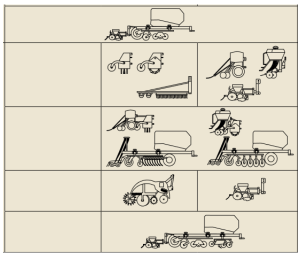
12 SUPPLEMENTARY INFORMATION

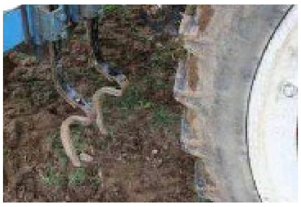
12.1 Details on the evaluated risk mitigation measures

Table S 1: Description of 16 risk mitigation measures selected for expert evaluation

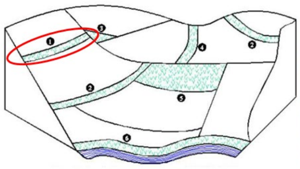
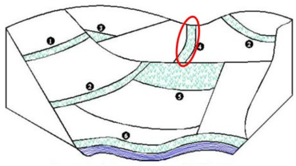
Measure	Description	Reference
No-till (in-field)	 Picture: V. Prasuhn, Agroscope, Switzerland No-till or zero tillage farming is an agricultural technique for growing crops or grassland farming without disturbing the soil through tillage. The seed is placed directly into the untilled soil in a single pass. A maximum of 25 % of the soil surface is disturbed [11].	1, 2, 5, 6, 7, 9, 10, 11
Strip tillage (in-field)	 Picture: H. Kirchmeier, LfL, Germany Strip-till is a conservation measure that uses shallow tillage but only in strips that will contain the seed row. Thus, it combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till. A maximum of 50 % of the soil surface is disturbed no deeper than 20 cm [11].	7, 10, 11

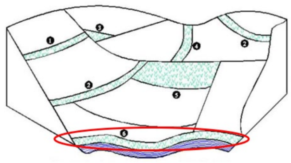
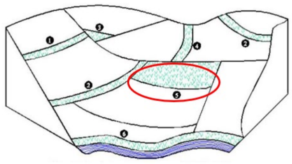
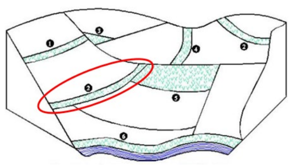
Measure	Description	Reference
Reduced tillage intensity (in-field)	 Picture: Excerpt taken from Ref. 10 showing techniques with either low number of passages and/or shallow tillage depth The term reduced tillage has no clear definition. Broadly speaking it covers all methods at the lower end of the intensity in terms of number of passages and tillage depth. The term is used extensively in the TOPPS-prowadis aproach [8]. Some sources speak of reduced tillage intensity when 15-30 % of crop residues are left on surface after planting (as opposed to conservation tillage with at least 30 % crop residues)[12].	1, 5, 6, 7, 8, 9
Contour tillage/disking or contour farming (in-field)	 Picture: National Resources Conservation Service, USDA, USA A practice in which tillage but also other farming operations are effected across a slope following its elevation contour lines. The established structure changes the direction of runoff from directly downslope to around the hillslope and allows more time for the water to settle into the soil.	5, 6, 8, 9

Measure	Description	Reference
Mulch-tillage (in-field)	 Picture: W. Sturny, Fachstelle Bodenschutz Kanton Bern, Switzerland Mulch-tillage is a conservation measure that uses shallow tillage with tools such as chisels, field cultivators, disks, sweeps or blades. The fraction of the disturbed soil surface is 100 % [11]. Some definitions additionally mention that the soil surface covered by crop residues should be at 30 % or higher [7, 12] and/or that the depth of tillage should not exceed 10 cm [10, 11].	2, 7, 9, 10, 11
Strip cropping (different crops in strips across slope) (in-field)	 Picture: J. Gerlach, No-Till Farmer Large fields can be subdivided in different crops grown parallel to the slope. Strips of row crops like maize can be followed by strips of crops that are less prone to erosionlike cereals or oilseed rape which lead to a reduced water flow and the trapping of sediment.	4, 5, 6, 8, 9
Living mulch (in-field)	 Picture: H. Ramseier, School of Agricultural, Forest and Food Sciences HAFL, Switzerland	6, 9, 10

Measure	Description	Reference
	Living mulches are cover crops planted either before or with a main crop and maintained as a living soil cover throughout the growing season as opposed cover crops which are commonly killed before planting the main crop. Their advantages are similar to cover crops, i.e. reduced risks of erosion, soil compaction, recycyling of unused soil nitrogen and potentially weed control [14].	
Tramline management (in-field)	 Picture: T. Cottinet and D. Heddadji, Chambre d'Agriculture de Bretagne, France Tramlines are the crop free areas where the tractor drives for spraying, fertilizing and harvesting. Tramlines can contribute overproportionally to runoff losses[13]. Tramline compaction can be reduced by avoiding to work under moist conditions. Further preventive measures are the use of low-pressure/twin tires or by breaking the compacted tramlines mechanically using a tine (picture above).	5, 8, 9, 10
Micro-dams (in-field)	 Picture: Landwirtschaftskammer Nordrhein-Westfalen, Germany	1, 5, 8, 10

Measure	Description	Reference
	Micro-dam is an umbrella term for all methods forming the relief in order to reduce runoff and erosion. For ridge crops like potatoes interridge bunds (picture above) or holes (e.g. with a Dyker) are formed strongly reducing water flow. For row crops like maize small dams are holes between the rows have the same effect.	
Cover crops in general (in-field)	 Picture: Landwirtschaftskammer Oberösterreich, Austria (left: compacted soil, right: soil with good aggregate structure) Cover crops fulfil a number of functions particularly in conservation agriculture. These range from protecting the soil during the period without crop plants, reducing nitrogen losses, suppressing weeds and improving soil structure. The contacted experts were asked to evaluate the latter aspect.	2, 5, 8, 9, 10
Cover crops with deep roots (in-field)	 Picture: Landwirtschaftskammer Oberösterreich, Austria	6, 10

Measure	Description	Reference
	Cover crops with particularly deep roots can reduce soil compactions and substantially increase infiltration capacity. Species like *Raphanis sativa* also called tillage radish can reach a thickness of several centimeters.	
Buffer strip (in-field)	  Picture left: Gril and Le Hénaff G. 2010, Cemagref, France (modified from CORPEN 1997) Picture right: Mosimann 2015 [15], Switzerland In field buffers are placed within fields and thereby reduce water flow between the fields. Some sources mention higher reduction efficiency then edge-of-field buffer strips [1].	1, 4, 5, 6, 8, 10
Thalweg buffer strip (in-field)	 Picture: Gril and Le Hénaff G. 2010, Cemagref, France (modified from CORPEN 1997) Thalwegs are often the starting point of heavy erosion. Thalweg buffers reduce runoff velocity, volume and sediment loads from adjacent fields. They are mainly suited to very large fields as they result in new field boundaries.	1, 2, 4, 5, 6, 8, 10

Measure	Description	Reference
Riparian strip (edge-of-field or off-field)	 Picture: Gril and Le Hénaff G. 2010, Cemagref, France (modified from CORPEN 1997) Riparian buffer strips are located below a field, between the field and a stream. Riparian buffer strips of a certain width are mandatory in several countries.	1, 2, 4, 5, 6, 8, 10
Thalweg buffer strip (off-field)	 Picture: Gril and Le Hénaff G. 2010, Cemagref, France (modified from CORPEN 1997) Like in-field thalweg buffers they reduce runoff and erosion by being placed in the most relevant zones of subcatchments. Off-field thalweg buffers might be implemented by using a whole field as a meadow or just the area around the thalweg.	1, 2, 4, 8, 10
Buffer strip (edge-of-field or off-field)	 Picture: Gril and Le Hénaff G. 2010, Cemagref, France (modified from CORPEN 1997)	1, 2, 4, 5, 6, 8, 10

Measure	Description	Reference
	Edge-of-field or off-field buffer strips are located below a field, between the field and the next field or between the field and a road. They can thereby reduce runoff flowing between fields and runoff reaching roads which can act as a shortcut to surface waters [16, 17].	

[1] Alix A. *et al.* (ed.), MAgPIE. Mitigating the Risks of Plant Protection Products in the Environment. From the two-part SETAC Workshop Mitigating the Risk of Plant Production Products in the Environment. 22–24 April 2013 Rome, Italy, 13–15 November 2013 Madrid, Spain, 455 pp (2017).

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[4] FOCUS , Landscape and Mitigation Factors In Aquatic Risk Assessment. Volume 2. Detailed Technical Reviews". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Asses sment, EC Document Reference SANCO/10422/2005 v2.0. 436 pp (2007).

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[8] TOPPS-Prowadis, Best Management Practices to reduce water pollution with plant protection products from run-off and erosion, 79 p., http://www.topps-life.org/key-documents5.html accessed on 2022-10-21 (2014).

[9] Swiss Federal Office of Agriculture, Cahier de fiches techniques: Erosion – réduire les risques OR Erosion - Risiken beschränken. Merkblätter-Set, 73 p., https://www.blw.admin.ch/blw/de/home/nachhaltige-produktion/umwelt/boden.html accessed on 2022-10-21 (2010).

[10] AID, Gute Fachliche Praxis – Bodenbewirtschaftung und Bodenschutz, aid infodienst Ernährung, Landwirtschaft, *Verbraucherschutz e.V. (AID)*, 120 pp (2015).

[11] Schoop J and Fischler M, Merkblatt Schonende Bodenbearbeitung. *Agridea, Eschikon 28, 8315 Lindau* (2019).

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[14] Hartwig NL, Ammon HU, Cover crops and living mulches, Weed Science, 50(6), 688-699, (2002).

[15] Mosimann T (with contributions of Bono R, Huber M, Schmutz D and Gasche T in Kap. 5 and 6), Erdreich. Eine Reise durch die Böden des Kantons Basel-Landschaft und seiner Nachbargebiete. *Verlag des Kantons Basel-Landschaft, Liestal*, 416 S 8 (2015).

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12.2 List of consulted experts and qualitative analysis

Table S 2: List of consulted experts and their main areas of expertise

Name and institution	Main area of expertise
Dr. Martin Bach Department of Landscape Ecology and Resources Management Universität Giessen Heinrich-Buff-Ring 26 DE - 35392 Gießen	Research on environmental fate of pesticides and nutrients
Dr. Richard Beisecker, Ingenieurbüro für Ökologie und Landwirtschaft GmbH Windhäuser Weg 8 DE - 34123 Kassel	Runoff and Erosion reduction, Agricultural advisory services
Dr. Joachim Brunotte Thünen-Institut Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei Bundesallee 47 DE - 38116 Braunschweig	Soil conservation measures

Name and institution	Main area of expertise
Dr. Klaus Gehring Bayrische Landesanstalt für Landwirtschaft Institut für Pflanzenschutz Lange Point 10 DE - 85354 Freising	Herbology, Water protection, Agricultural advisory services
Michael Morgenstern Landesamt für Ländliche Entwicklung, Landwirtschaft und Flurneuordnung Pflanzenschutzdienst FGL Risiko- und Kontrollmanagement Müllroser Chaussee 54 15236 Frankfurt (Oder)	Plant protection service

Table S 3: Available quantative data of current dissemination of measures in Germany

Category		Surface [ha] (share of arable land)
Soil cultivation [1]	Moldboard plow	6,313,100 (53.4%)
	Conservation tillage	4,717,900 (39.9%)
	No-till	93,900 (0.8%)
Vegetative Filter strips [2]	VFS adjacent to streams in arable land	47.1% of streams

[1] Destatis, Land- und Forstwirtschaft, Fischerei - Bodenbearbeitung, Erosionsschutz, Fruchtwechsel/Agrarstrukturerhebung, Statistisches Bundesamt, Erschienen am 17.08.2017, Artikelnummer: 5411209169004 (2017).

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Note: For all other measures mentioned in Table S4 there are no statistical data. The survery on soil cultivation has been discontinued after 2016.

Table S 4: Expert assessment of 16 risk mitigation measures in terms of economic viability, controllability, current [2] and potential dissemination [3]

Measure [1]	Economic viability	Control-lability	Current dissemination	Potential dissemination	Typ of measure
No-till	+ (0 to +)	++ (+ to ++)	- - (-- to -)	- (- - to 0)	In-field
Strip tillage	0 (- to +)	++ (+ to ++)	- (- to 0)	0 (- to 0)	In-field
Reduced tillage intensity	++ (+ to ++)	+ (0 to ++)	+	+ (- to ++)	In-field
Contour tillage/disking	-	++ (+ to ++)	- - (- - to -)	- (- - to -)	In-field
Mulch-tillage	0 (0 to +)	+ (0 to +)	+	+ (0 to +)	In-field
Strip cropping (different crops in strips across slope)	-	+ (+ to ++)	- - (-- to -)	- - (-- to -)	In-field
Living mulch	-	+ (- to ++)	- (- to +)	- (- - to 0)	In-field
Manage tramlines	- (- to 0)	+ (0 to ++)	- (- - to -)	- (- - to 0)	In-field
Micro-dams	0 (- to +)	++ (+ to ++)	- (- - to +)	- (- - to +)	In-field
Cover crops in general	0	+	+	+	In-field

Measure [1]	Economic viability	Control-lability	Current dissemination	Potential dissemination	Typ of measure
	(- to +)	(0 to ++)	(+ to ++)	(0 to ++)	
Cover crops with deep roots	0 (- to 0)	+ (+ to ++)	0 (0 to +)	0 (- to +)	In-field
Buffer strip (in field)	- (- - to -)	+ (0 to ++)	- (- - to 0)	- (- - to +)	In-field
Thalweg buffer strip (in field)	- (- - to +)	++ (+ to ++)	- (- - to -)	- (- - to +)	In-field
Riparian strip	- (- - to +)	++ (+ to ++)	+ (+ to ++)	+ (- - to ++)	Edge-of-field and off-field
Thalweg buffer strip (outside of field)	- (- - to +)	++ (+ to ++)	0 (- to +)	0 (- to ++)	Off-field
Buffer strip (outside of field)	0 (- - to +)	++ (+ to ++)	0 (- to +)	- (- - to ++)	Edge-of-field and off-field

[1] Measures that are highlighted in color were chosen as main focus of the quantitative investigation. The colors correspond to the three major categories, i.e., following three top groups: soil conservation measures (**orange**), vegetative filter strips (**blue**) and relief forming measure **(brown**). [2] The current dissemination can be partially quantified with evaluations from agricultural stastistics (cf. table S4) [3]Classification ranging from ++ (very good or very high, green), + (good or high, light green), 0 (medium, white), - (poor or low, light grey) to - - (very poor or very low, grey). The mean value of the expert assessments is shown, as well as the lowest and highest value in brackets (not shown if all responses were equal). Data on the current dissemination were available for the following measures: No-till, conservation tillage (umbrella term for measure

strip tillage, reduced tillage intensity and mulch-tillage) and für riparian buffer strips (cf. section 3.1). For the remaining measures, estimates were provided by the experts.

12.3 Description of dataset Reichenberger et al. (2019)[41]

The consolidated VFS test dataset compiled by Reichenberger et al.[41] can be found here:

https://www.sciencedirect.com/science/article/abs/pii/S0048969718329243?via%3Dihub

However, the paper of Reichenberger et al.[41] is not *open access*, and neither is the dataset. An overview of the variables contained in the dataset is given in Table S5 .

Table S 5: Dependent and independent variables included in the test dataset compiled by Reichenberger et al.[41]

type	variable	unit	description
semantic descriptors	study	-	author name + year
	site	-	site name (+ state)
	country	-	country
	soil_description		any available semantic descriptor (e.g. soil series, soil type, texture class)
	compound		name of compound (active substance or metabolite)
field topsoil characteristics	percClay	%	clay content of field topsoil
	percOM	%	organic matter content of field topsoil
	fracOC	kg/kg	organic carbon content of field topsoil; fracOC = percOM/(100*1.724)
event characteristics	precip_mm	mm	rainfall during the event
	Qi_L	L	total inflow (run-on + rainfall) into the VFS
	Ei_kg	kg	eroded sediment load entering the VFS
	Vi_L	L	runoff inflow (run-on) into the VFS
VFS characteristics	VL_m	m	length of VFS in flow direction ("VFS width")
	striparea_m2	m^2	area of the VFS
sorption + phase distribution coefficients	Koc_L_kg	L/kg	normalized Freundlich adsorption coefficient
	Kd_L_kg	L/kg	linear sorption coefficient for pesticide in field topsoil; Kd = Koc * fracOC
	Fph	-	pesticide phase distribution coefficient in runoff; Fph = Qi/(Kd * Ei)
	LN_Fph_1		ln(Fph + 1)
target variables (= dependent variables)	dQ_perc	%	relative reduction of total inflow Qi by VFS (ΔQ); dQ_perc = (Qi – Qo)/Qi * 100 %
	dE_perc	%	relative reduction of total incoming eroded sediment load Ei by the VFS (ΔE); dE_perc = (Ei – Eo)/Ei * 100 %
	dP_meas_final	%	relative reduction of total incoming pesticide load mi by the VFS (ΔP); dP_perc = (mi – mo)/mi * 100 %

12.4 Boxplots VFS

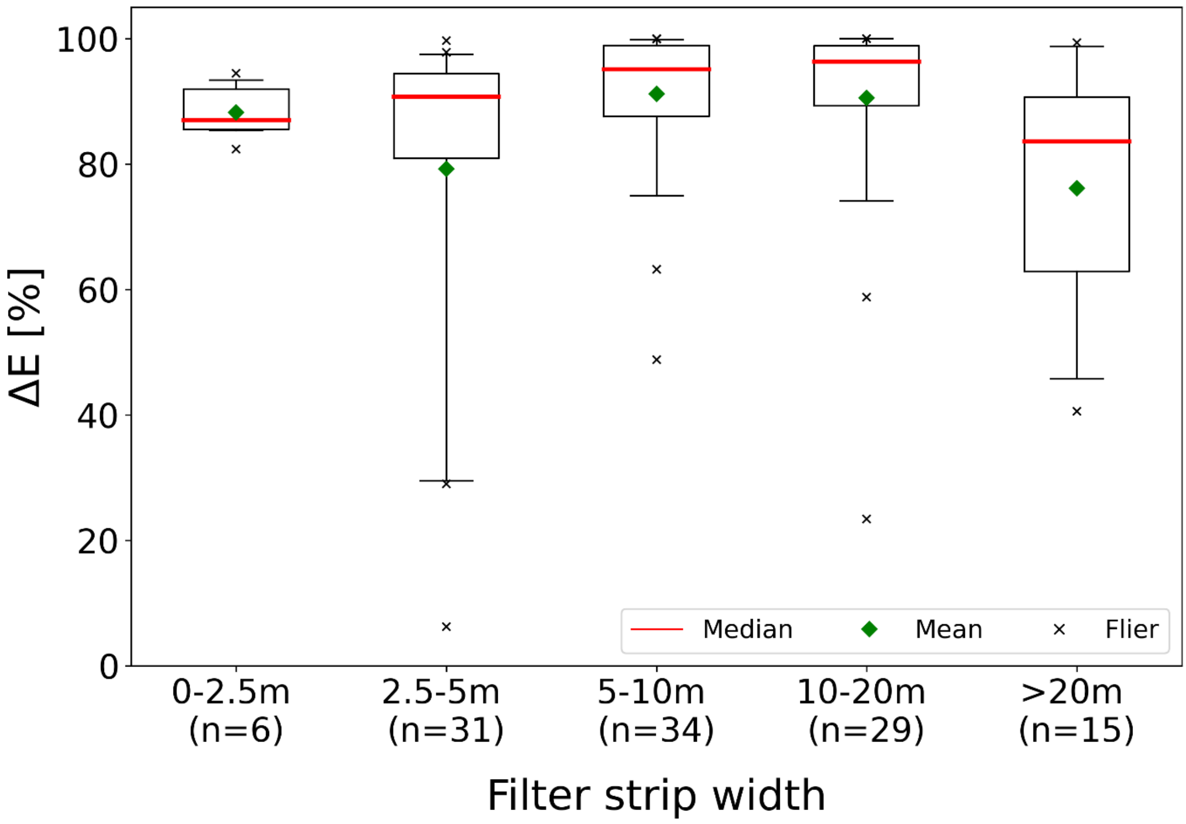

Figure S 1: Relative reduction of total eroded sediment load by the vegetative filter strip ΔE as a function of filter strip width (length in flow direction). Data source: Reichenberger et al.[41]

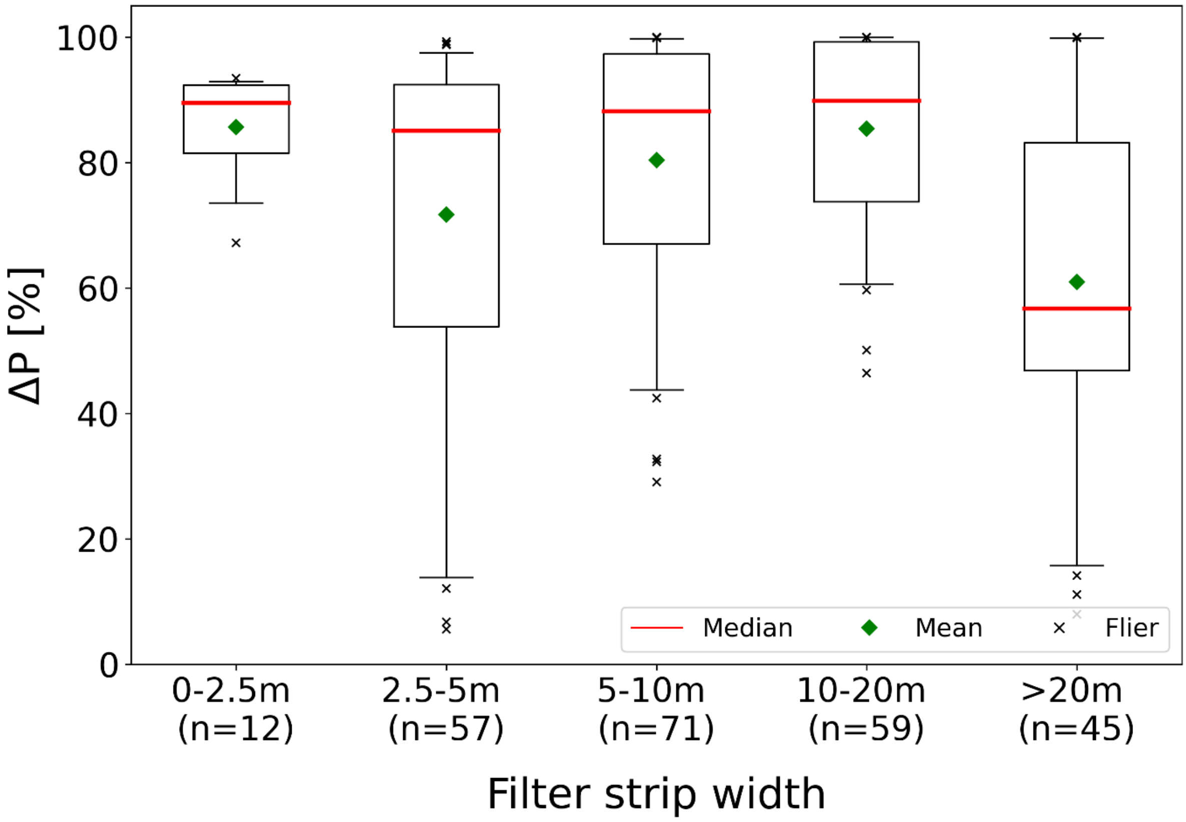

Figure S 2: Relative reduction of pesticide load by the vegetative filter strip ΔP as a function of filter strip width (length in flow direction). Data source: Reichenberger et al.[41]

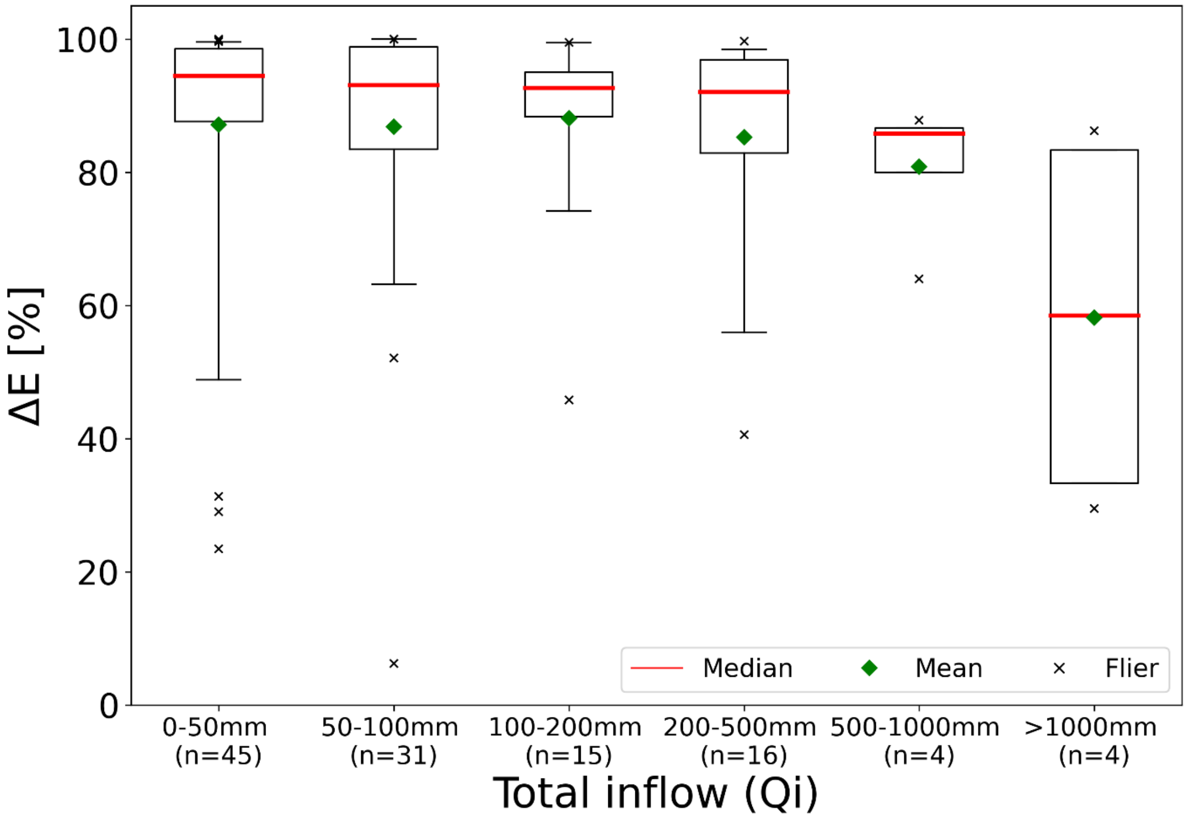

Figure S 3: Relative reduction of total eroded sediment load by the vegetative filter strip ΔE as a function of total inflow normalized to the VFS area Qi. Total inflow equals the runoff leaving the field andthe rainfall on the vegetative filter strip. Data source: Reichenberger et al.[41]

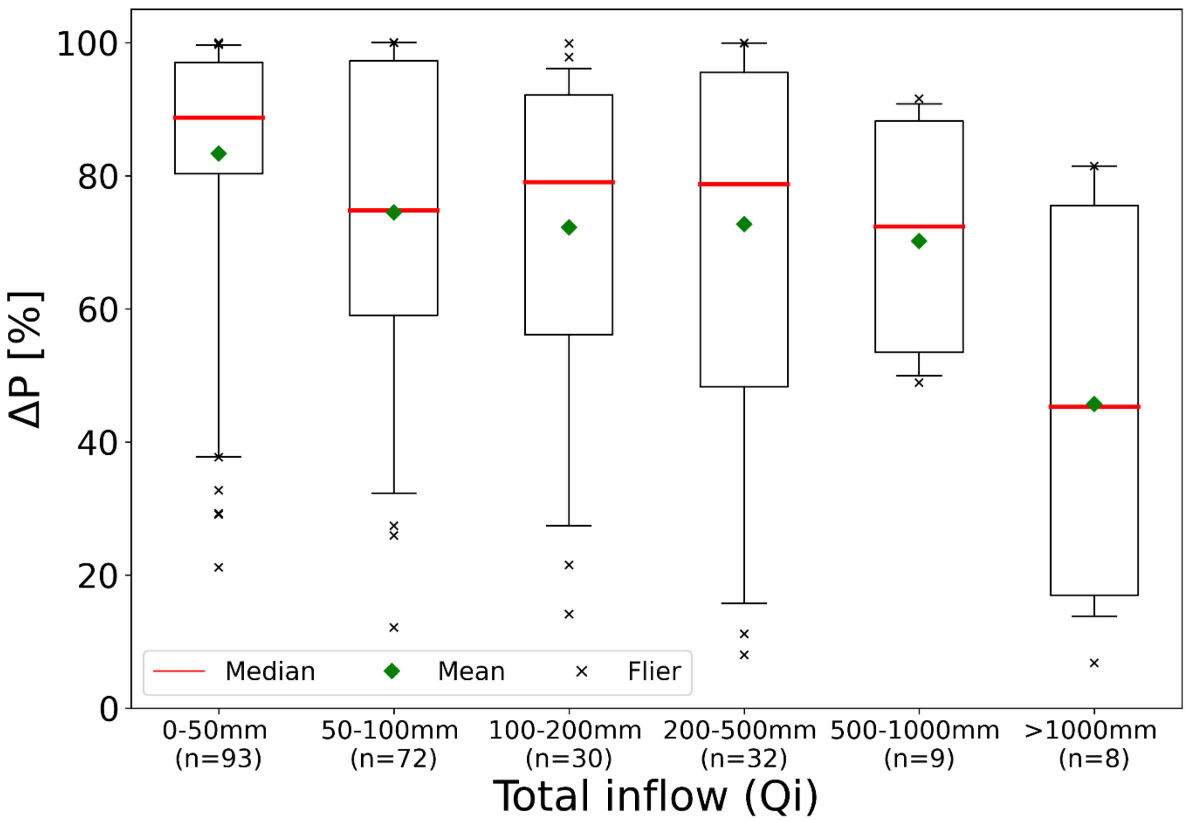

Figure S 4: Relative reduction of total pesticide load by the vegetative filter strip ΔP as a function of total inflow normalized to the VFS area Qi. Total inflow equals the runoff leaving the field and the rainfall on the vegetative filter strip. Data source: Reichenberger et al.[41]

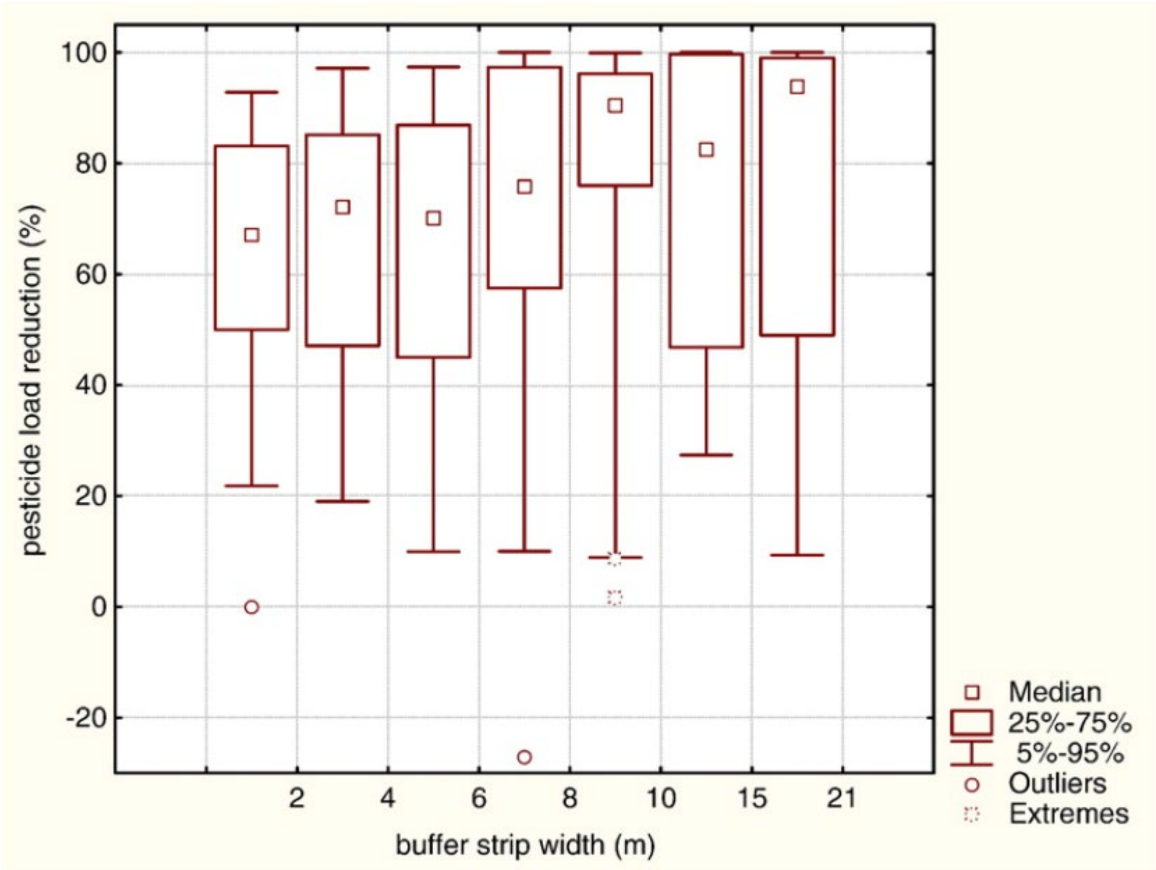

Figure S 5: Relative reduction of pesticide load by the vegetative filter strip ΔP as a function of filter strip width (length in flow direction) from Reichenberger et al. (2007)[23]. This figure is based on n = 277 data points

12.5 CART results

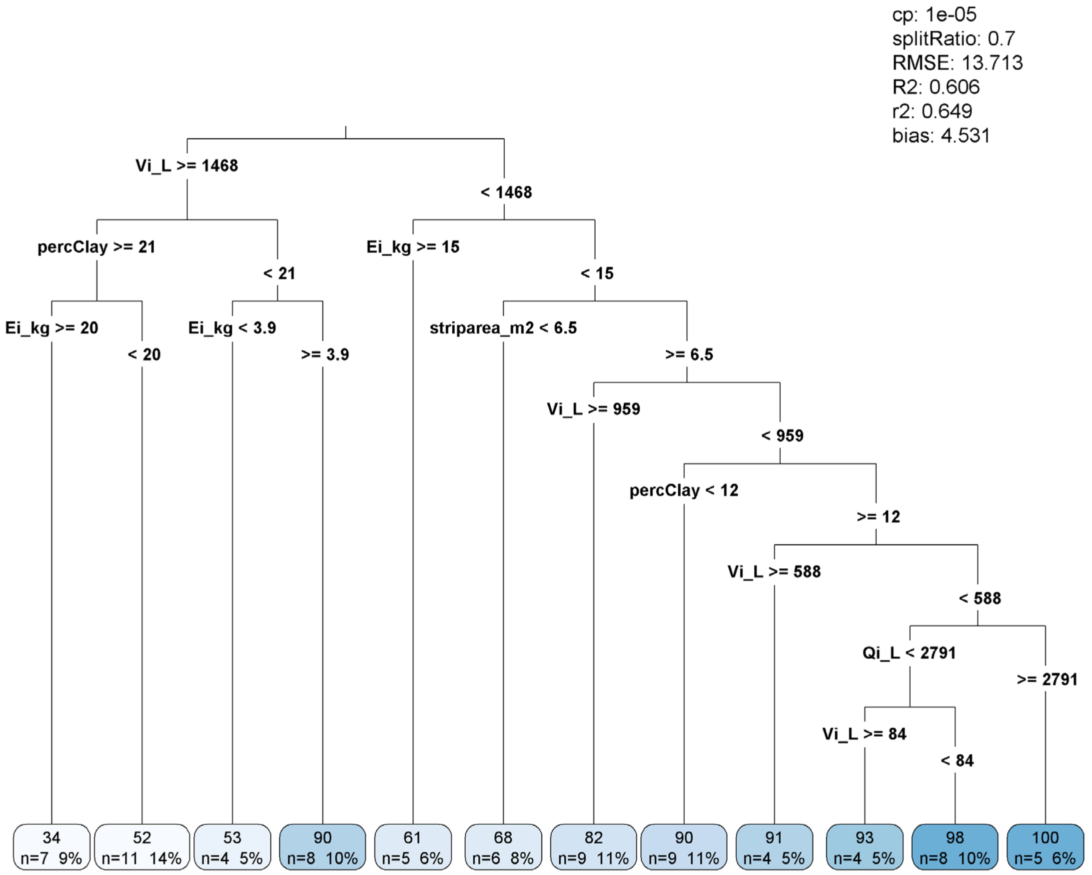

Figure S 6: Decision tree for the best CART run for ΔQ (relative reduction of total inflow (run-on + rainfall) by the vegetative filter strip). At every split, the independent variable which was used for the split is shown. For the final classes at the bottom of the tree, class means and sample sizes (absolute and normalized to 100 %) are given.
Variables: percClay = topsoil clay content (%), Ei_kg = soil loss from field (kg); Vi_L: incoming surface runoff (L), stripearea_m2 = VFS area (m^2),Qi_L = total incoming water flow (incoming surface runoff and rainfall on the VFS; L)); … .

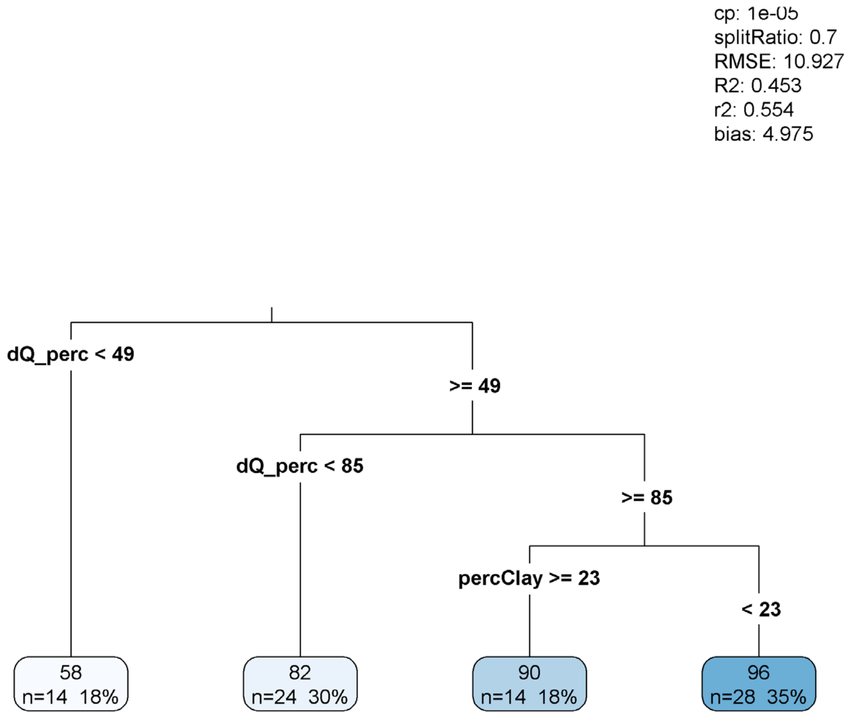

Figure S 7: Decision tree for the best CART run for ΔE (relative reduction of eroded sediment load by the vegetative filter strip). For the final classes at the bottom of the tree, class means and sample sizes (absolute and normalized to 100 %) are given. Variables: percClay = topsoil clay content (%), dQ_perc = relative reduction of total inflow by the VFS (%)

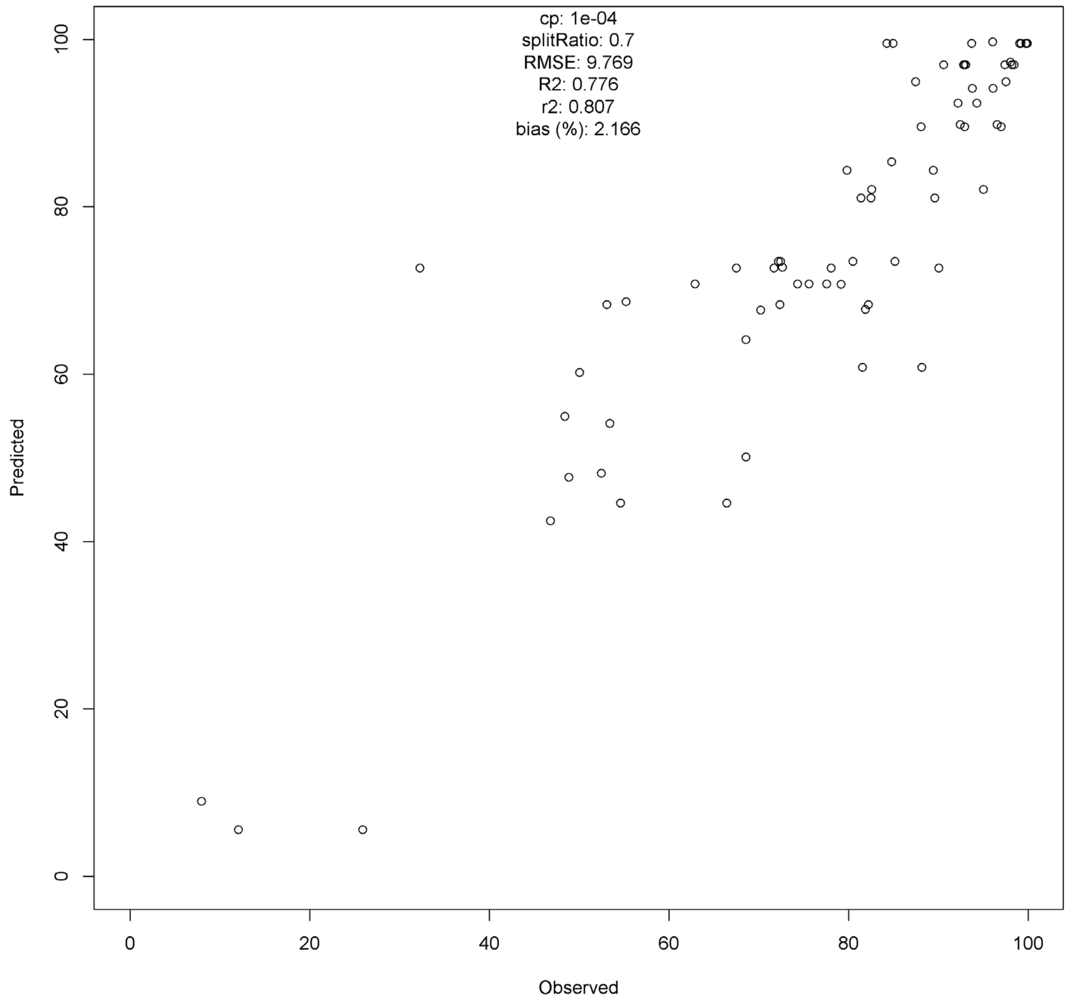

Figure S 8: Scatterplot of observed vs. predicted values for the best CART run for the relative reduction of pesticide load ΔP. The points displayed are the 30 % of the data which were not used for establishing the decision tree, i.e. the validation dataset.

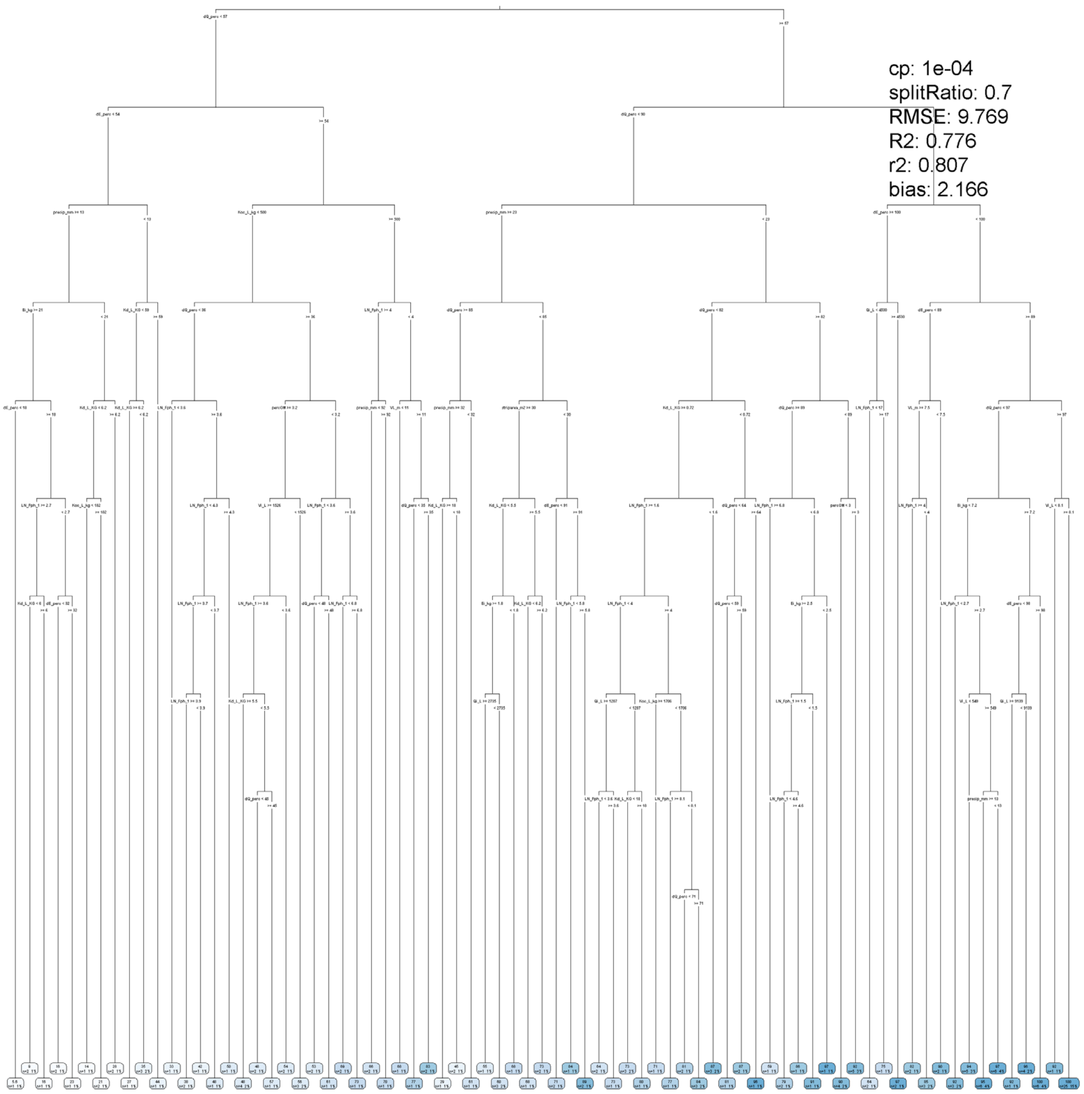

Figure S 9: Decision tree for the best CART run for ΔP (relative reduction of pesticide load) by the vegetative filter strip).

Table S 6: Relative importance (%) of independent variables 1), 2) for the target variables based on the best CART run. The column highlighted in grey shows the results for the independent variable VFS width (length in flow direction, VL_m)

target variable	variant*	NSE	percOM	precip_mm	percClay	striparea_m2	VL_m	dQ_perc	dE_perc	LN_Fph_1	Koc_L_kg	Kd_L_kg	Vi_L	Vi_L_m2 striparea	Ei_kg_m2 striparea	Qi_L_m2 striparea	Ei_kg	Qi_L
ΔQ	1	0.606	10	11	12	7	5	NA	NA	NA	NA	NA	23	NA	NA	NA	*21*	11
ΔQ	2	0.401	13	11	10	11	2	NA	NA	NA	NA	NA	NA	23	*20*	9	NA	NA
ΔQ	3	0.605	11	12	13	9	6	NA	NA	NA	NA	NA	25	NA	NA	NA	*23*	NA
ΔQ	4	0.401	14	12	10	12	5	NA	NA	NA	NA	NA	NA	24	*22*	NA	NA	NA
ΔE	1	0.453	3	0	6	*12*	9	66	NA	NA	NA	NA	3	NA	NA	NA	NA	1
ΔE	2	0.453	2	0	5	9	6	50	NA	NA	NA	NA	NA	*12*	7	9	NA	NA
ΔE	3	0.453	3	0	6	*12*	9	66	NA	NA	NA	NA	3	NA	NA	NA	0	NA
ΔE	4	0.453	2	NA	5	10	6	55	NA	NA	NA	NA	NA	*13*	8	NA	NA	NA
ΔP	1	0.776	1	3	2	2	7	34	*22*	5	2	2	7	NA	NA	NA	7	7
ΔP	2	0.754	3	3	2	1	7	35	*23*	3	1	1	NA	8	10	4	NA	NA
ΔP	3	0.776	3	3	2	2	7	35	*23*	7	2	2	7	NA	NA	NA	8	NA

target variable	variant*	NSE	percOM	precip_mm	percClay	striparea_m2	VL_m	dQ_perc	dE_perc	LN_Fph_1	Koc_L_kg	Kd_L_kg	Vi_L	Vi_L_m2 striparea	Ei_kg_m2 striparea	Qi_L_m2 striparea	Ei_kg	Qi_L
ΔP	4	0,757	3	3	2	2	7	33	*22*	7	2	2	NA	8	11	NA	NA	NA

[1)] Most important variable in **bold**, second most important in *italics*. The sum of relative importance over a row yields 100. NA = *not applicable*

[2)] **ΔQ**: relative reduction of total inflow (run-on + precipitation) by the VFS), **ΔE**: relative reduction of eroded sediment load, **ΔP**: relative reduction of pesticide load, *Vi_L_m2striparea* and *Vi_L:*. surface runoff entering the VFS (normalized to VFS area and absolute), *Ei_kg_m2 striparea* and *Ei_kg:* soil loss from the field (normalized to VFS area and absolute), *percOM* organic matter content of field topsoil, *precip_mm* precipitation, *percClay* clay content of field topsoil, *striparea_m2* VFS area, *VL_m* filter strip width (= length in flow direction), *dQ_perc relative reduction of surface runoff, dE_perc* relative reduction of eroded sediment load, *LN_Fph_1* transformed distribution coefficient between dissolved and particle-bound phase *, Koc_L_kg* sorptions coefficient normalized to organic carbon, *Kd_L_kg linear s*orption coefficient of the substance in soil, *Qi_L_m2striparea* and *Qi_L:* total inflow into the VFS (run-on + rainfall) normalized to VFS area (normalized to VFS area and absolute). * Variant 1: Q_i, V_i, E_i not normalized; Variant 2: Q_i, V_i, E_i normalized to VFS area; Variant 3: like variant 1, but Q_i not used, since it's a linear combination of other variables: Qi_L = Vi_L + precip_mm * striparea_m2; Variant 4: like variant 2, but Q_i not used, since it's a linear combination of other variables: Qi_L_m2striparea = Vi_L_m2striparea + precip_mm

[3)] Nash-Sutcliffe coefficient for prediction

12.6 Field study with event-based data on surface runoff, erosion and pesticide loss (Erlach, 2005)

Table S 7: Measured runoff volumes from Erlac[43] and modified Curve Number for conventional mouldboard ploughing and mulch-tillage

crop	Date	Precipitation mm	Runoff ploughing mm	Runoff mulch-tillage mm	CN (plough)	CN (mulch)	Reduction of CN by mulch-tillage
maize	21.06.98	5.2	0.04	0	92	< 92	n.a.
maize	22.06.98 (I)	2.9	0.115	0,04	97	96	0,7
maize	22.06.98 (II)	2.9	0.16	0,02	97	95	1,3
maize	01.08.98	13.4	0.04	0	81	< 80	n.a.
maize	12.07.99	11.9	0.075	0	84	< 82	n.a.
maize	19.07.99	6.1	0.02	0	90	< 90	n.a.
maize	20.07.99	5.2	0.03	0	92	< 92	n.a.
maize	30.06.01	35	1.415	0,57	70	66	3,9
winter wheat	22.11.99	9.2	0.025	0	86	< 86	n.a.
winter wheat	29.01.00	6.6	0.015	0,015	90	90	0,0
winter wheat	24.02.00	20.6	0.045	0,03	73	73	0,4

crop	Date	Precipitation mm	Runoff ploughing mm	Runoff mulch-tillage mm	CN (plough)	CN (mulch)	Reduction of CN by mulch-tillage
winter wheat	01.03.00	12.6	0.045	0,015	82	81	0,9
winter wheat	03.03.00	10.2	0.035	0,015	85	84	0,6
winter wheat	08.03.00	24.9	0.06	0,045	70	69	0,3
winter wheat	10.03.00	6.7	0.015	0,015	89	89	0,0
winter wheat	17.03.00	11.3	0.03	0,01	83	83	0,7
winter oilseed rape	07.09.00	10.1	0.23	0	96	< 96	n.a.
winter oilseed rape	16.09.00	13.5	0.845	0	95	< 95	n.a.
winter oilseed rape	25.09.00	11	0.87	0	96	< 96	n.a.
winter oilseed rape	27.09.00	3	0.245	0	99	< 99	n.a.

n.a.: not available

Table S 8: Measured soil losses by Erlach[43] for conventional mouldboard ploughing and mulch-tillage

Crop	Date	Precipitation mm	Soil loss ploughing $g\ m^{-2}$	Soil loss mulch-tillage $g\ m^{-2}$	Relative reduction by mulch-tillage %
maize	21.06.98	5.2	2.16	0	100.0
maize	22.06.98 (I)	2.9	6.56075	1.736	73.5
maize	22.06.98 (II)	2.9	6.336	0.477	92.5
maize	01.08.98	13.4	0.552	0	100.0
maize	12.07.99	11.9	0.52875	0	100.0
maize	19.07.99	6.1	0.39	0	100.0
maize	20.07.99	5.2	0.2505	0	100.0
maize	30.06.01	35	32.828	12.597	61.6
winter wheat	22.11.99	9.2	0	0	-
winter wheat	29.01.00	6.6	0	0	-
winter wheat	24.02.00	20.6	0.0765	0	100.0
winter wheat	01.03.00	12.6	0.135	0	100.0
winter wheat	03.03.00	10.2	0	0	-

Crop	Date	Precipitation mm	Soil loss ploughing g m^{-2}	Soil loss mulch-tillage g m^{-2}	Relative reduction by mulch-tillage %
winter wheat	08.03.00	24.9	0.162	0.06525	59.7
winter wheat	10.03.00	6.7	0	0	-
winter wheat	17.03.00	11.3	0	0	-
winter oilseed rape	15.09.00	62.1	n.a.	0	n.a.
winter oilseed rape	07.09.00	10.1	0.0529	0	100.0
winter oilseed rape	16.09.00	13.5	0.714025	0	100.0
winter oilseed rape	25.09.00	11	0.7569	0	100.0
winter oilseed rape	27.09.00	3	0.060025	0	100.0

Table S 9:Measured pesticide losses in surface runoff (dissolved and particle-bound) from Erlach[43] for conventional mouldboard ploughing and mulch-tillage in maize (pre-emergence)

Active substance	Date	Ploughing **mg ha^{-1}**	**Mulch-tillage mg ha^{-1}**	**Relative reduction by mulch-tillage %**
Metolachlor	21.06.98			
Metolachlor	22.06.98 (I)	59.7	18.3	69.4
Metolachlor	22.06.98 (II)	61.7	7.45	87.9
Metolachlor	01.08.98	3.45	0	100
Metolachlor	12.07.99	44.55	0	100
Metolachlor	19.07.99	22.05	0	100
Metolachlor	20.07.99	6.85	0	100
Metolachlor	30.06.01	810	205	74.7
Metolachlor	total	1004.85	230.75	77.0
Pendimethalin	21.06.98			
Pendimethalin	22.06.98 (I)	45.7	10.1	77.9
Pendimethalin	22.06.98 (II)	45.5	2.7	94.1
Pendimethalin	01.08.98	3.5	0	100

Active substance	Date	Ploughing mg ha^{-1}	**Mulch-tillage mg ha^{-1}**	**Relative reduction by mulch-tillage %**
Pendimethalin	12.07.99	38.85	0	100
Pendimethalin	19.07.99	12.05	0	100
Pendimethalin	20.07.99	10.15	0	100
Pendimethalin	30.06.01	585	105	82.0
Pendimethalin	total	737.25	117.8	84.0
Terbuthylazin	21.06.98			
Terbuthylazin	22.06.98 (I)	61.6	24.6	60.1
Terbuthylazin	22.06.98 (II)	61.5	10.5	83.0
Terbuthylazin	01.08.98	6.25	0	100
Terbuthylazin	12.07.99	25.2	0	100
Terbuthylazin	19.07.99	12.1	0	100
Terbuthylazin	20.07.99	5.55	0	100
Terbuthylazin	30.06.01	1180	110	90.7
Terbuthylazin	total	1345.95	145.1	89.2

Table S 10: Measured pesticide losses in surface runoff (dissolved and particle-bound) from Erlach[43] for conventional mouldboard ploughingand mulch-tillage in winter wheat(post-emerngence)

Active substance	Date	Ploughing (mg ha^{-1})	**Mulch-tillage (mg ha^{-1})**	**Relative reduction by mulch-tillage (%)**
Chlortoluron	22.11.99	0.8	0	100
Chlortoluron	29.01.00	0.3	0.7	-133.3
Chlortoluron	24.02.00	2.3	1.1	51.1
Chlortoluron	01.03.00	2.3	0.75	67.4
Chlortoluron	03.03.00	2	0.7	65.0
Chlortoluron	08.03.00	2.6	1.8	30.8
Chlortoluron	10.03.00	0.4	0.5	-25.0
Chlortoluron	17.03.00	1.15	0.3	73.9
Chlortoluron	total	11.05	5.85	47.1
Isoproturon	22.11.99	0.3	0	100
Isoproturon	29.01.00	< 0.001	0.1	< -9900
Isoproturon	24.02.00	0.2	0.2	0
Isoproturon	01.03.00	0.1	0.2	-100

Active substance	Date	Ploughing (mg ha^{-1})	Mulch-tillage (mg ha^{-1})	Relative reduction by mulch-tillage (%)
Isoproturon	03.03.00	0.05	0.1	-100
Isoproturon	08.03.00	0.1	0.25	-150
Isoproturon	10.03.00	< 0.001	0.05	< -4900
Isoproturon	17.03.00	< 0.001	0.1	< -9900
Isoproturon	total	< 0.453	1	< - 120.8

Table S 11: Measured pesticide losses in surface runoff (dissolved and particle-bound) from Erlach[43] for conventional mouldboard ploughingand mulch-tillage in winter oilseed rape (early post-emergence)

Active substance	Date	Ploughing (mg ha^{-1})	Mulch-tillage (mg ha^{-1})	Relative reduction by mulch-tillage (%)
Metazachlor	07.09.2000	0.11	0	100
Metazachlor	16.09.2000	0.81	0	100
Metazachlor	25.09.2000	0.18	0	100
Metazachlor	27.09.2000	0.05	0	100
Metazachlor	total	1.15	0	100

12.7 Microdams

Table S 12: Measured surface runoff and fitted curve numbers in the studies investigated by Sittig et al.[15] for potatoes

Study	Event	P (mm)	runoff control (mm)	runoff microdams (mm)	runoff reduction (%)	CN control	CN microdam	CN reduction	texture	slope %
Olivier et al. (2014)	18.05.2011	40.0	0.058	0.018	69.0	58	57	1	Sandy loam	>3
Olivier et al. (2014)	25.05.2011	15.0	0.034	0.004	88.2	79	78	1	Sandy loam	>3
Olivier et al. (2014)	01.06.2011	8.9	0.178	0.024	86.5	89	87	2	Sandy loam	>3
Olivier et al. (2014)	09.06.2011	30.0	3.333	0.225	93.2	79	67	12	Sandy loam	>3

Study	Event	P (mm)	runoff control (mm)	runoff microdams (mm)	runoff reduction (%)	CN control	CN microdam	CN reduction	texture	slope %
Olivier et al. (2014)	15.06.2011	8.0	0.070	0.039	44.3	89	88	1	Sandy loam	>3
Olivier et al. (2014)	20.06.2011	16.0	1.570	0.107	93.2	87	79	8	Sandy loam	>3
Olivier et al. (2014)	23.06.2011	6.1	0.047	0	100.0	91	<90	>1	Sandy loam	>3
Olivier et al. (2014)	29.06.2011	36.0	>7.407 1)	2.000	>73.0	>82	71	>11	Sandy loam	>3
Olivier et al. (2014)	01.07.2011	5.1	1.393	0.090	93.5	97	93	4	Sandy loam	>3

Study	Event	P (mm)	runoff control (mm)	runoff microdams (mm)	runoff reduction (%)	CN control	CN microdam	CN reduction	texture	slope %
Olivier et al. (2014)	08.07.2011	2.5	0	0.009	n.a.	<96	96	<0	Sandy loam	>3
Olivier et al. (2014)	12.07.2011	0.9	0.004	0.006	-50.0	99	99	0	Sandy loam	>3
Olivier et al. (2014)	19.07.2011	41.0	2.519	0.121	95.2	69	58	11	Sandy loam	>3
Olivier et al. (2014)	26.07.2011	20.0	1.126	0.104	90.8	82	75	7	Sandy loam	>3
Olivier et al. (2014)	04.08.2011	7.5	0.026	0.004	84.6	89	88	1	Sandy loam	>3

Study	Event	P (mm)	runoff control (mm)	runoff microdams (mm)	runoff reduction (%)	CN control	CN microdam	CN reduction	texture	slope %
Olivier et al. (2014)	09.08.2011	19.0	0.714	0.127	82.2	81	76	4	Sandy loam	>3
Olivier et al. (2014)	16.08.2011	37.0	5.541	0.637	88.5	78	65	13	Sandy loam	>3
Olivier et al. (2014)	19.08.2011	40.0	>7.407	6.667	>10.0	>79	78	>1	Sandy loam	>3
Olivier et al. (2014)	24.08.2011	33.0	>7.407	6.963	>6.0	>84	83	>1	Sandy loam	>3
Olivier et al. (2014)	30.08.2011	15.0	>7.407	6.222	>16.0	>96	95	>1	Sandy loam	>3

Study	Event	P (mm)	runoff control (mm)	runoff microdams (mm)	runoff reduction (%)	CN control	CN microdam	CN reduction	texture	slope %
Olivier et al. (2014)	total	381	>46.2	23.4	>49.4	83 [2)]	73 [2)]	10 [2)]	Sandy loam	>3
Aurbacher et al. (2010) [3)]		68 [3)]	19.5 [3)]	0.4 [3)]	97.9	75	39	36	silty (loess)	2 - 10
Areas (2005) [4)]		40				92	73	17	silt loam	
Areas (2007)		30	19	3	84.2	95	78	9	loam	

[1)] Overflow of the recipient

[2)] Rainfall-weighted mean over all events (Sittig et al., 2020)[15]

[3)] Mean over 35 trials with simulated rainfall; due to the nonlinearity of the CN approach, fitting of CN to averaged runoff data is only valid if the rainfall amount was approximately the same in all trials

[4)] Mean CN over dry and moist soil

Table S 13: Seasonal pesticide loads in surface runoff and eroded sediment (Olivier et al.[51], see Sittig at al.[15]) and seasonal pesticide reduction efficiencies for microdams in potatoes

Phase	Treatment	Aclonifen (mg ha^{-1})	Linuron (mg ha^{-1})	Flufenacet (mg ha^{-1})	Metribuzin (mg ha^{-1})	Mean Reduction
Sediment	control	29368	8802	3692	209	-
	microdams	929	435	113	16	-
	reduction	97 %	95 %	97 %	93 %	96 %
Water	control	29368	8802	3692	209	-
	microdams	929	435	113	16	-
	reduction	97 %	95 %	97 %	93 %	96 %
Total load	control	30902	18750	7536	1802	-
	microdams	1000	1734	673	282	-
	reduction	97 %	91 %	91 %	84 %	91 %

Table S 14: Seasonal total loads of several pesticides (in surface runoff and eroded sediment combined; Goffart et al.[52], see Sittig et al.[15]) and seasonal pesticide reduction efficiencies for microdams in potatoes

Phase	Treatment	Fluazinam (mg ha^{-1})	Mancozeb (mg ha^{-1})	Aclonifen (mg ha^{-1})	Flufenacet (mg ha^{-1})	Metribuzin (mg ha^{-1})	Mean Reduction
Total load	control	62	132560	21108	8651	3582	-
	microdams	28	3258	214	7	390	-
	reduction	56 %	94 %	99 %	100 %	70 %	84 ± 20 %

Table S 15: Meausred runoff from Sui et al.[45] and fitted Curve Numbers for four separate events and three microdam variants.

Datum	precipitation (mm)	Runoff control (mm)	Runoff for 65 (53)[1] cm Length (mm)	Runoff for 75 (63)[1] cm Length (mm)	Runoff for 85 (73)[1] cm Length (mm)	CN control	CN for 65 (53)[1] cm Length	CN for 75 (63)[1] cm Length	CN for 85 (73)[1] cm Length	Mean CN for microdam	Difference (CN control – mean CN microdams)
02.08.2012	16.9	1.60	0.55	0.53	0.72	86	82	82	83	82	4
19.08.2012	43.1	2.67	0.52	0.44	0.58	68	60	60	61	60	8
13.07.2013	5.29	1.68	0.32	0.28	0.35	98	95	94	95	94	3
16.08.2013	68.0	12.9	3.87	3.61	5.04	69	57	56	59	57	12
Average											7

[1] Values in parenthesis are for experiments in 2013.

Table S 16. Calculated Curve Numbers as a function of the irrigation event for Keshavarz et al.[46]

Inflow L s^{-1}	Variant	Curve Numbers					
		Event 1	Event 2	Event 3	Event 4	Mean	Reduction
0.6	Control	65	75	79	82	75	-
0.6	Microdams with 10 m distance	49	61	73	73	64	9
0.6	Microdams with 20 m distance	56	64	77	77	68	7
0.9	Control	73	81	84	80	80	-
0.9	Microdams with 10 m distance	55	67	74	75	68	12
0.9	Microdams with 20 m distance	64	71	77	74	71	9
	Average						9