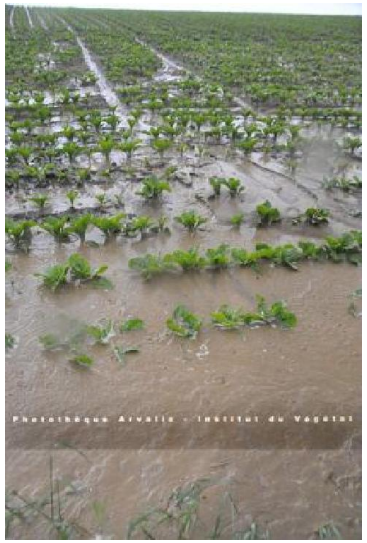
Mitigation Measures for Runoff



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Basic mitigation options

- In field measures
- Out of field measures

Catchment:

Investigation area to understand water transfer and implement suitable mitigation plan

Scale to implement measures e.g vegetative buffer and retention structures

Field:

Unit to understand the movement of excess water in different locations at different periods of time.

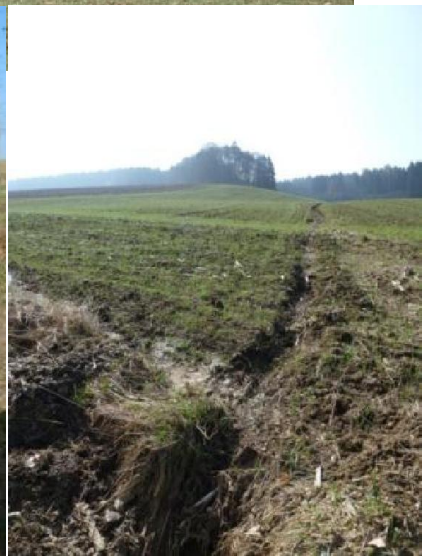
Scale to implement in field measures.

Scale of diagnosis case study

Natural and human erosion gullies to drain water out of field

Solution 1
Audited field scale

- Double sow in talweg
- Establish a buffer in talweg



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Solution 2
Catchment scale

- Reprofile the path in the hops
- Enlarge the ditch and create a retention pond along the pathway

Scale of diagnosis case study

Solution 1

Collecting at the end

- Implement a buffer zone at the edge of the field

Solution 2

Preventing at source

- Double sow along talweg
- Implement a buffer along talweg

Mitigation measure toolbox overview

Soil management	• Reduce tillage intensity • Manage tramlines • Prepare rough seedbed • Establish in-field bunds	• Manage surface soil compaction • Manage subsoil compaction • Do contour tilling/disking • Increase organic matter
Cropping practices	• Use Crop rotation • Do strip cropping • Enlarge headlands	• Use annual cover crops • Use perennial cover crops • Double sowing
Vegetative buffers	• Use in-field buffers • Establish talweg buffers • Use riparian buffers • Use edge-of-field buffers	• Manage field access areas • Establish hedges • Establish/maintain woodlands
Retention structures	• Use edge-of-field bunds • Establish veget. ditches	• Establish artificial wetlands/ponds • Build fascines
Adapted use of pesticides & fertilizer	• Adapt application timing • Optimize seasonal timing	• Adapt product and rate selection
Optimized irrigation	• Adapt irrigation technique	• Optimize irrigation timing and rate

Pictogram explanation

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

Diffuse runoff Diff. ☑	Concentrated runoff Conc. ☑
Runoff by infiltration restrictions Infilt. ☑	Runoff by saturation Sat. ☑
Preventing at source Prevent. ☑	Collecting at the end Collect. ☑

Efficiency

Low
Medium
High

Runoff Mitigation Measures

Soil Management (7 measures)

Soil management 7

- Reduce tillage intensity
- Manage tramlines
- Prepare rough seedbed
- Establish in-field bunds
- Manage surface soil compaction
- Manage subsoil compaction
- Do contour tilling/disking

Cropping practices

Vegetative buffers

Retention structures

Adapted use of pesticides

Optimized irrigation

SOIL MANAGEMENT

Influence water infiltration capacity of the soil

- breaking of soil compactions (surface and subsurface)
- increase the soil porosity (water holding pores)

Principles

- Keep water in the field
- Avoid runoff at the source

Reduced tillage, together with crop rotations and cover crops are the three core practices in conservation agriculture.

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

1 Reduce tillage intensity

What to do

- Improve pore continuity in the topsoil and thus enhances infiltration of water
- Increase crop residues to slow down water flow on the surface
- Reduce slaking effect of rain drops on uncovered soil surfaces (capping process)
- Increase biological activity in the topsoil layer

How to do it

- Changing the tillage system: Reduce ploughing to no till
- Reduce agressivity of the machinary
- Reduce number of passage
- Reduce velocity
- Replace PTO driven with non PTO driven

1 Reduce tillage intensity

No tillage

Tillage

Example 1

Example 2

1 Reduce tillage intensity

Light tilling may be necessary:

- **On clay soils :**
  - Reduce the amount of soil cracks formed during the summer and avoid soil compaction.
- **On soils with swelling clays:**
  - Facilitate infiltration capacity and avoid run off by saturation.
- **With an artificial drainage network:**
  - Reduce preferential water flow through the topsoil towards the tile drains.

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

2 Manage subsoil compaction

What to do

- Avoid plough pan
- Avoid subsurface compaction

How to do it

- Avoid ploughing when soil is too moist
- Avoid harvesting when soil is too moist
- If necessary, break compaction mechanically (ripping) or by growing plants with deep roots

Diff. ☑ | Conc. ☑ | Infilt. ☑ | Sat. ☑ | Prevent. ☑ | Collect ☑

3 Manage surface soil compaction

What to do

- Increase infiltration
- Avoid crusts

How to do

- Break crusts mechanically

3 Manage surface soil compaction

Example 2

Maize – crusted soil capping soils

Maize – crust mechanically broken

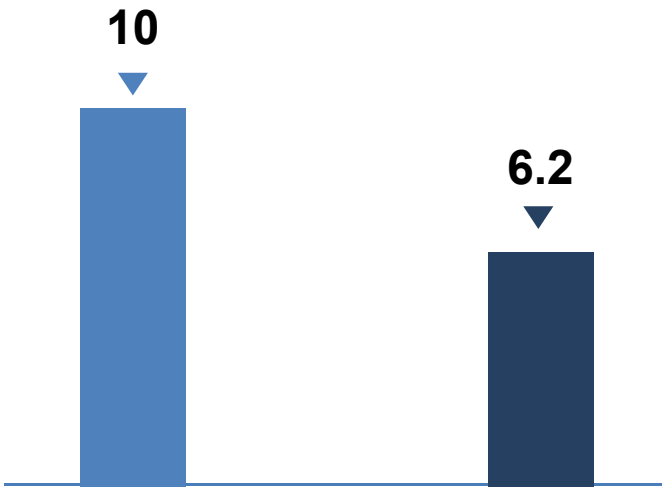
Efficacy of « breaking the capping layer » - winter crop

40 % runoff less

After breaking the capping layer

Rules to be respected to keep the crop safe when breaking mechanically the crust

- Cultivate in good soil moisture conditions (end of february)
- Use low-pressure tyres or reduce tyre pressure
- In winter cereals, at early growths stage
- Consider the proper application dates of herbicides.



Runoff in mm in Foucart, Normandy
From 14th to 17th june 2003
*(*rainfall of 54 mm)

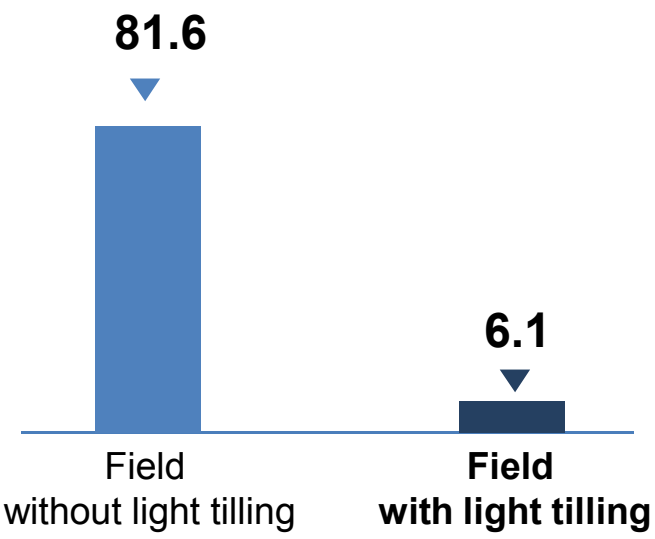
Chambre d'agriculture de la Seine-Maritime

Efficiency of Light tilling and hoeing

Light tilling after harvesting

13 time runoff less

(on a field with light tilling)

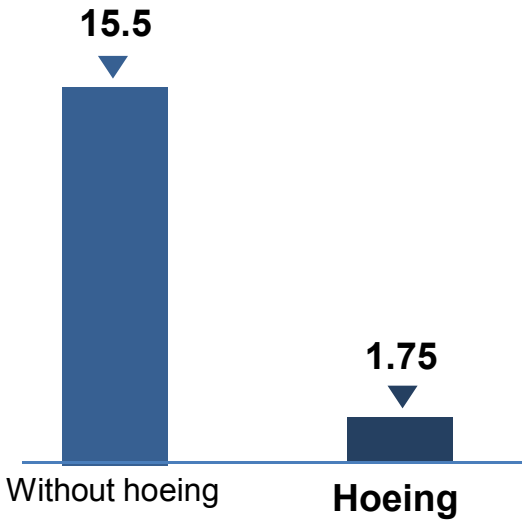


Runoff in mm in Epreville-en-Roumois, Normandy
End of sept 2000 to beginning of april 2001
Chambre d'agriculture de l'Eure

Hoeing

8 time less runoff

With hoeing



Runoff in mm
Epreville en Roumois et Foucart- spring 2004
(simulation of rainfall of 30 mm)
ChambreS d'agriculture de l'Eure et de la Seine Maritime)

Corn: drilling ray-grass stage 8 to 10 leaves

After harvesting silage a intercrop would be difficult to drill.

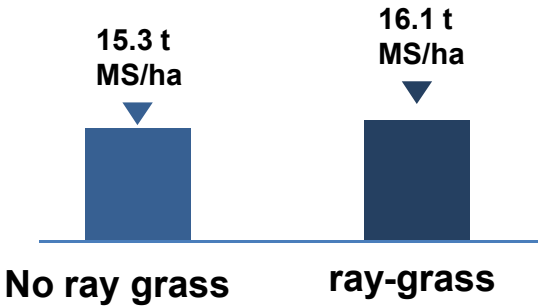
Drilling ray-grass into the corn (mid June) can reduce runoff:

- stage 8 to 10 leafs
- with a hoe equipped with a drilling machine.
- 17-18 kg seed per hectare.

It grows quite easy but slow (because of the corn). Keeps growing after harvest.

Ray – grass destruction should be done end of winter or used as pasture.

….without effect on corn yield



(synthesis 1999-2002 Normandy

Runoff reduction from 1/3 to 2/3….

Source Areas flyer

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4 Prepare rough seedbed

What to do

- Slow down speed of runoff water.
- Increase the infiltration of water into the soil.
- Avoid the “splash-effect” of the rain droplets



4 Prepare rough seedbed

How to do

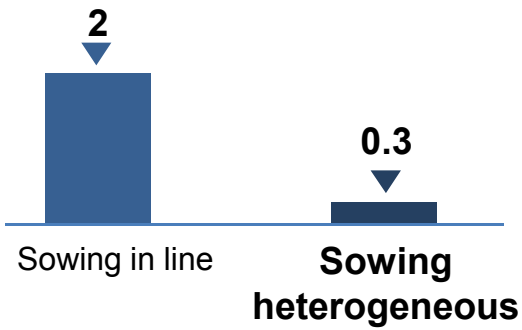
- Reduce tillage to a minimum when preparing the seedbed
- Do not roll over after drilling

Modify drilling to manage runoff on corn

Sow with cereal drill

To reach heterogeneous repartition of the seeds and remove seeding tracks and tramelines

7 time less runoff

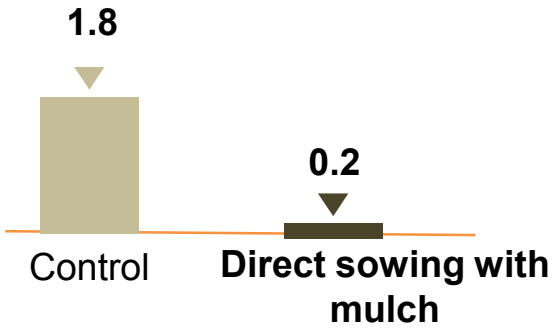


Runoff in mm
Villainville – 15th and 16th june 2006 (rainfall of 17 mm)
(Chambre d'agriculture de la Seine Maritime)

Direct sowing with mulch

To keep soil protected

9 time less runoff



Runoff in mm
Gueutteville – 3rd and 4th of july 2005 (rainfall of 30 mm)
(Chambre d'agriculture de la Seine Maritime)

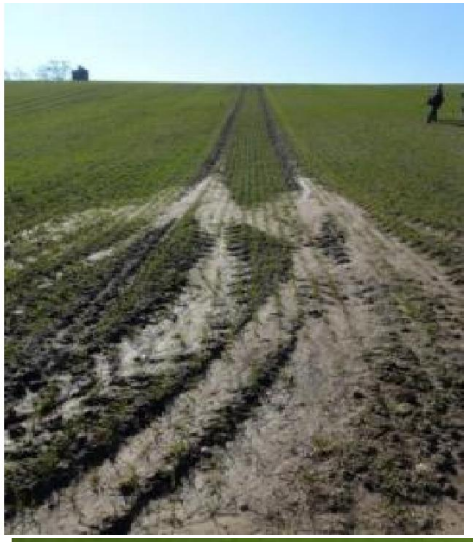
Source Areas

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

5 Manage tramlines

What to do / How to do it

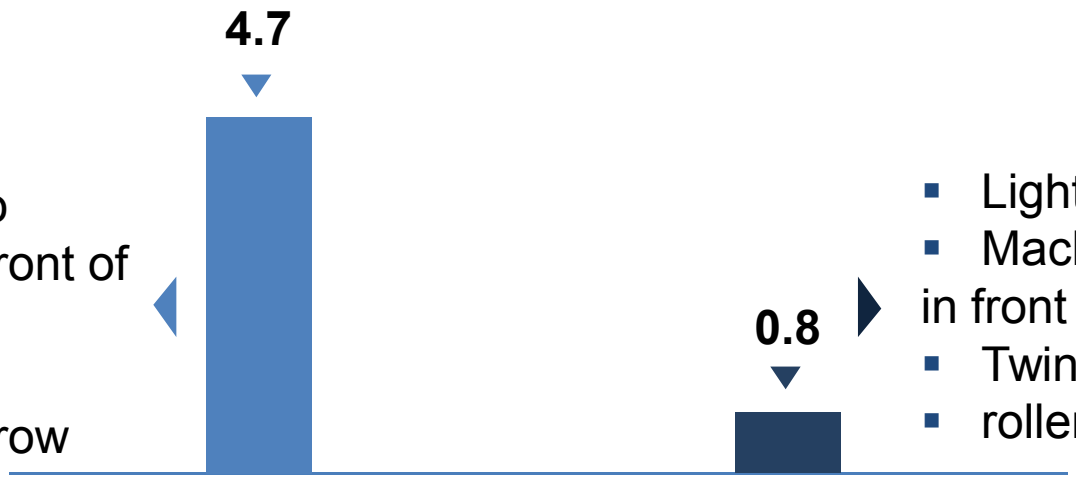
- Whenever possible, tramlines should run across the slope.
- If possible, shift tramlines in field from year to year
- Use low-pressure tires
- Tramlines where runoff occurs should be disked after passing of the tractor OR vegetated OR equipped with bunds.
- A deep soil compaction under tramlines should be broken up mechanically.



Runoff reduction in tramelines
- with cereals -

Until 6 time less runoff

(preserving coarse aggregates)



- Heavy truck
- Machinery to compact in front of the truck
- Large tires
- Rotative harrow
- roller packer

- Light truck
- Machinery to compact in front of the truck
- Twin tires
- roller

Runoff in mm in Normanville (76) - 8 december 2006
(rainfall of 21 mm during 5h30 on saturated soil)
Chambre d'agriculture de la Seine-Maritime

Source Areas

6 Create bunds in the field

What to do

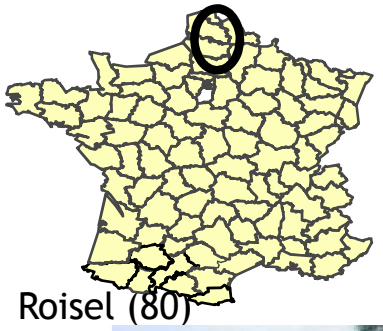
- Create barrier / small dam which retains water in the field and slows down the water flow

Le Transloy (62)

6 Create bunds in the field

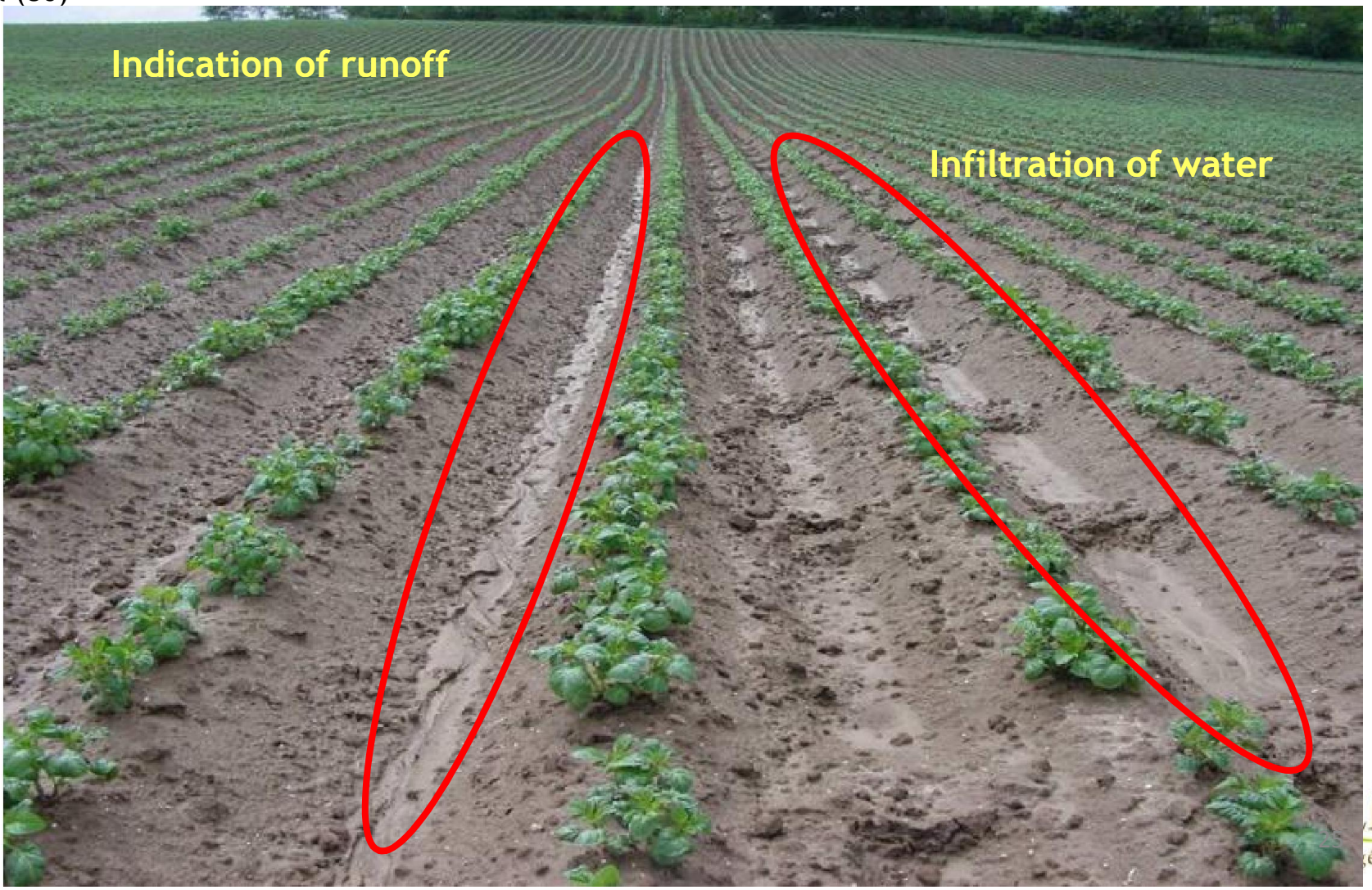
How to do

- Design bunds to retain runoff water.
- Using specific machinary to create interrow bunds.



Roisel (80)

Effect of Bunding

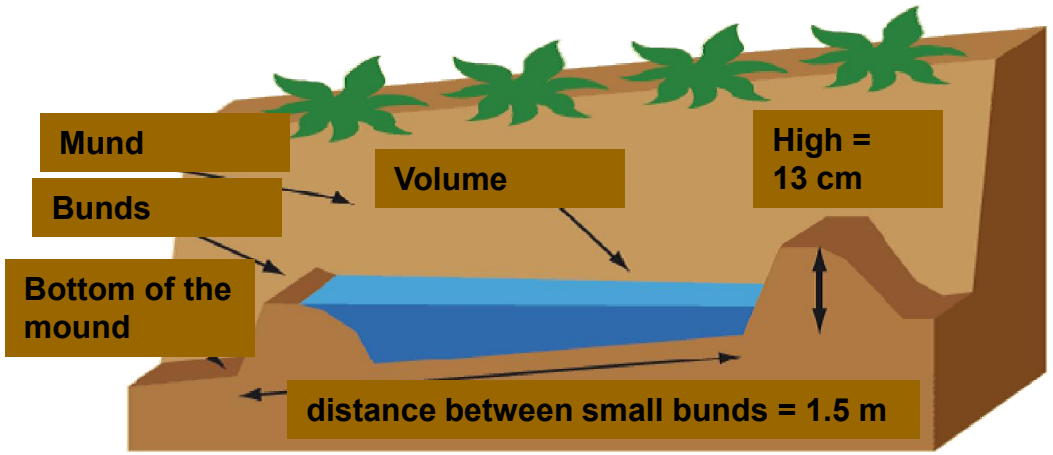


Bunding and sizing

To reach maximum efficacy:

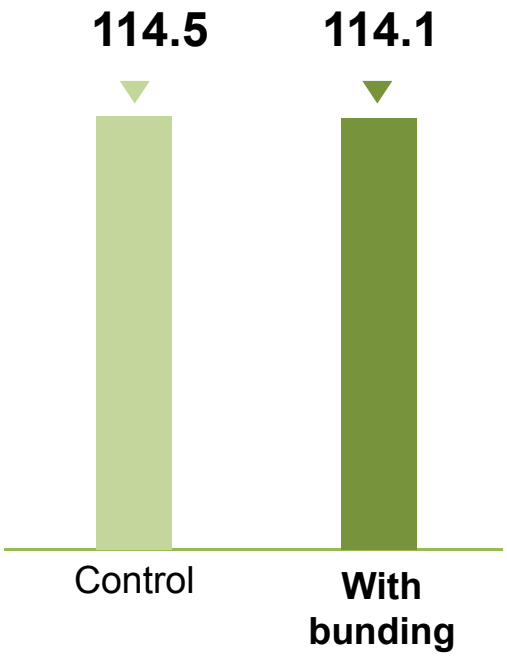
- Bunds should be:
  - separated from each other of about 1.5 m
  - 13 cm high.
- Slope should not exceed 4 %
- Bunds should be located in staggered rows from one row to another.

High and distance between small bunds

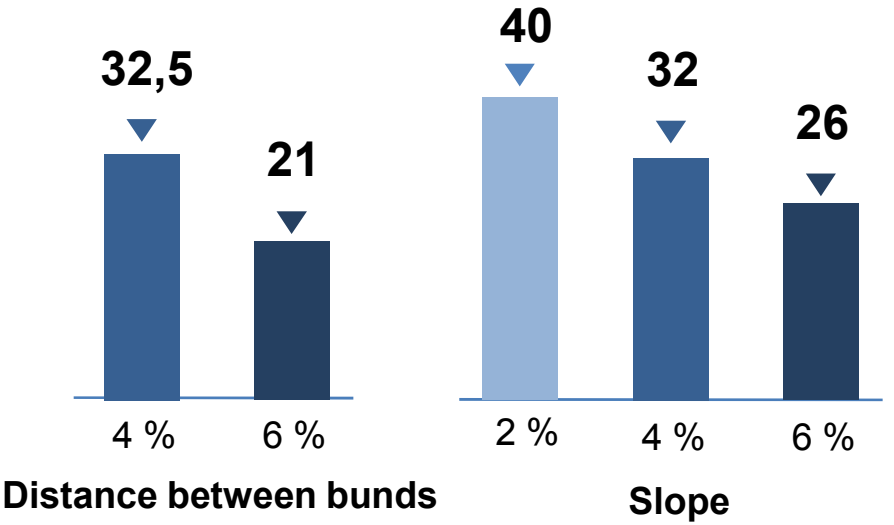


Bunding efficacy

No effect on yield (in t/ha)



Slope and distance between bunds influence the water volume stored
(in mm)



Source Areas

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

7 Contour tilling

What to do

- Creates rough surfaces acting as small bunds to slow down water flow
- Increase water infiltration
- Redirect and dispers water flowing down hill

How to do

- Special equipment needed to follow the contour lines during farming operations
- Carefully analyse the fields on their suitability :
- Uniform slopes of 2 to 10 %
- Lenght of slope no longer than 35 m
- Tractor with wheels vs crawler

Source: BASF

Runoff Mitigation Measures

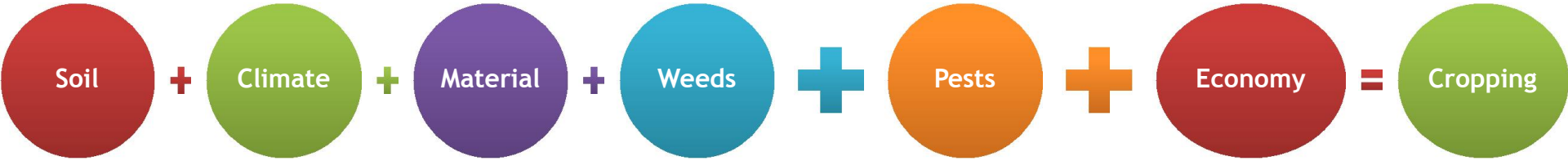
Cropping practices 4

Soil management		
Cropping practices	• Use Crop rotation • Do strip cropping	• Use annual cover crops • Use perennial cover crops
Vegetative buffers		
Retention structures		
Adapted use of pesticides		
Optimized irrigation		

Cropping practices

Cropping practices can strongly reduce the risk for runoff and erosion. Specific crops can improve the soil structure and stability.

- increase water infiltration through crops with deep root systems (porosity)
- protect the soil surface by plant cover / organic matter cover to reduce damage of soil surface due to heavy rains.
- rotation of different crops in large fields and / or in the landscape can serve the function of buffers by reducing speed of water flow and reducing runoff through infiltration (strip cropping).



1 Optimize crop rotation

What to do

- Create succession of crops through time and catchment scale

How to do

- Alternate between crops providing a dense soil cover

2 Implement strip cropping in field (across the slope)

What to do

- Create succession of crops through time and catchment scale

How to do

- Divide large fields vulnerable to runoff / erosions by planting different crops in strips across the slope.
- To be implemented at field or catchment scale

Source:, BASF

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

3 Implant annual cover crops

What to do

- Plant annual cover crop that would fit best into the crop rotation

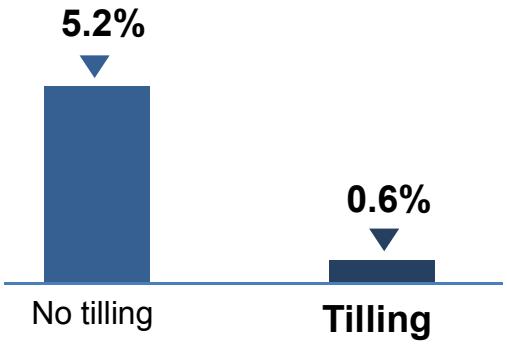
How to do

- Seeding conditions for cover crop should allow for fast and dense establishment of vegetation
- Funding options and legal requirements should be considered if locally available

3 Plant annual cover crops

Managing cover crop

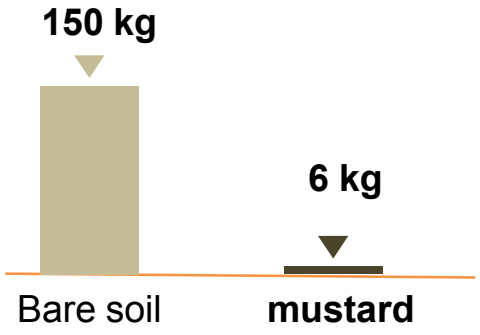
10 time less runoff
(light tilling)



% of runoff with 280 mm of rain
from 1st december to 31st january
(Offranville 2002-2003 - Chambre d'agriculture 76)

Create rugosity,
Break the crusting of capping layers

25 time less erosion
(cover crop)



Diffuse erosion cumulated per hectare for 198 mm of rain
from 17th november to 28th january
(Fresquiennes 2004-2005 - Chambre d'agriculture 76)

Cover the soil to protect it and preserve effects of soil management

Source Areas flyer

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

4 Establish perennial cover crops in plantations

What to do

- Maintain the cover crop in a way that it provides a rather complete soil cover and keeps the ability to mitigate runoff / erosion (resistance through strong stems).

How to do

- Maintain the cover crop by mowing or other means to control the height of the cover crop (not higher than 25 cm).
- If cover crops cannot fully cover the soil surface bring in additional organic materials to cover the soil.
- Consider also aspects on biodiversity when selecting the cover crop

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

5

Enlarge headland

As the headland is usually cultivated in a perpendicular direction to the rest of the field, this area may serve as a cropped barrier for water running downslope.

What and how to do

- Drill crops at the headlands across the slope.
- Enlarge the headland if field has been diagnosed as having a higher runoff risk : Determine the size and the sowing density
- Double sowing of the headland might be an option to further increase the mitigation effect of the headland (buffer strip).
- Headlands can be expanded until the land is getting to steep to work safely with the machines.

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

6 Double sowing

What to do

- When sowing cereals in a talweg then double the sowing density to normal, can be a solution to reduce the flow of water.

How to do

- The double-sowing is done in a strip across the slope or in a talweg in addition to the first sowing process.
- The placement of the double-sowed strip follows in principle the same methodology as an in-field vegetated buffer strips. But stays productive !

Runoff Mitigation Measures
Vegetative buffers

Soil management

Cropping practices

Vegetative buffers 7

- Use in-field buffers
- Establish talweg buffers
- Use riparian buffers
- Use edge-of-field buffers
- Manage field access areas
- Establish hedges
- Establish/maintain woodlands

Retention structures

Adapted use of pesticides

Optimized irrigation

Vegetative buffers

Definition

- Non treated, grassed or wooded perennial zone, between cultivated fields, in position to intercept runoff, anywhere in a catchment

How it works

- Provide infiltration areas for surface runoff water
- Slow down surface runoff water through appropriate vegetation
- Catch sediments

Various aims

- Overall reduction of erosion in a landscape
- Reduction of losses of PPP to surface water
- Reduction of nutrients (phosphorus, nitrogen) inputs to surface water
- Reduction of sediments in streams.
- Providing habitats for increasing biodiversity in agricultural landscapes
- Increasing ecosystem connectivity in agricultural landscapes

Measures to be implemented

differenciated regarding nature and locations

1. Establish and maintain edge of field buffer
2. Establish and maintain In field buffer
3. Establish and maintain talweg buffers
4. Establish and maintain riparian buffer
5. Establish and maintain hedges
6. Establish and maintain Woodlands

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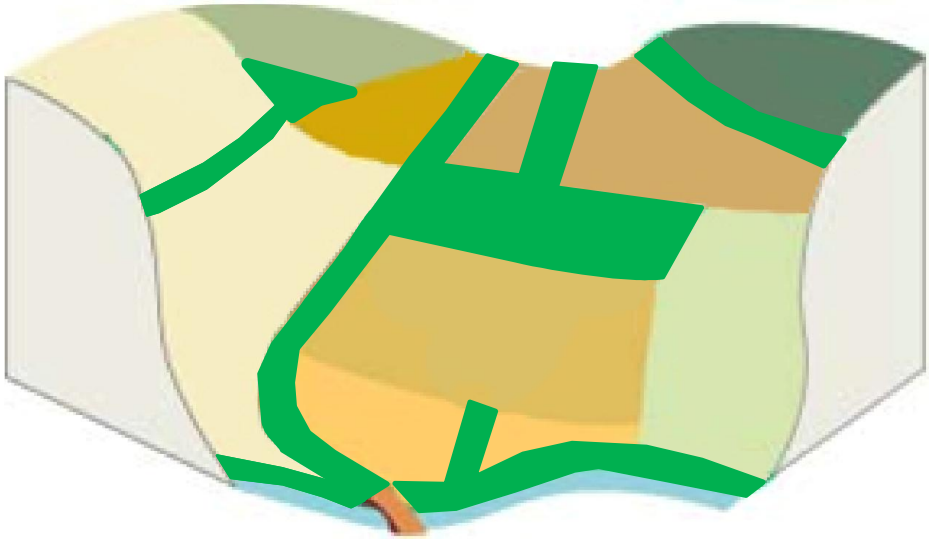
Establish or maintain buffer zones

What to do

- Establish buffers permanently
- Locate properly in the catchment
- Size it properly to prevent runoff



❶ In field buffer

❷ Edge of field buffer

❸ Field corner buffer

❹ Talweg buffer

❺ Meadow (or wood) across a talweg

❻ Riparian buffer

Source: CORPEN

…and also along roads, paths, around chasmes …

Various types

Grass strip

Hedges

Woodland

Wild land *(from wood clearing)*

Type ✖ ***Locations***

Source: IRSTEA

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Types and locations

In field

Edge of field

In a field access area

Meadow across a talweg

Riparian forest

Between field and road

Source: IRSTEA

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123456

Establish or maintain buffer zones

How to do

- Plant local and adapted species (drought or inondation) that should exhibit stiff leaves / stems in order to resist water
- Do not fertilize or spray buffer zones
- Do not drive over the buffer
- If sediments accumulate, spread sediments across the buffer.
- Do not create short cuts through buffer



Specificity on talweg

What is it

- Situation where two different slopes come together in a landscape (small valley, hollow).
- May collect water from both or various slopes during rain events and may lead to concentrated (linear) water flow in a landscape.
- Often starting point of heavy rill / gully erosion.

What to do / How to do

- Roll over to compact soil in the talweg
- Plant a grass cover along the talweg
- In high risk situations hedges should be planted in addition to the grass across the talweg to increase buffer efficiency.

Sedimentation along talweg

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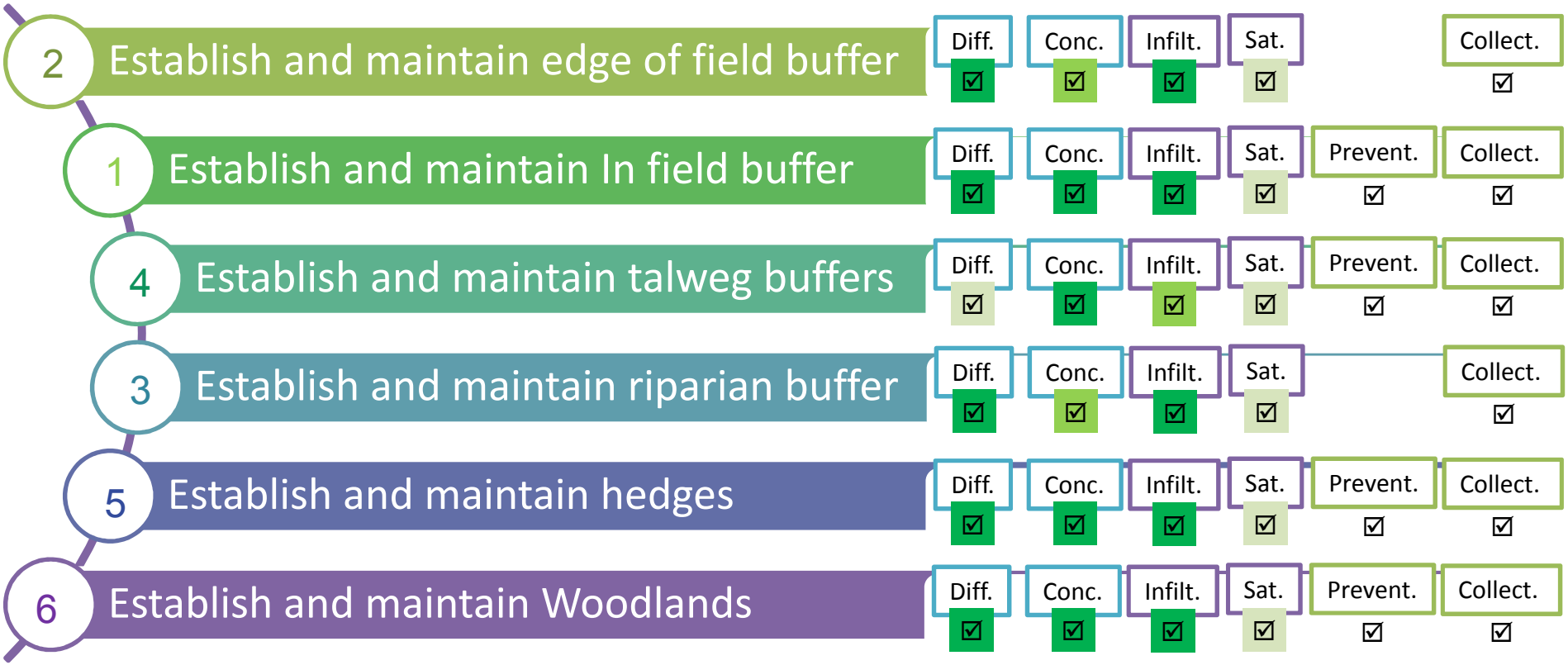
G.Le Hénaff - IRSTEA

Summary
Measures to be implemented



Diagnosis tool to locate and size buffer zones

1. Regulatory context coming in EU: buffer along rivers with a narrow strip

2. May not be sufficient when need to protect important ressources (drinking water, …) in a catchment

3. Need for a **two steps local diagnosis**

- *to verify presence and efficacy of riparian buffers*
- *if necessary, to propose the implementation of a complementary buffering device:*
  - widening of riparian buffers
  - implementation of in-field buffers
  - implementation of buffer along "non-compulsory" brooks and upstream ditches

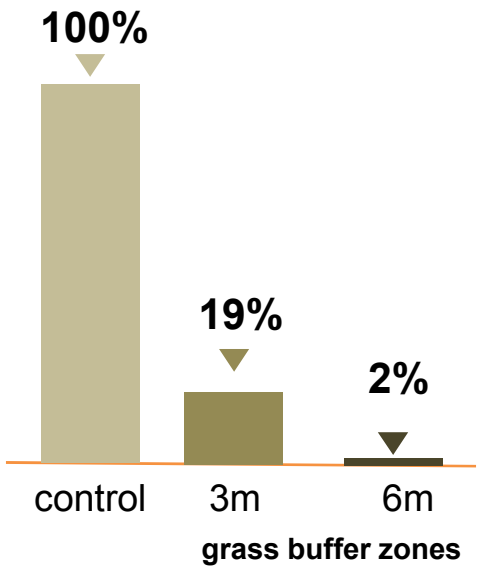
Buffer zones: efficacy to prevent runoff

Buffers are quite efficient trapping sediment and reducing the overall amount of water leaving the field:

- Slowing down water,
- Increasing level of infiltration.

Infiltration can vary between 10 to 200 mm/h/m² in well structured soils while capping soils infiltrate only 2 to 5 mm/h/m²

5 to 50 time less eroded sediment with buffer zones



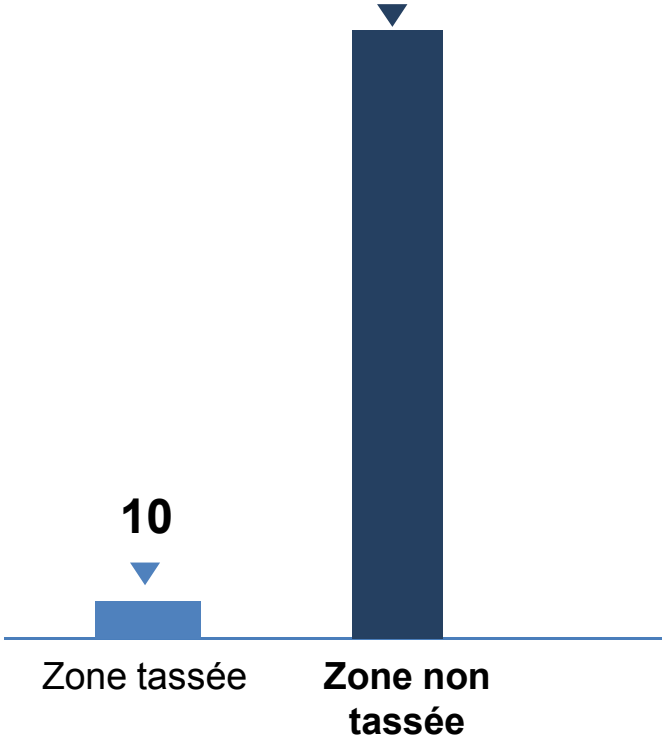
Quantity of sediment going out of wheat field
During one campain
(INRA 97/98 Le-Bourg-Dun)

Source Areas flyer

Buffer zones

permanent grass strip would be the most efficient solution to avoid gullies.

Few months after sowing, trucks can go through the buffer in dry conditions. To be avoided in wet conditions.



Infiltration capacity of a grassy buffer zone in mm/h

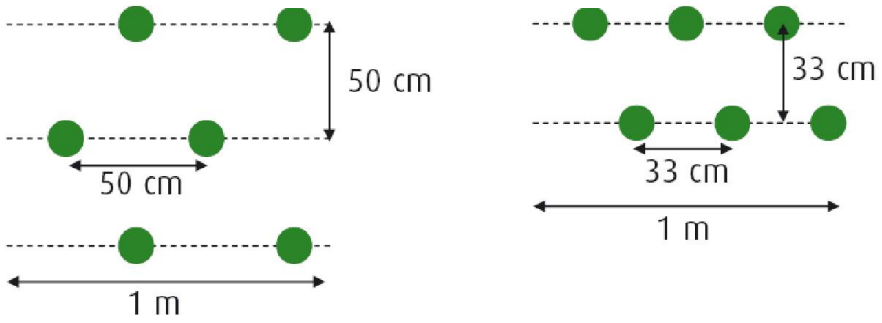
Source Areas flyer

Designing and sizing a hedge – to prevent runoff

Efficient hedge to prevent runoff:

Hedges should be planted in two to three staggered rows, with a width of 50 cm to 1 m. Plants should be as dense as possible taking into account species and their ability to fill in open space.

Planting scheme



Density when planting:

The objective is to reach a density of 40 stalks/m² after 10 years.

Leave at least 50 cm of grass buffer from each side so roots are not damaged when ploughing the field.

Hedge efficiency

		Dense hedge	Low density
Density		60 stems /m²	1 stem /m²
Stem diameter		**2 cm**	8 cm
Medium speed of runoff water at slope (3 and 15%)	3 %	0,12 m/s	0,40 m/s
	15 %	0,55 m/s	2 m/s
Hydraulic interest		Very high	Low

7 Manage field access areas

What to do / How to do

- Use gravel or coarse stones to fortify the direct machinery travel tracks
- Sow a robust grass species, which is deep rooting, sediment tolerant and traffic resistant
- Smooth and recessed wheel tracks on the access area should be avoided
- If possible, locate field access area uphill

Runoff Mitigation Measures

Retention structures

Soil management		
Cropping practices		
Vegetative buffers		
Retention structures	3	• Use edge-of-field bunds • Establish vegetated ditches • Establish Retention ponds/artificial wetlands
Adapted use of pesticides		
Optimized irrigation		

Retention structures
(wetland buffers)

Nature:

- Natural wetland areas: water meadows, riparian forests, enclosed vegetated ditches or ponds.
- Constructed wetlands: infrastructure installations such as dams which retain and collect runoff water and sediments.

How it works:

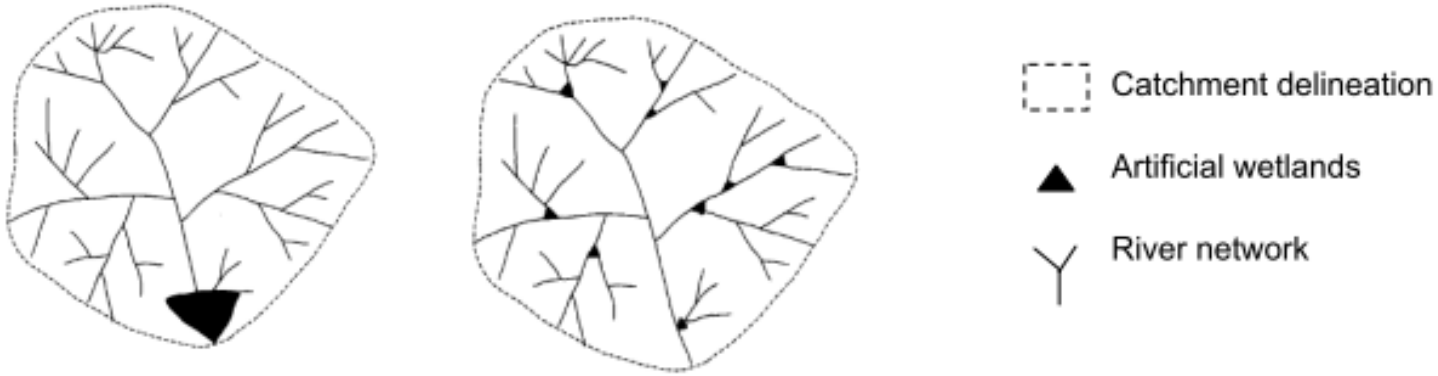
- Collecting runoff water (concentrated flow) and/or water discharged from drained areas.
- Treating diffuse contamination and not point source contamination
- Treating water subsequently discharged into the nearby surface water.
- Require maintenance due to sediment and organic matter depositions, which may reduce the buffer's retention capacity and soil hydraulic permeability.

1 Establish or maintain retention structures

What to do

- Maintain natural wetlands
- Implement constructed wetlands

Locate constructed wetlands according objectives



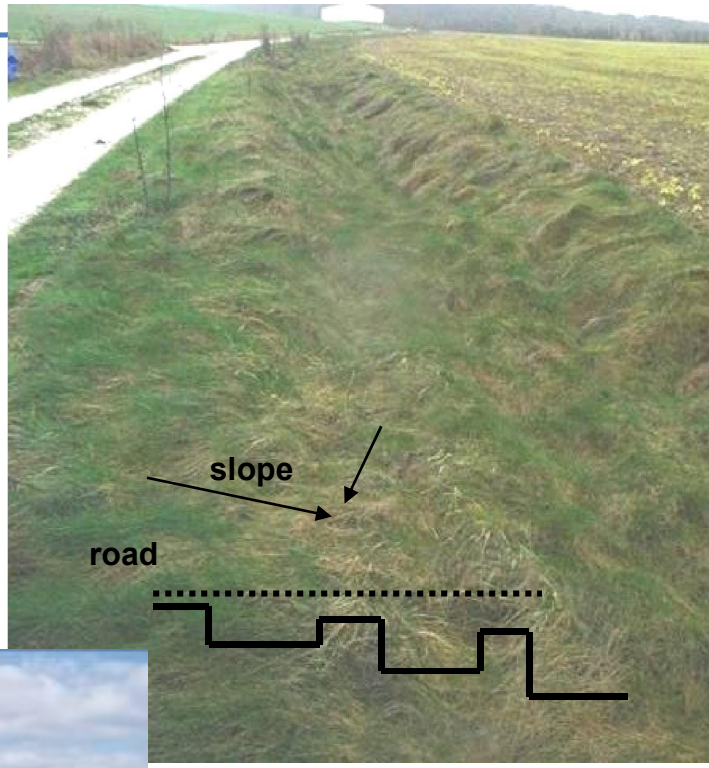
Source: ARTWET project: Adapted from Mitsch, 1992 and van der Valk and Jolly, 1992.

Right: Disseminated = mitigate pesticides transfer
Left: Interface Urban / Agricultural = protect from flood and mitigate pesticides transfer

1 Establish or maintain retention structures

Main types of retention structures

- Create bunds edge of fields
- Vegetated ditches
- Gravel filters
- Water surface / retention pond
- Successive Natural or Artificial Overflows
- Baffles
- Natural wetlands



Source: ARTWET

1 Establish or maintain retention structures

How to do

- Locate properly
- Limite exchange between artificial wetlands and groundwater
- Size wetlands adapted to expected runoff:
  - Volume: Ratio of artificial wetland/contributory watershed area in a range of 1 to 2%
  - Depht: in the range of 0.2 to 1 m with an average of 0.5m
  - Lenght: maximum length water pathway
- Prefer the seeding of local species, non invasive, which could be found in the vicinity
- Manage moisture content
- Clean out regularly (1 to 3 years) artificial wetlands

2 Build fascines (dispersion structures)

How to do

- Dig the soil up to 30cm depth and 50 cm width.
- Push in two rows of logs (about 1.0 to 1.5 m long) on the verges of the ditch: Logs should be spaced ca. 1 to 1.5 m apart.
- Logs should be pushed in until 50 cm deep in soil. Subsequently the ditch is filled in with bundles up to the top of the logs and digged out soil is used to fill in the ditch and create smooth boundaries towards the surrounding soil surface.
- Fascines can be combined with vegetative buffers, by constructing them in the middle of a grassed buffer strip. Mini-dams can be combined with vegetative ditches.

Runoff Mitigation Measures
Adapted use of pesticides

Soil management

Cropping practices

Vegetative buffers

Retention structures

Adapted use of pesticides

3

- Adapt application timing
- Optimize seasonal timing
- Adapt product and rate selection

Optimized irrigation

Correct PPP use

PPP registration addresses risks in relation to environmental and human safety aspects.

- Related to water protection these PPP evaluations may result in regulatory requirements listed on product labels.
- Mandatory requirements on product labels must be considered as an integral part of the complex strategy to reduce surface water contamination.

Diff. ☑ Conc. ☑ Infilt. ☑ Sat. ☑ Prevent. ☑ Collect ☑

1 Optimize application timing

What to do

- Select appropriate PPP, according to the time window for application
- Reduce pesticide concentrations in potential runoff

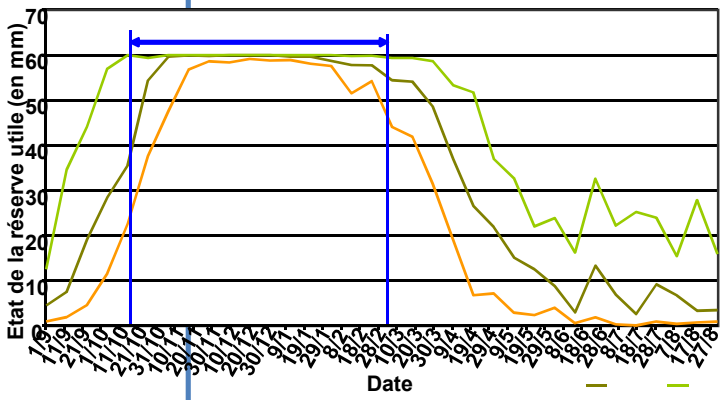
How to do

- Study PPP label carefully if application timing requirements exist
- Apply pesticides only when no significant rainfall is forecast for at least two days

2 Optimize seasonal application timing

What to do

- Apply pesticides outside of main groundwater recharge / drainflow season
- Reduce pesticide concentations in runoff and drainflow
- Select appropriate PPP, according to the time window for application
- Study PPP label carefully if application timing requirements exist



How to do

- Do not spray if soils are saturated with water or artificial drains are flowing
- Do not spray on frozen soils or on snow covered fields

3 Select appropriate PPP

What to do / How to do

- Select appropriate PPP regarding target and pressure
- Read PPP label carefully
- Respect required risk reduction measures
- Indicate field areas, where application restrictions need to be respected
- See options to ensure crop protection
  - modifying the use pattern of PPP
  - Consider to decrease the risk of water contamination.
  - If no solution can be found consider other crops to be planted.

Always do not forget measures to reduce point source pollution

Good pesticide knowledge

1 Pesticides transport

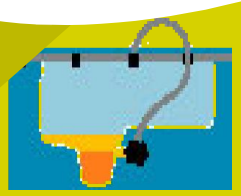
2 Storage

3 Farmer protection

4 Filling and mixing site

5 Sprayer equipments

6 Sprayer waste management



7 Wastes manage ment

Runoff Mitigation Measures

2 Optimized irrigation

Soil management

Cropping practices

Vegetative buffers

Retention structures

Adapted use of pesticides

Optimized irrigation • Adapt irrigation technique • Optimize irrigation timing and rate

Irrigation

Irrigation is an artificial application of water to soil where natural water availability for a crop is not sufficient at certain times.

Different irrigation technologies

- Flood irrigation
- Sprinkler
- Drip

To be distinguished:

- Well-controlled irrigation and restrictive irrigation
- Systematic irrigation

Irrigation effects:

- Direct: runoff by capping: On spring crops (corn, etc.)
- Indirect: Runoff by saturation: saturation period in winter starts early

Diff. ☑ | Conc. ☑ | Infilt. ☑ | Sat. ☑ | Prevent. ☑ | Collect ☑

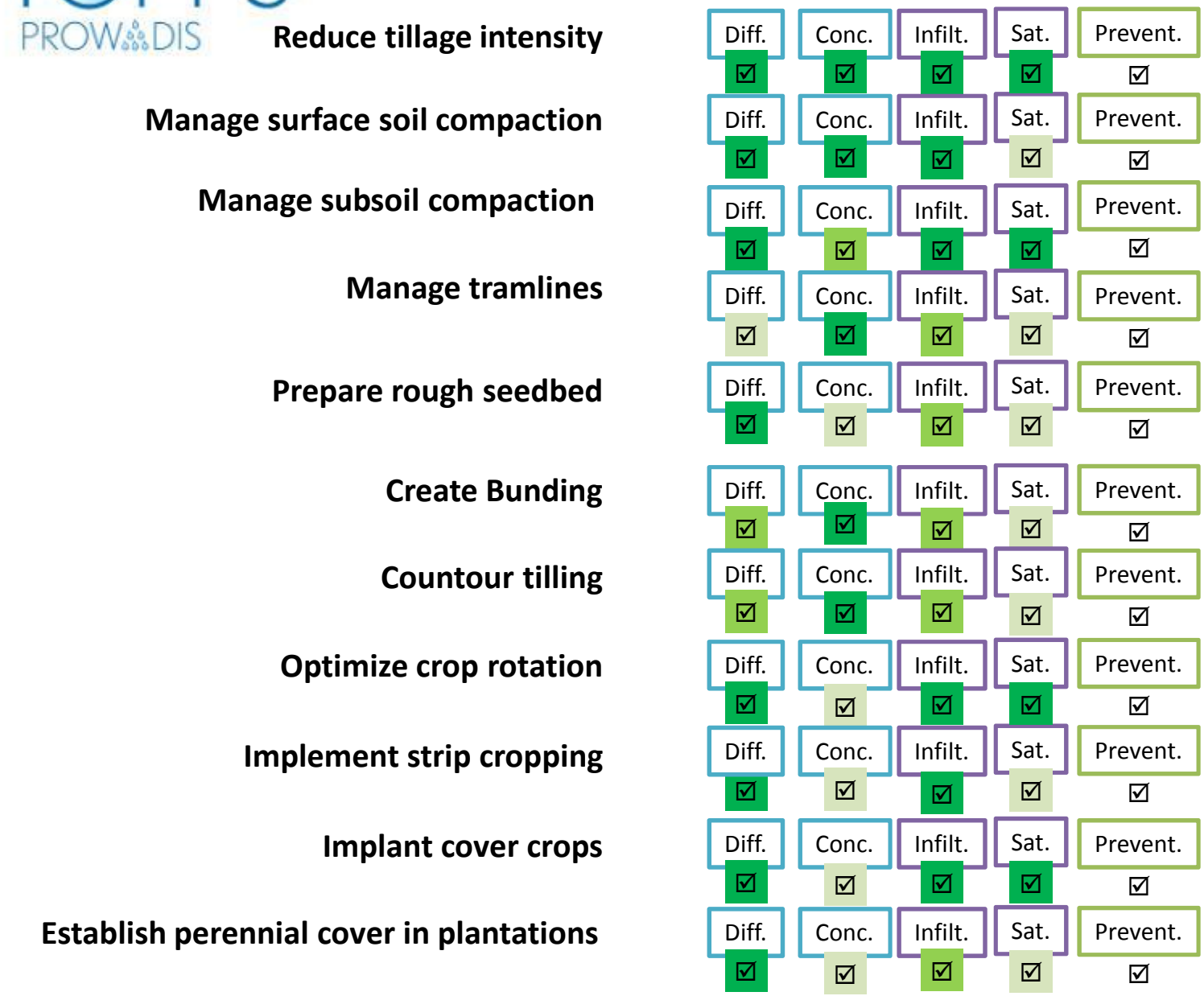
Select irrigation technologie

Optimize irrigation timing and rate

What to do / How to do ?

- Invest in less water consuming and better manageable technologies
- Sprinkler irrigation may help to save water and to reduce runoff.
- Monitor, estimate and manage the correct amount of water needed by the crop.
- Use IT-based decision support systems available for planning of irrigation in some countries.

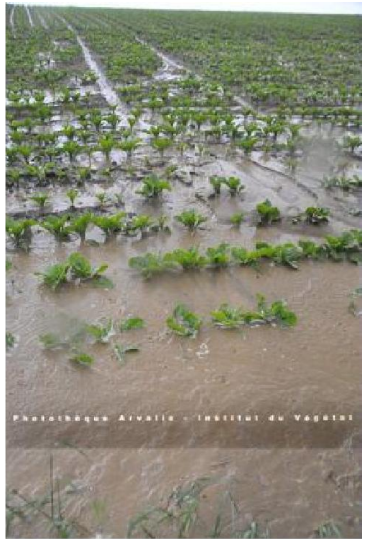
Summary - Measures to be implemented



Establish and maintain edge of field buffer	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑		Collect. ☑	
Establish and maintain In field buffer	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑	Collect. ☑	
Establish and maintain talweg buffers	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑	Collect. ☑	
Establish and maintain riparian buffer	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑		Collect. ☑	
Establish and maintain hedges	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑	Collect. ☑	
Establish and maintain woodlands	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑	Collect. ☑	
Manage field access areas	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Implement and maintain constructed wetlands	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑		Collect. ☑	
Select appropriate PPP	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Optimize product application	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Optimize application timing	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Optimize irrigation	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Double sowing	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		
Enlarge headland	Diff. ☑	Conc. ☑	Infilt. ☑	Sat. ☑	Prevent. ☑		

TOPPS PROWADIS

Case study



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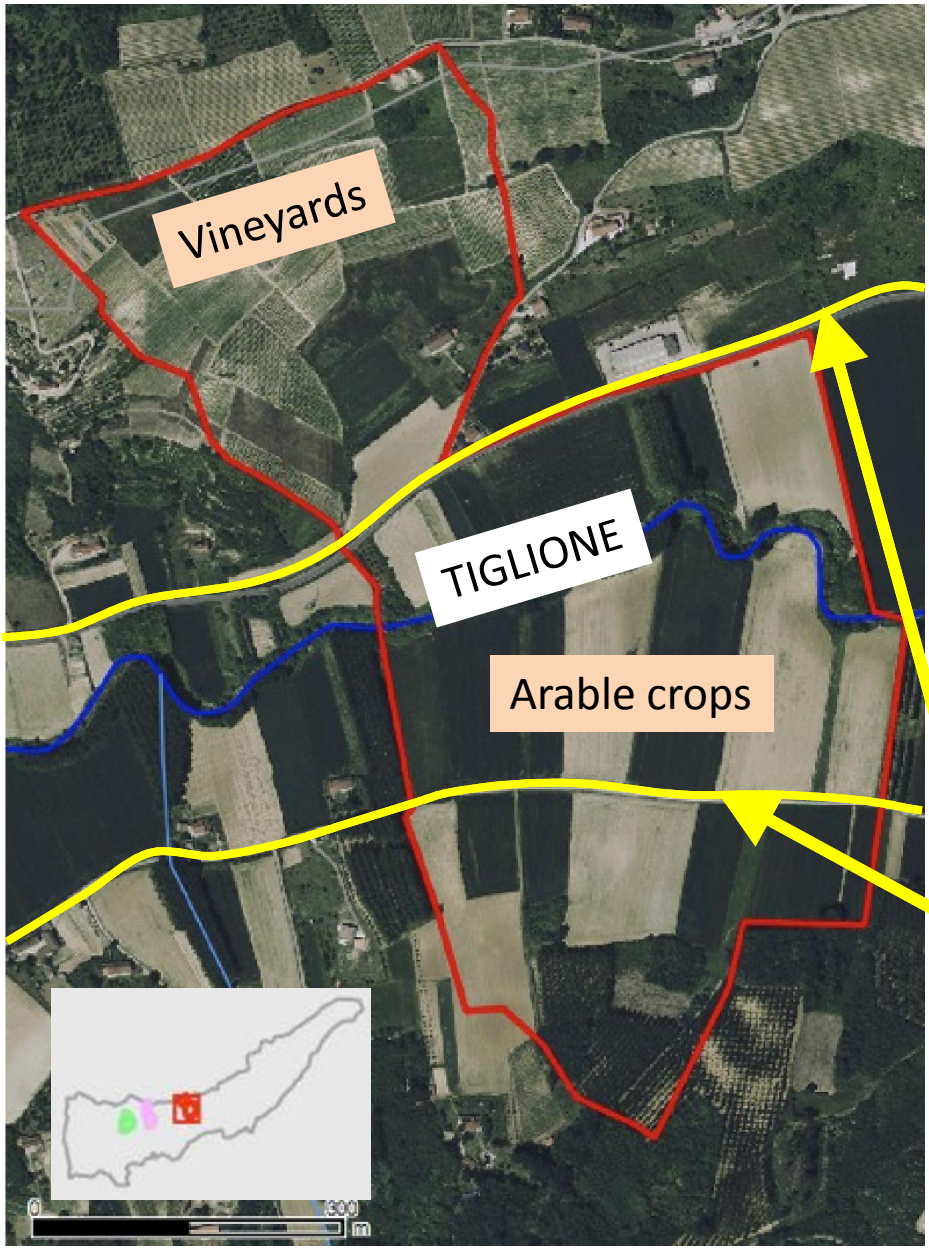
Catchment audit in Italy: demonstration catchment areas



each area includes

- **alluvial plain** of Tiglione (both on right and left sides)
- **slopes**

crops

- **alluvial plain** cereals, patches of permanent meadows and some poplar plantations
- **slopes:** vineyards or natural vegetation

accessibility

- two roads run ~ parallel to the two sides of Tiglione (150-300 m)

Field diagnosis: validation

Erosion on the hillside zone

Field diagnosis: validation

Concentrated runoff with erosion in thalwegs

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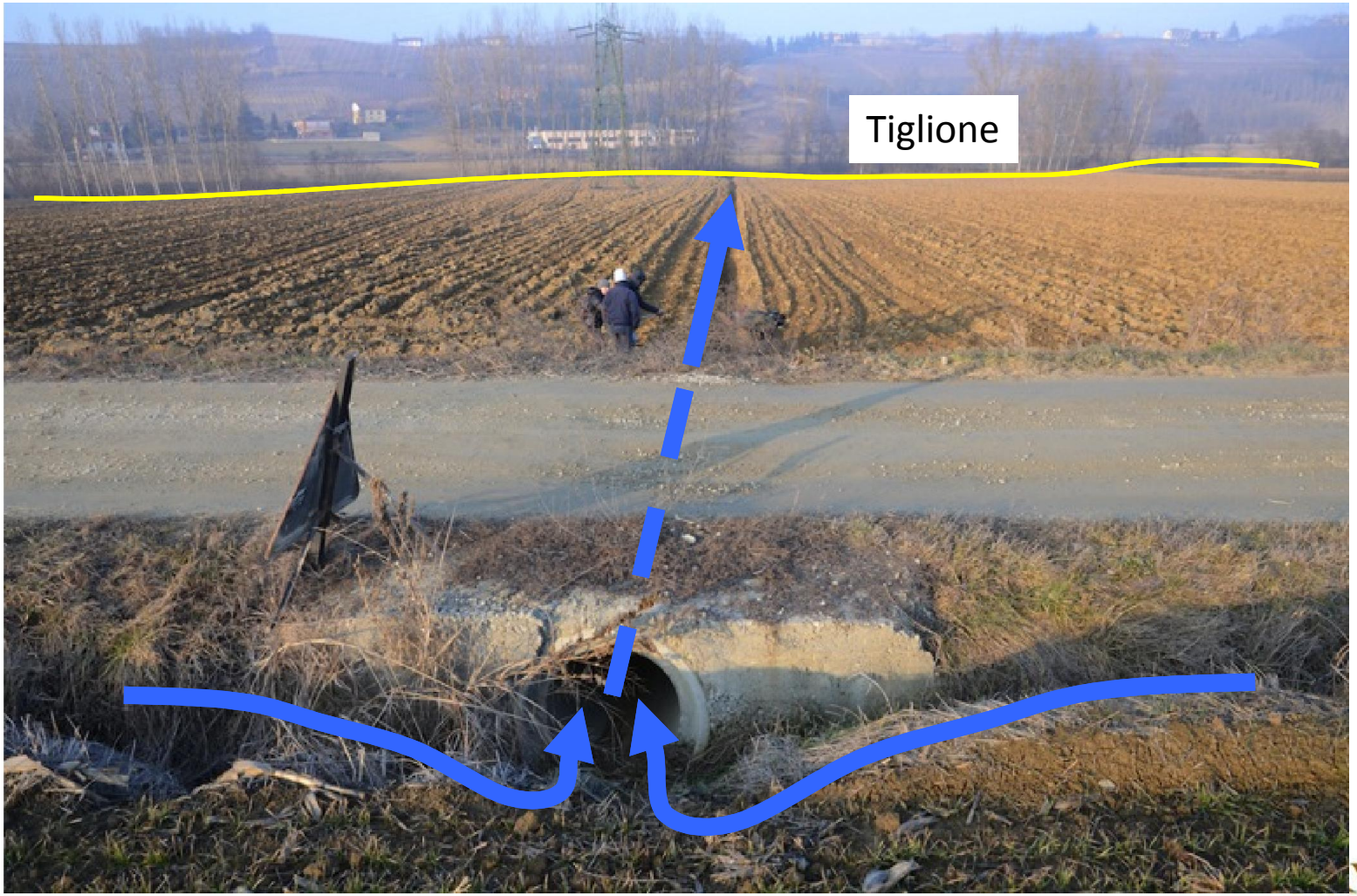
Presence of short cuts (direct connection between hillside zone and river)

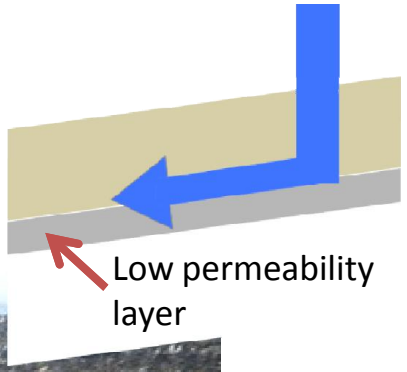


Field diagnosis: riparian audit

Large variability of conditions

- presence/absence of riparian buffer
- presence/absence of shrubs and trees on the banks
- soil tillage close to the bank in some fields

Large variability of conditions: **landslides** (lateral seepage and bare bank)



Proposed actions: RIPARIAN ZONE

Grassed buffer strip and tree

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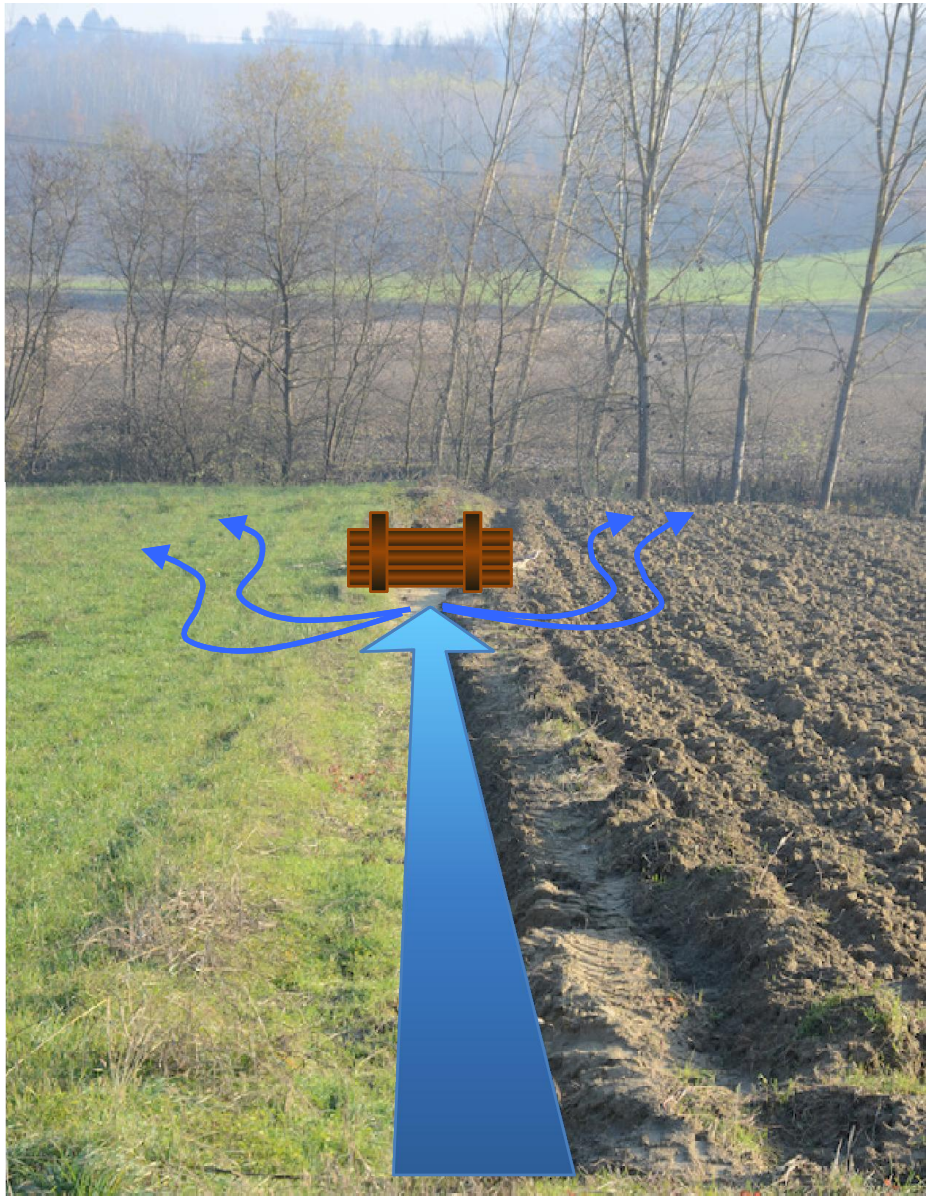
Proposed actions: RIPARIAN ZONE

Dispersion structures: fascines, wooden barriers, etc.



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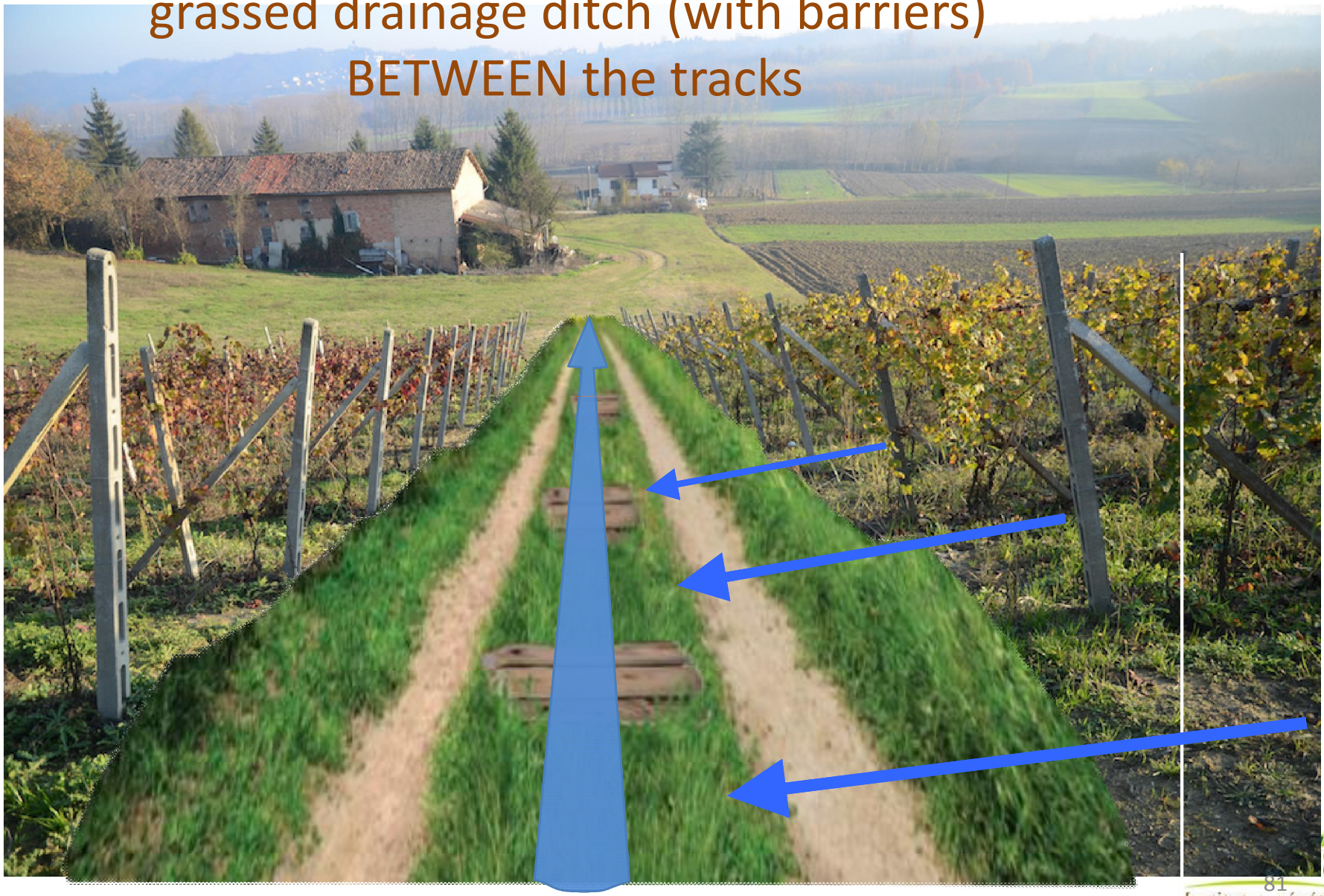
Proposed actions: HILLSIDE ZONE

grassed drainage ditch (with barriers)
BETWEEN the tracks



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Thank you!