes tenuis	170	85
Monocephalus fuscipes	110	69
Dicymbium nigrum	110	65
Oedothorax fuscus	104	58
Pardosa pullata	100	42
Pachygnatha degeeri	58	54
Pachygnatha clercki	19	19
Oedothorax retusus	16	31
Diplocephalus latifrons	12	23
Walckenaeria acuminata	12	23
Gongylidiellum vivum	9	31
Micrargus subaequalis	9	12
Tiso vagans	7	23
Leptorhoptrum robustum	6	19
Pardosa palustris	5	15
Agyneta decora	5	12
Erigonella hiemalis	5	12
Lepthyphantes zimmermanni	5	12
Xysticus cristatus	5	8
Meioneta saxatilis	4	15
Bathyphantes approximatus	4	12
Clubiona lutescens	4	12
Pocadicnemis pumilla	4	12
Savignia frontata	4	12
Bathyphantes nigrinus	3	12
Diplocephalus permixtus	3	12
Gongylidium rufipes	3	12
Hypomma bituberculatum	3	12
Lepthyphantes angulatus	3	12
Lepthyphantes cristatus	3	12
Neriene clathrata	3	12
Trochosa terricola	3	12
Alopecosa pulverulenta	3	8
Lepthyphantes alacris	3	8
Micrargus herbigradus	3	8
Ceratinella brevipes	2	8
Dismodicus bifrons	2	8
Lepthyphantes mengei	2	8
Oxyptila trux	2	8
Clubiona compta	2	4
Meta segmentata	2	4

Species	Total indiv.	% Freq.
Agyneta conigera	1	4
Agyneta subtilis	1	4
Baryphyma trifons	1	4
Bolyphantes luteolus	1	4
Centromerita bicolor	1	4
Diplocephalus picinus	1	4
Diplostyla concolor	1	4
Gonatium rubens	1	4
Harpactea hombergi	1	4
Lepthyphantes ericaeus	1	4
Lepthyphantes flavipes	1	4
Leptothrix hardyi	1	4
Maso sundevalli	1	4
Microneta viaria	1	4
Pirata piraticus	1	4
Porhomma pygmaeum	1	4
Tallusia experta	1	4
Tapinocyba pallens	1	4
Walckenaeria antica	1	4
Walckenaeria vigilax	1	4