Seed spillage from grain trailers on road verges during oilseed rape harvest: an experimental survey

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OSR feral population.

Context

Human-mediated seed dispersal (i.e. anthropochory) greatly increases the dispersal of crop species across agroecosystems.

In the case of oilseed rape (OSR, *Brassica napus* L.), concerns have been raised about feral OSR populations growing on roadverge which could constitute reservoirs of modified genes in the context of the coexistence of genetically modified (GM) and non-GM plants (Squire *et al.* 2011).

These OSR feral populations are assumed to originate from grain trucks losses (Crawley & Brown 1995; Aono *et al.* 2006; Knispel & McLachlan 2010) and spillage from grain trucks during harvest has never been quantified.

Field hard-working team.

Materials and Methods

- Survey of an agricultural area of 41 km^2 around the grain silo of Selommes (Loir-et-Cher, France).
- Experimental approach: 85 seed trap-sites on the road verges.
- Record of trap-sites characteristics (see Table 1) and OSR spillage (see Figure 1) during harvest.
- Choice of the best fitted linear model for the data.
- Prediction of losses at road scale on R2 road that serviced 66ha of OSR fields.

One-day seeds trapped.

	Type	Modalities	Description
Surface_OSR (ha)	Quantitative	From 2.8 to 147.5	Total area of all OSR fields adjacent to the road and connected to the road by network[1]
Lanes	Qualitative	1 or 2	Number of lanes on the road
Dist_field (in m)	Qualitative	0, 40 or 400 then 0 or faraway	Distance between the trap-site and the nearest OSR field
Dist_road (in m)	Quantitative	from $2.4 \cdot 10^{-2}$ to 1.7[2]	Distance between trap-sites and the edge of the road
Dist_Silo (in m)	Quantitative	From 1073 to 8848	Distance between the trap-site and the grain silo at Selommes[3]

Table 1. The five explanatory variables for the number of seeds recorded in trap-sites.
[1]Based on a farmer survey concerning trips between fields and silos (from CETIOM data, 1999).
[2]Only four trap-sites were placed at more than 1m.
[3]Calculated along a given road from georeferenced data with R software.

Results

- We collected 7710 seeds in 8 days, with a unique deposition event of 1548 seeds (R12 road, Fig.1).
- Seed spillage increased with the surface area of OSR fields serviced (see Table 2), whereas local elements (e.g. distance from the trap-site to the verge of the road and to the nearest field) decreased the amount of seed deposited at a given site.
- We detected an interaction between the number of lanes and the distance to the main silo: seed loss decreased with distance to the main silo on one-lane roads but was constant on two-lane roads.
- On R2 road we predicted the spillage on the verge in the direction of transportation to be nearly two million seeds (mean: 404 seeds.m^{-2} ± 94).

. ≤10%; * ≤5%; ** ≤1%; *** ≤0.1%.

	Estimate	Standard error	P-value
(Intercept)	4.259	0.820	$1.81 \cdot 10^{-6}$***
Surface_OSR	$9.93 \cdot 10^{-3}$	$4.23 \cdot 10^{-3}$	$2.35 \cdot 10^{-2}$*
Dist_field_faraway	–0.644	0.236	$7.84 \cdot 10^{-3}$**
ln(Dist_road)	–0.470	0.183	$1.21 \cdot 10^{-2}$*
Lanes_2	–0.617	0.800	0.442
Dist_Silo	$-4.45 \cdot 10^{-4}$	$1.13 \cdot 10^{-4}$	$1.97 \cdot 10^{-4}$***
Dist_Silo:Lanes_2	$2.95 \cdot 10^{-4}$	$1.71 \cdot 10^{-4}$	$8.83 \cdot 10^{-2}$.

Table 2. Summary of the linear model describing relationships between the natural logarithm of seeds lost +1 and landscape elements. On a two-lane road, when *Dist_field* is 0m, the expected response equals $(4.259 - 0.617) + 9.93 \cdot 10^{-3} \cdot Surface\_OSR - 0.470 \cdot \ln(Dist\_road) + (-4.45 \cdot 10^{-4} + 2.95 \cdot 10^{-4}) \cdot Dist\_Silo = 3.642 + 9.93 \cdot 10^{-3} \cdot Surface\_OSR - 0.470 \cdot \ln(Dist\_road) - 1.491 \cdot 10^{-4} \cdot Dist\_Silo$.

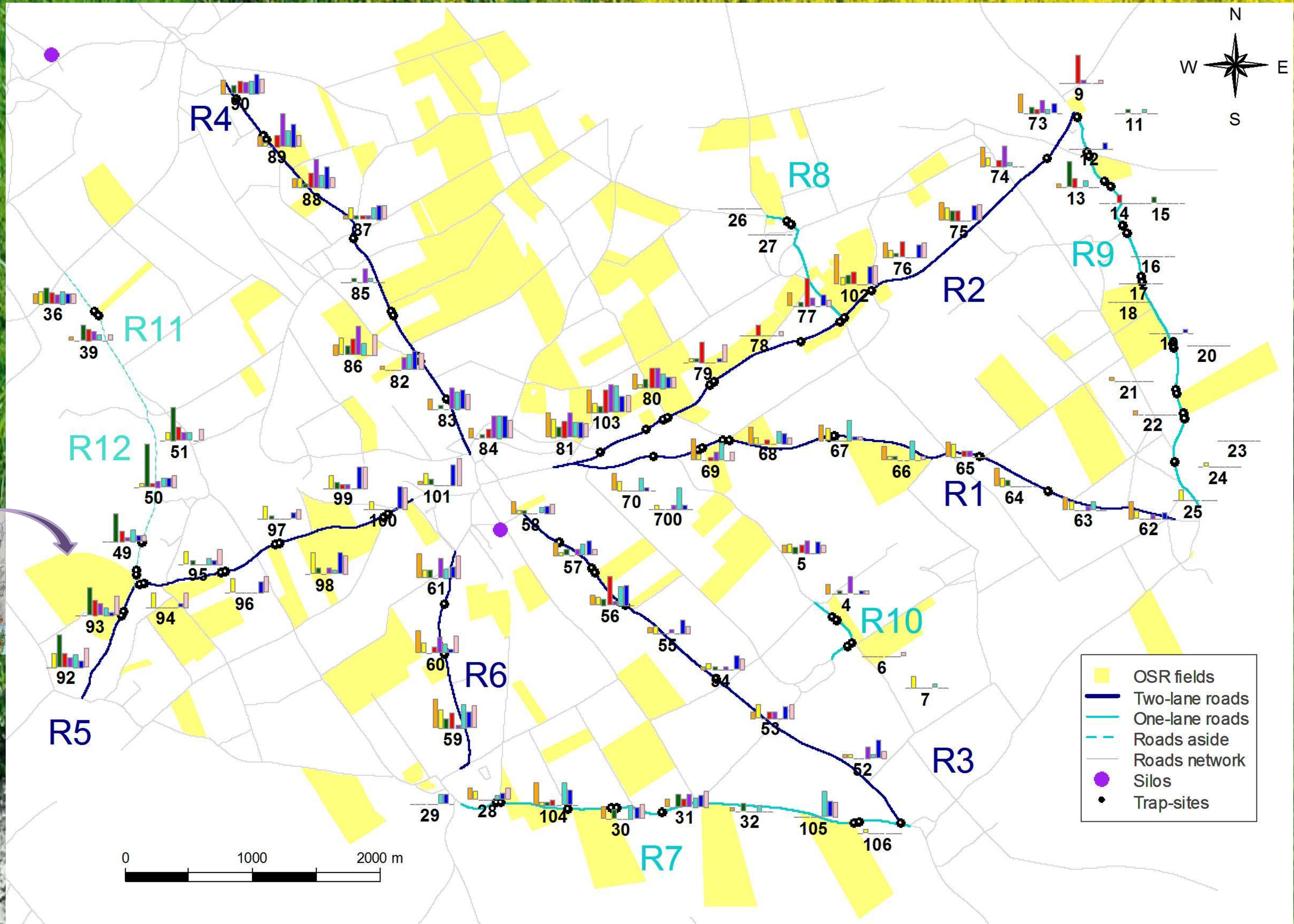

Figure 1. Global map of the Selommes area with daily barplots of OSR seed collected at each trap-site location. Seed amounts are $\ln(x + 1)$ transformed; all barplot axes have the same scale between 0 and 8 (which indicates 0 to 2980 seeds). Each trap-site is associated with a number. Each road is represented by an R-number code.

Discussion

Spillage of OSR seed from grain trailers during harvest appears to be a very common phenomenon, affecting both main roads to the grain silo and other roads. We show that grain trailers frequently disperse seeds up to a distance of 400 m which is the farthest dispersal distance for OSR seed ever quantified.

Feral populations of OSR originate from seed transportation (15%) and also from immigration of seed from fields (35-40%), local recruitment (10%) and persistent seed banks (35-40%; Pivard *et al.* 2008) but only spillage from grain trailers can disperse OSR seeds farther than hundreds of metres.

In a context of OSR GM coexistence, it might be quite impossible to completely eliminate the spillage of small seeds from grain trailers. However, this spillage could be reduced by appropriate policies: covering the top of grain trailers, not overfilling trailers and reducing the distances travelled between fields and silos could limit the loss of seed.

Our results emphasize that seed spillage from grain trailers must be considered in order to model seed dispersal and the persistence of feral populations of OSR. Furthermore, our study highlight the role of the surface area of fields and the transportation to grain silos in seed dispersal by grain trailers. So, local and landscape elements and rare events of massive seed deposition should be integrated into models.

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Further informations

http://www.ese.u-psud.fr/gmbioimpact/