

## From organic to conventional cropping – subsequent effects on weed incidence

Wechsel vom ökologischen zum konventionellen Landbau – Auswirkungen auf die Verunkrautung

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### Abstract

In Finland, repeated weed surveys in spring cereals are carried out to follow the changes in weed populations. Organic farming gained popularity in the late 1990s but now some farms have returned back to conventional cropping. In consequence, weed infestation level declined substantially in such fields. Slightly higher abundance of some weed species was observed compared with the fields under continuous conventional cropping. Still, organic cropping did not pose any marked subsequent weed problems which could not be managed with chemical control and crop competition.

**Keywords:** Biodiversity, organic farming, spring cereals, weed survey, weed shift

### Zusammenfassung

Anhand wiederholter Aufnahmen der Verunkrautung auf Ackerflächen mit Sommergetreide in Finnland lassen sich Änderungen der Unkrautpopulationen verfolgen. Nach einem höheren Anteil des ökologischen Landbaus in den 1990er-Jahren sind jetzt einige Betriebe wieder zu konventioneller Bewirtschaftung übergegangen. Auf so bewirtschafteten Feldern ließ sich im Vergleich zur Situation auf den 10 Jahre zuvor ökologisch bewirtschafteten Äckern ein beträchtlicher Rückgang der Verunkrautung feststellen. Bei ständiger konventioneller Bewirtschaftung wurde eine leicht erhöhte Abundanz einiger Arten beobachtet. Durch einen ökologischen Landbau werden keine Unkrautprobleme geschaffen, die nicht mit chemischer Unkrautbekämpfung und Konkurrenz der Kulturpflanzen behoben werden können.

**Stichwörter:** Biodiversität, Sommergetreide, Unkrauterhebung, Veränderung der Verunkrautung, ökologischer Landbau

### Introduction

As cropping practices change, the habitat in which weeds grow is altered and changes in weed populations result. Repeated weed surveys in Finnish spring cereal fields track the weed shift in relation to the crop management. Monitoring results are available both from conventionally and organically cropped fields. Organic cropping gained popularity in the late 1990s when many farms moved into organic farming. Recently, some of these farms have returned back to conventional cropping.

In this study, subsequent effects of organic cropping in conventionally cropped fields were studied by comparing the weed occurrence in the conventionally cropped spring cereals fields which had been under organic cropping when surveyed ten years earlier. We expected that organic cropping results in some long-term changes in weed incidence. For instance RIESINGER and HYVÖNEN (2006) found increased abundance of *Elymus repens* as a function of the duration of organic farming. We wanted to explore how efficiently weeds are controlled with conventional practices after that the fields had been organically cropped for some time, either for one or two 5-year contract period.

### Material and Methods

National weed surveys in spring cereals (barley, oat, wheat) have been carried out in Finland since the early 1960s. Monitoring data used in this report derive from two consecutive surveys conducted in southern and central Finland in 1997-1999 (SALONEN *et al.*, 2001) and ten years later in 2007-2009 (SALONEN *et al.*, 2011).

The number of farms visited was 283 and one to five spring cereal fields were examined on each farm, giving a total of 382 fields which were the same in both decades. Altogether 46 fields under

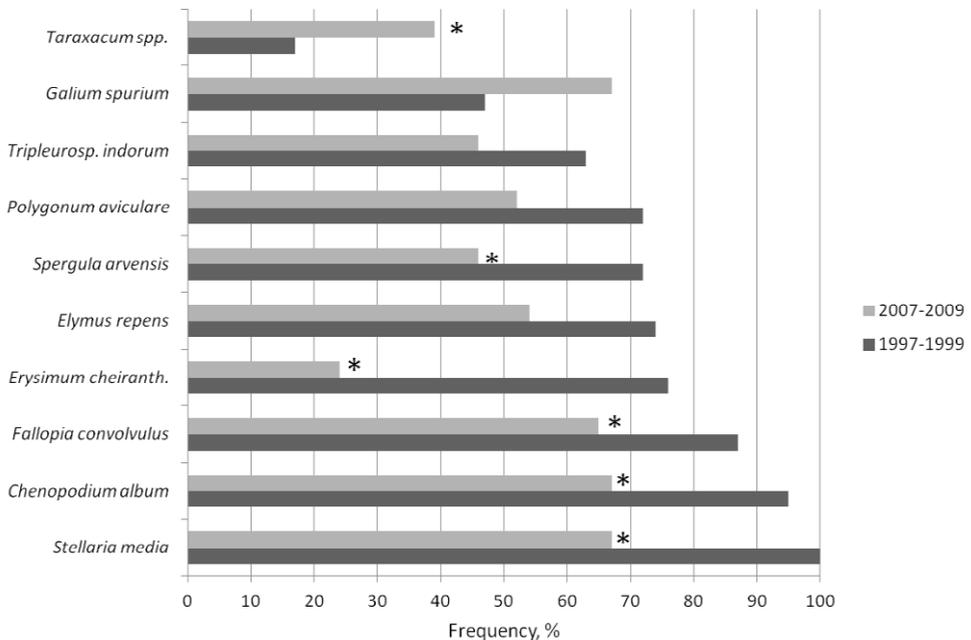
organic cropping in the 1990s had switched back to conventional cropping and chemical weed control ten years later. Altogether 297 fields that had been all the time under conventional cropping were used as reference fields.

The same sampling protocol of weeds was followed in both decades. Weed occurrence was assessed by counting and weighing all weed species from randomly established sample quadrates in mid July – early August. Weed density was determined from 10 quadrates with a rectangular frame measuring 0.1 m<sup>2</sup> (25 cm x 40 cm). The air-dry biomass of weeds was weighed from four out of these ten quadrates. The frequencies of occurrence indicate the proportion of fields where each weed species was found. A detailed description of survey regions and sampling protocol is available in the recent article (SALONEN *et al.*, 2011).

## Results

In general, the frequency of occurrence of many weed species declined significantly in conventional cropping (Fig. 1). However, some species, like *Galium spurium* and *Taraxacum* spp., were more frequent now in conventional fields compared with the earlier years under organic cropping. This trend was observed also in the fields under continuous conventional cropping. As subsequent effect of organic cropping, the frequencies of *Chenopodium album*, *Fallopia convolvulus* and *Spergula arvensis* were still about 15% units higher than in the continuous conventional cropping.

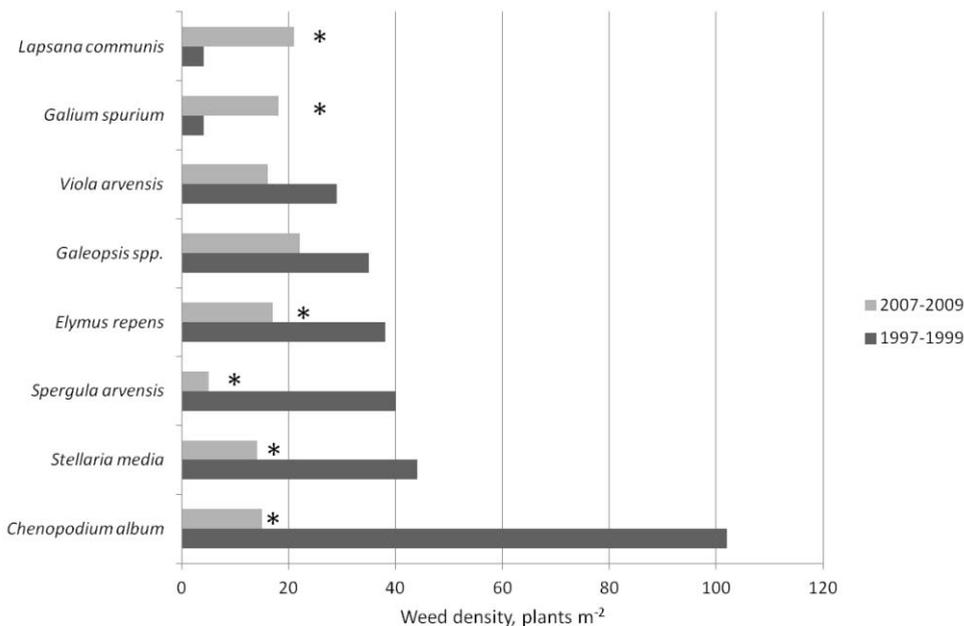
The average number of weed species per field had been 18 in the years under organic cropping and had now declined to 14 in conventional cropping, being slightly higher than the average number of weed species, 12, observed in other conventionally cropped survey fields.



**Fig. 1** Weed species with the most marked change in frequency of occurrence between the organic cropping in the 1990s and conventional cropping in the 2000s. \* Fisher's Exact Test  $P < 0.05$ .

**Abb. 1** Stetigkeit von Unkrautarten auf Feldern mit ökologischer Bewirtschaftung in 1990er-Jahren im Vergleich zu konventioneller Bewirtschaftung in den 2000er-Jahren. \* Fisher's Exact Test  $P < 0.05$ .

A marked decline in the total density of weeds was obvious from organic years to conventional years. The average density of weeds in organically cropped fields was 428 plants m<sup>-2</sup> in the 1990s. Ten years later, when the same fields were conventionally cropped, the average density of weeds was 180 plants m<sup>-2</sup>. This was primarily due to the decline of weed species susceptible to applied herbicides and better crop competition. *Chenopodium album*, *Stellaria media* and *Spergula arvensis* were typical weed species in this respect (Fig. 2). In comparison, the total weed density in continuous conventional cropping was on average 152 plants m<sup>-2</sup> in 2007-2009.



**Fig. 2** Weed density (plants m<sup>-2</sup>) in organic cropping in the 1990s compared to conventional cropping in the 2000s. \* Wilcoxon test P < 0.05.

**Abb. 2** Bestandesdichte von Unkräutern (Pflanzen m<sup>-2</sup>) auf Feldern mit ökologischer Bewirtschaftung in 1990er-Jahren im Vergleich zu konventioneller Bewirtschaftung in den 2000er-Jahren. \* Wilcoxon test P < 0.05.

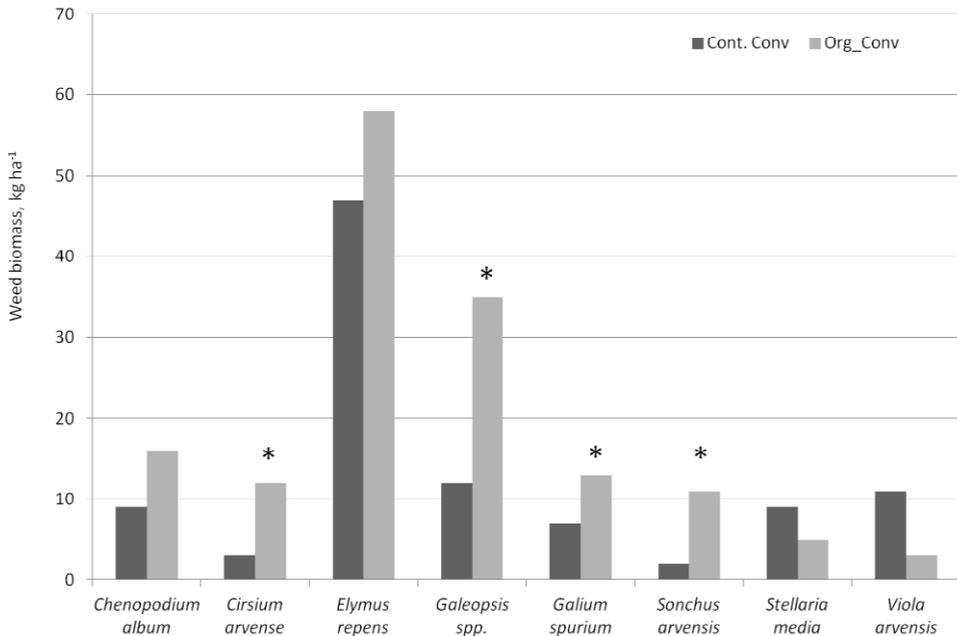
The average total air dry biomass of weeds, which was 765 kg ha<sup>-1</sup> in organic cropping in the 1990s, had now dropped down to 193 kg ha<sup>-1</sup> in conventional cropping. This was slightly higher than the average biomass, 181 kg ha<sup>-1</sup>, recorded in the fields under continuous conventional cropping. This difference was mainly due to a higher infestation of perennial weeds *Cirsium arvense*, *Elymus repens* and *Sonchus arvensis* as well as some broad-leaved species like *C. album* and *Galeopsis spp.* (Fig 3).

Lower weed biomass in conventionally cropped stands was obviously associated with better crop competition, too. Namely, the average air-dry biomass of cereal crop in organic cropping had been only 3843 (SD 1972) kg ha<sup>-1</sup> but was now 6833 (SD 2067) kg ha<sup>-1</sup> in conventional cropping and 6420 (SD 2370) in continuous conventional cropping, respectively.

## Discussion

The area of organic farming in Finland has levelled out at around 9% of arable land. Some farms have, however, returned back to conventional cropping due to various reasons, including the increased weed infestation. According to our findings, the relatively good efficacy of available herbicides and better crop competition in conventional cropping were sufficient to control weeds

in these “come-back” fields. Both sulfonylureas and phenoxy acid herbicides were used for chemical control (SALONEN *et al.*, 2013).



**Fig. 3** Weed biomass in conventional cropping after organic cropping (Org\_Conv) and in continuous conventional cropping (Cont. Conv). Data from the 2007-2009 survey. \* Wilcoxon test  $P < 0.05$ .

**Abb. 3** Trockenmasse von Unkrautarten bei konventioneller Bewirtschaftung nach ökologischem Landbau (Org\_Conv) und bei kontinuierlich konventioneller Bewirtschaftung (Cont.Conv). \* Wilcoxon test  $P < 0.05$ .

In conclusion, weed infestation in conventional cropping after organic cropping was slightly higher than in the fields with continuous conventional cropping. However, organic cropping did not pose any insurmountable subsequent problems in weed management in conventional cropping of spring cereals. Obviously, the seed bank of weeds was increased during the years under organic farming. Therefore, in the crops with less effective weed control options some problems may arise.

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