Measures to reduce diffuse pesticide pollution from agricultural land

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Concentrations of pesticides in groundwater and surface water resources continue to increase despite strict regulations, posing threats to drinking water and biodiversity. Diffuse pollution from agricultural fields is one of the main sources of this contamination. However, pesticides are also a key part of farming systems. In this study we aimed to investigate the effectiveness of on-field management measures to reduce diffuse pesticide pollution. We inventoried and compared such measures using two main sources: findings from a systematic literature analysis, including a quantitative meta-analysis for some measures when data quality allowed, and experiences from 8 case studies across Europe from the FAIRWAY project.

Four main pathways of off-site pesticide transport have been identified; drift, leaching to groundwater, subsurface flow to surface waters and overland runoff (Rittenburg et al. 2015). Overland flow transport includes transport of particulate pesticide by erosion and sediment. Local soil and climatic conditions influence which pathways are dominant within a field (Reichenberger et al. 2019; Borggaard and Gimsing 2008). The most important characteristics of the pesticide that influence its potential transport are their solubility, sorbtivity and half-life time (Wauchope 1978; Rittenburg et al. 2015).

To reduce the transport of pesticides from agricultural fields, measures and good agricultural practices have been developed and implemented at farm level. Despite the amount of available measures, transport of pesticides to ground and surface waters is still a risk. Within FAIRWAY, our objective was to evaluate the use, effectiveness and applicability of these measures for eight case studies across Europe. These local practices were compared with the most promising measures identified in current literature and reviews.

In each case study area the effectiveness of different measures, their cost, adoptability and applicability for farmers was inventoried through a questionnaire in February 2018. The respondents were experts who are in close contact with land managers who apply the measures in the case study areas. Respondents were asked to list agri-environmental schemes (AES) options and their perception of the potential impact on the reduction of pesticide pollution in terms of effectiveness and implementation costs (on a scale from low to moderate to high) as well as the pathway that the measure addresses.

Table 1 summarizes the findings on the effectiveness, costs, applicability and adoptability as experienced by the eight case studies in the FAIRWAY project.

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Table 1: Measures applied in the case study areas and their effectiveness, costs, applicability and adoptability as perceived by the questionnaire respondents (mostly case study leaders).

Measure	Involved Countries	Effectiveness		Costs	Applicability	Adoptability
		Ground water	Surface water			
Safe pesticide cleaning and storage facilities	NL, IR	+/-	+	?	++	-
Safe storage unit for pesticides	IR	?	+	?	?	?
Vegetated buffer strips	FR, SL	?	++	€€	+	-
Crop rotation improvement	FR	++	?	€€€	+	-
Input reduction	FR, UK	++	?	€€€	+	-
Network engagement[1]	UK	?	+			
Alternative (pesticide or mechanical)	UK, IR	?	+	?	?	++
Integrated Pest Management[2]	UK, DK	+++	?	€	+	+
Obligatory reduced input	POR, DK, SL	+++	+++	€	+++	+++
Bio filters/beds	IR	?	++	?	?	?
Economic management[3]	DK	+++	?	€€	+++	+++

NOTE: Symbols in the table indicate a scale from negative to positive with – is negative, +/- is neutral and +++ is very positive. For the cost three categories are made low (€), moderate (€€) and high (€€€). When there is no data a ? is shown.

[1]Network engagement: embedding information and communication at all levels from supply chain to agronomist to farmers to stimulate change of practice.

[2]Intergrated Pest management, is a holistic farm management method to reduce pesticide use, by using alternative mechanical and biologic pest management in combination with adjusted cropping and resource management.

[3]These measure increase the price of pesticides, which is intended as an extra incentive to look for alternative crop management methods.

We found that in both the literature review and the case studies, interventions involving a farming system change, such as IPM or crop rotations were evaluated to be effective, but costly. In the case studies, obligatory reducing inputs was rated very positively in terms of effectiveness as well as in terms of applicability and adoptability. In the literature analysis, application rate reduction was rated only slightly positively.

On-field measures rated positively for reduction to surface water in the literature review were vegetated filter strips and constructed wetlands, followed by drift reduction, crop rotation and IPM. This aligns with the experiences in the case studies, as (apart from input reduction) vegetated buffer strips and bio filters / beds were positively rated for reduction to surface water. However, the adoptability of vegetated buffer strips was rated negatively or, in case of bio beds, unknown.

The findings of this study show that on-field measures can contribute to reduced pollution from overland transport, but that they are not sufficient to mitigate water resources pollution. To achieve reduction of pesticide pollution in water sources, measures should also focus on farm system redesign including reduced inputs, on-site measures and regional or national approaches to facilitate a sustainable farming system. Literature review/analysis and information from ongoing case studies complemented each other.