

RUN-OFF

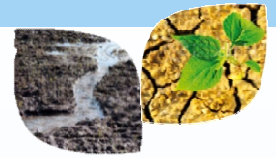
Best Management Practices
to reduce water pollution with plant
protection products from
run-off and erosion



TOPPS
PROW&DIS

RUNOFF MITIGATION

A PICTURE COURSE



RUNOFF MITIGATION

A PICTURE COURSE

- WATER CIRCULATION IN THE FIELD AND LANDSCAPE
- SIGNS OF RUNOFF AND EROSION
- ESTIMATED PROBLEMS
- PROPOSED SOLUTIONS

**Materials from TOPPS prowadis partners and experts
compiled by Arvalis**



OBJECTIVE OF RUNOFF MITIGATION PICTURE COURSE

- This material was developed under the TOPPS prowadis project (2011 to 2014) supported by ECPA (European Crop Protection Association)
- This material is aimed to be used by advisers and other interested stakeholders to create awareness for unintended pesticide contamination of surface water and on mitigation measures to reduce such contaminations.
- This picture course is part of a comprehensive set of training and dissemination materials consisting of

Diagnosis course, Solutions course, Field Manual, Best Management Document , an awareness flyer and others.

Project partners:

Technical support group:
Arvalis Inst du vegetal, FR
Irstea, FR

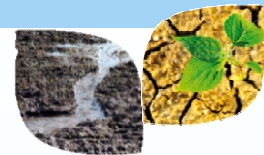
InAgro, BE
University Cordoba, ES
LFL Bavarian Res Centre Agric., DE
University Turin, IT
Danish Agr. Advisery Service, DK
Nat. Env. Institute, PL

Experts from ECPA
BASF
Bayer Cropscience
Syngenta

Pictures: Originate mainly from field audits conducted :

- During AQUAVALLEE (ARVALIS) or buffer zones audit (IRSTEA) made in France,
- During catchment audits in the TOPPS pilot catchment areas (BE,ES,DE,DK,IT,PL)

Pictures can be downloaded for non commercial use and should be referenced.



HOW TO USE THE COURSE

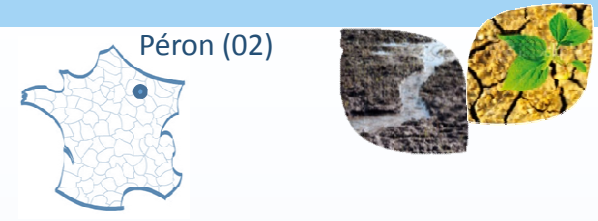
Course can be used in a flexible way

- a) Show the pictures as listed
- b) Select pictures for specific trainings / topics
- c) Integrate pictures in own presentations
- d) Link the pictures with the other TOPPS course materials: Diagnosis / Solutions

Most important: use it !

TOPPS projects aim to provide awareness and actionable recommendations on how to mitigate unintended losses of pesticides to water. We want to achieve this by developing Best Management Practices and by disseminating and training them to operators. Projects are executed across EU countries as multistakeholder projects including broad expertise and knowledge

Runoff



Problems:

- Runoff and sedimentation in tracks
- Runoff stays and accumulates downhill, in the field



Solution:

Use low pressure tire





Light runoff along the tramlines



Solutions:

Orient tramlines across the field slope as far as possible.

Then, the runoff infiltrates slowly downfield



Runoff



Problems:

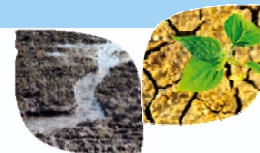
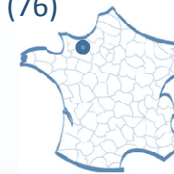
- Runoff, gullies and sedimentation downhill on a loamy capping soil
- Water infiltrates through the bank directly to a zone of fast infiltration (rabbit holes)



Solutions:

Review soil cultivation techniques and implement buffer zones to avoid concentration of water in these field.





Sedimentation of silt close(versiegeln) the soil surface



Silty soil may develop capping of the soil.

Problem:

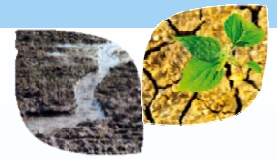
- Clay sediments may completely close the penetration capabilities of the soil (close the soil surface)



Solution:

Review the preparation of the soil and seeding technique. Iter content.





Capping (crusted) and sedimentation



Problem:

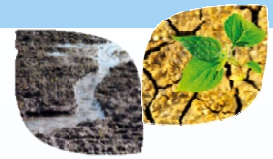
- Patches of silty crusts prevent infiltration of water.



Solutions:

- Review soil cultivation (reduce / no tillage)
- Increase organic matter in the soil.

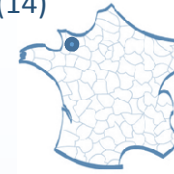




Sedimentation and capping



JMM - ARVALIS



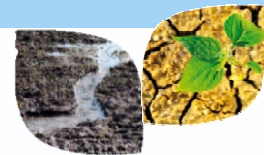
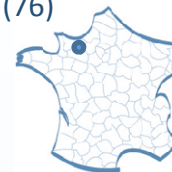
Runoff and / or erosion



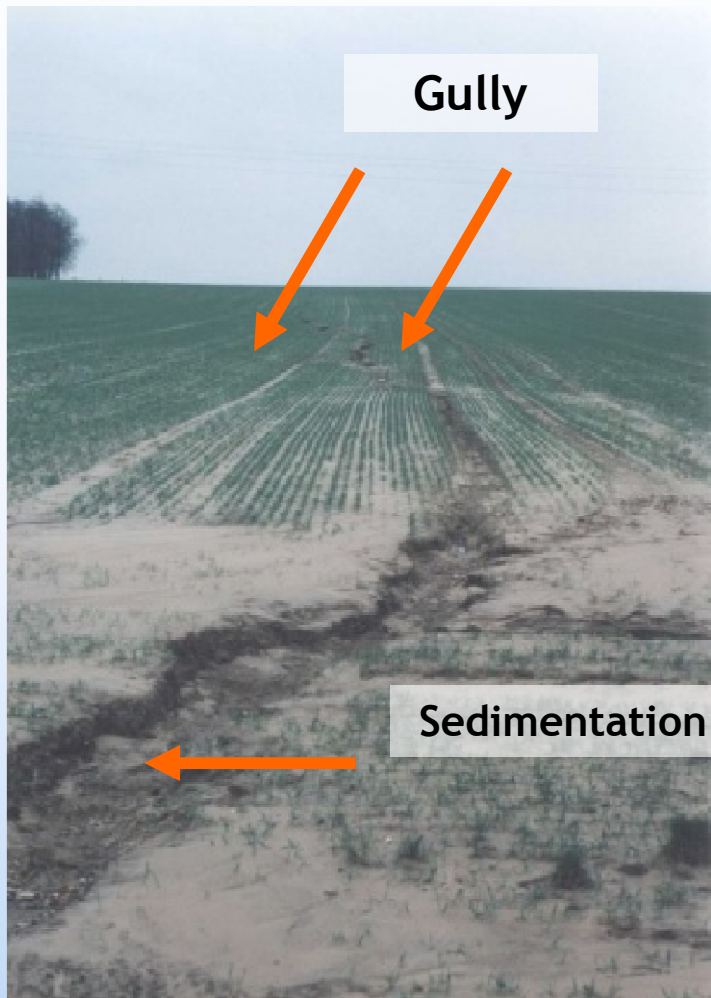
Orientation of slope

Solutions:
Lower field : runoff can be mitigated by implementing buffer zone (hedge)





Erosion



Problem:

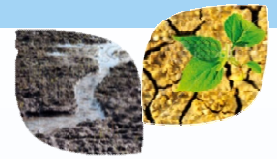
- Run-off with the creation of gullies and sedimentation downhill from plots



Solutions:

- Review the cultivation method
- Set up a buffer zone across the plot of land,
- Reduce the size of the plot and produce a checkerboard of crops.
- If there are potatoes in the crop rotation: Barbutte and Dyker.





Runoff effects

Type of soil: silt above chalk bedrock



Problem:

- Gully built by concentrated runoff



Solution:

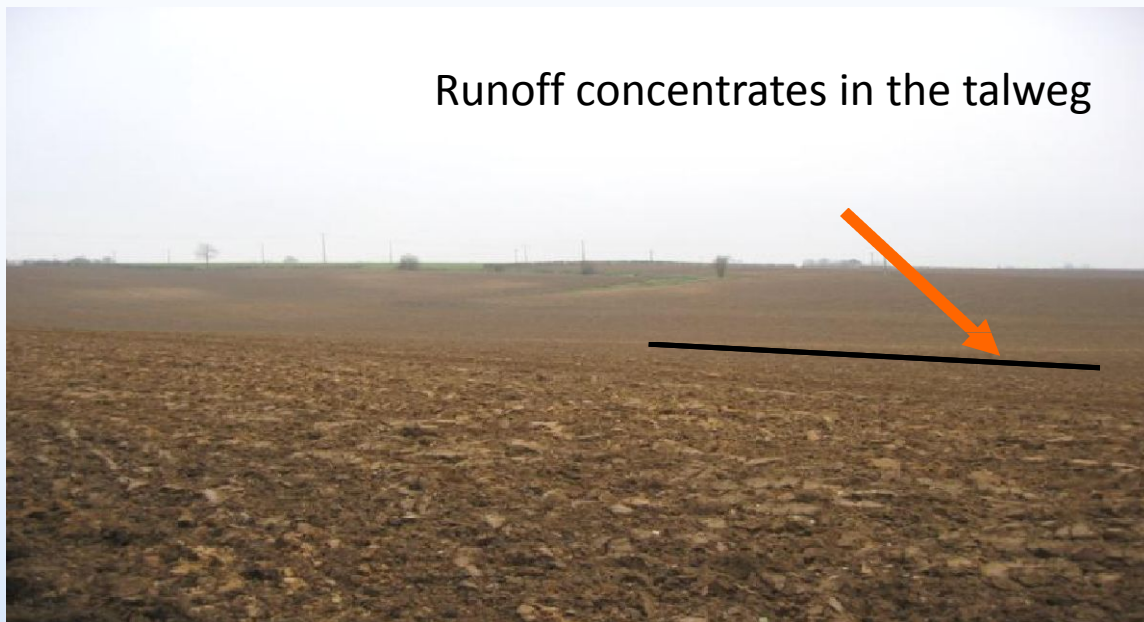
Implement a talweg buffer strip





Runoff risk increases with long slopes

Runoff concentrates in the talweg

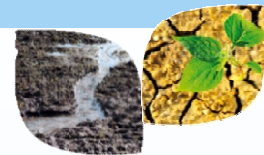
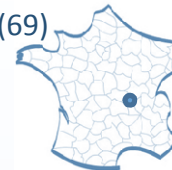


Type of soil: silty soils

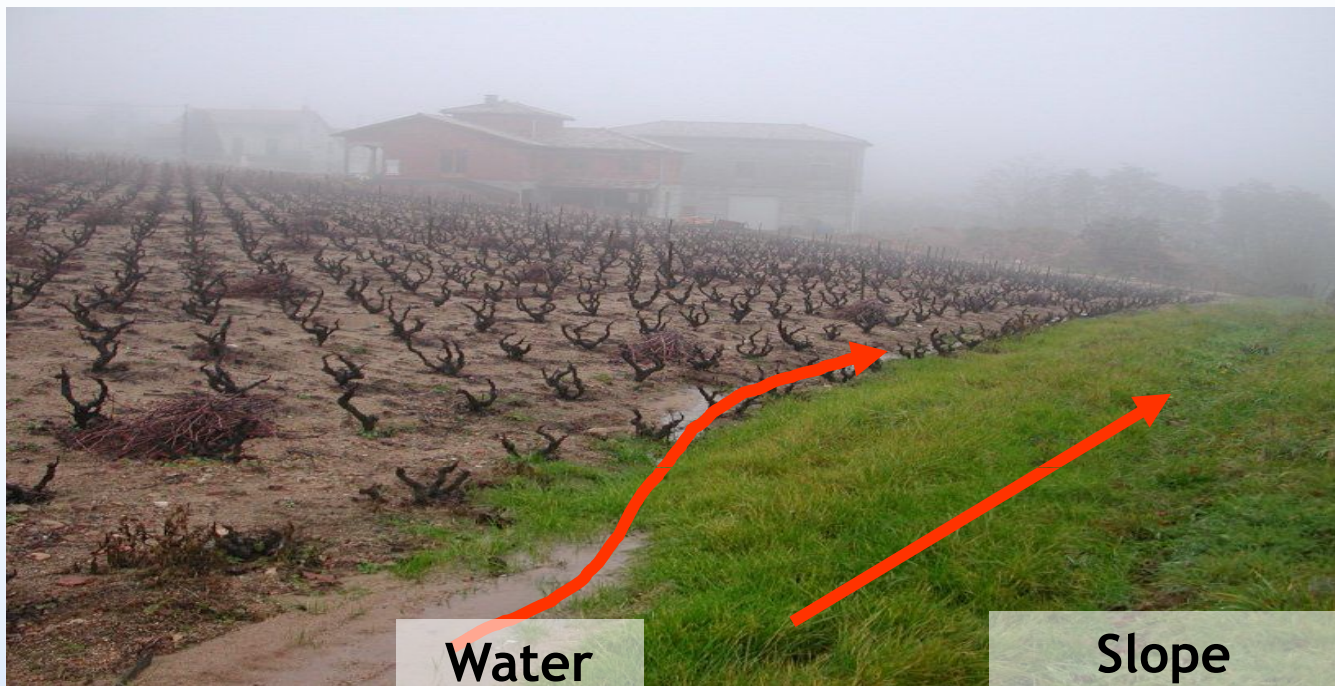
Solutions:

- Divide field,
- Implement a talweg buffer
- Increase organic matter





Runoff effects



Water

Slope

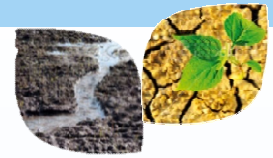


Problems:

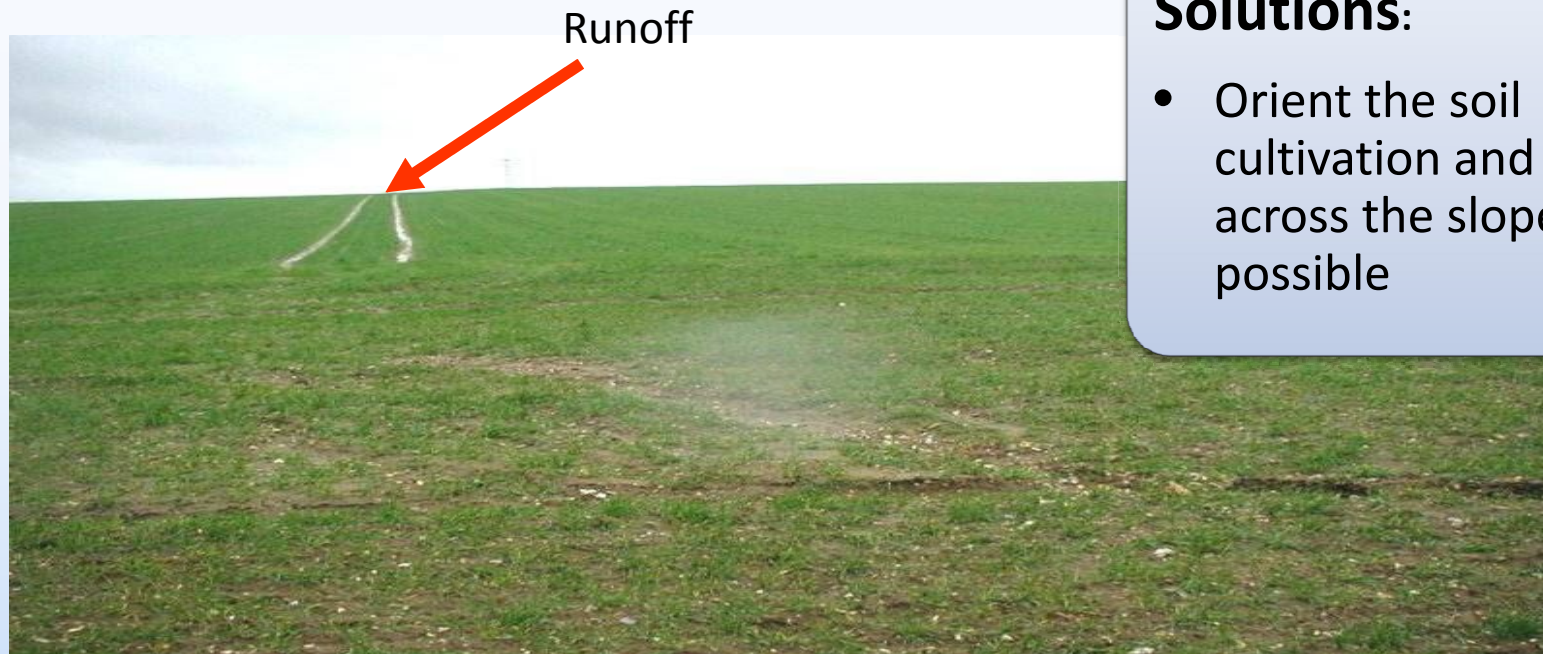
- Runoff water avoid the grass pathway and runoff down field quickly with products.
- Two years after the picture the first row disappear.

Solutions:

- Rearrange the water pathway that water cannot take shortcut.
- Seed interrow or mulch.



Concentrated runoff in tramlines

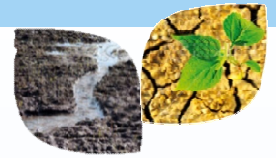


Silty soil

Solutions:

- Orient the soil cultivation and seeding across the slope if possible





Concentrated Run-Off



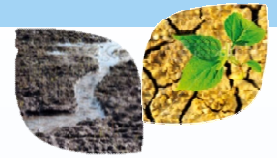
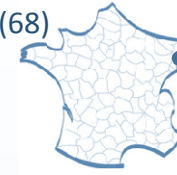
Problem:

- Concentrated run-off intercepted by grass strips

Solutions:

- Run-off may be intercepted by a talweg buffer.
- Reduce the size of the plot. Check for the presence of a tillage pan.
- If one is found, use a chisel plough





Runoff along the seed rows

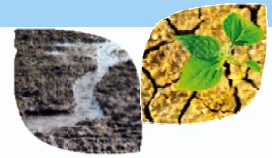
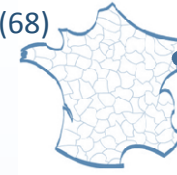


Silty capping soil

Solutions:

- Review the soil cultivation technique
- Increase infiltration capacity of the soil by increasing organic matter
- Plant across the slope
- Reduce the field size





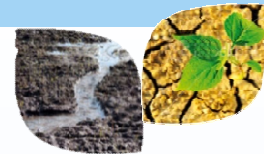
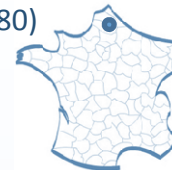
Runoff at the edge of the field



Solutions:

Implement an edge of field buffer to increase infiltration capacity





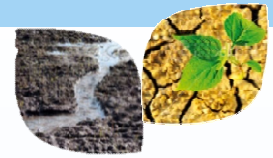
Runoff on capping silty soil in potatoe



Solutions:

- Review soil cultivation (seedbed to fine?)
- Apply bunding techniques between the dams
- Increase organic matter
- Reduce field length





Runoff on crusted silty soil in potatoe

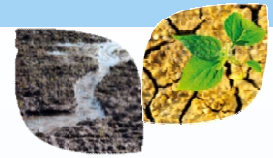
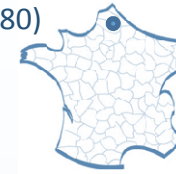


Dams are destroyed on. 1000 m2

Solution:

Bunding between the dams





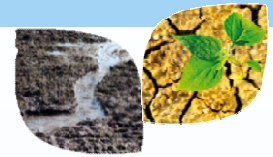
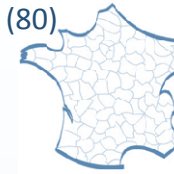
Bunding in row crops is an effective mitigation measure



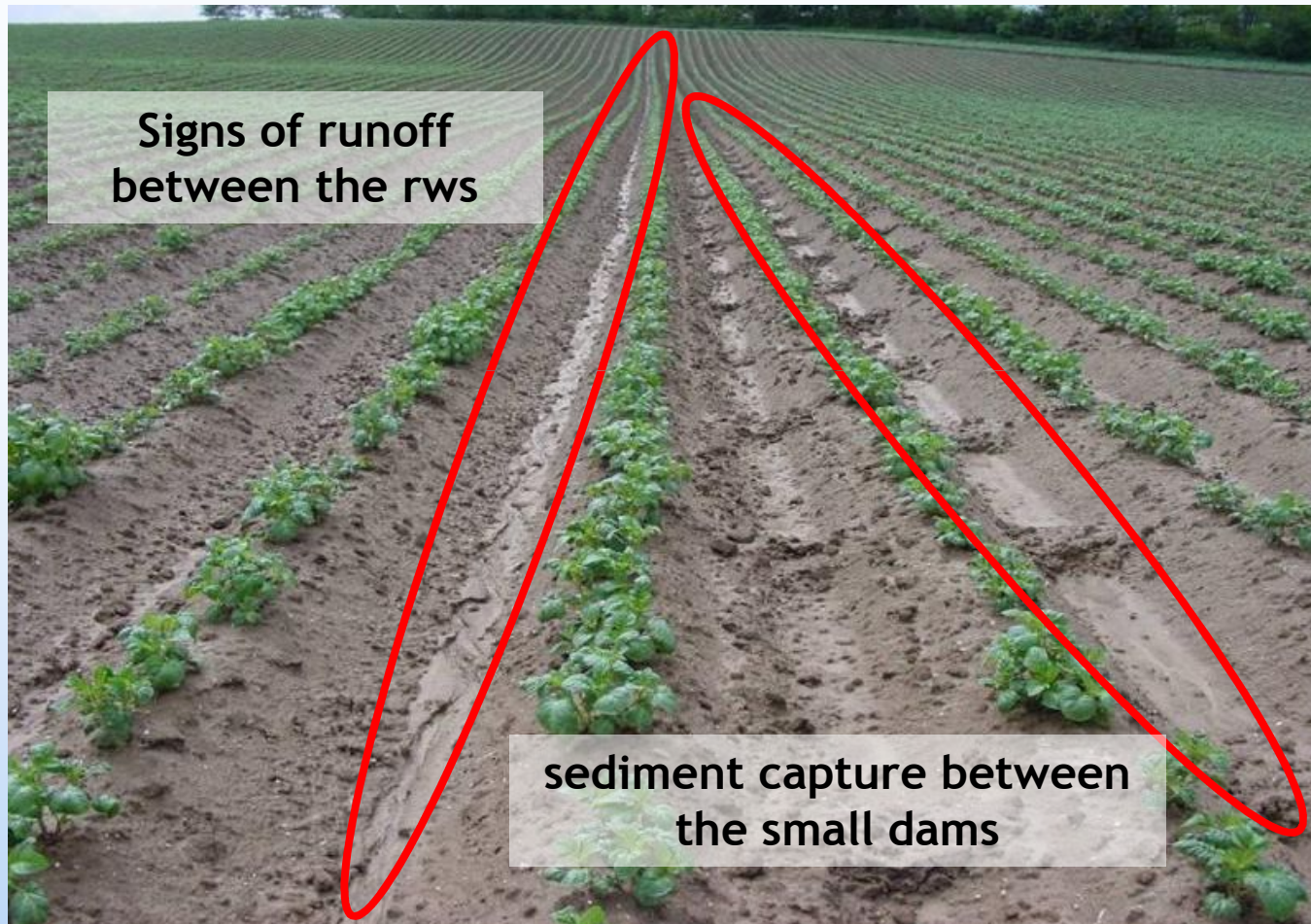
Solution:

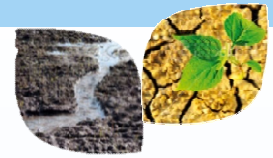
Create small dams between the rows





Small dams between the rows are effective measures





Runoff due to compaction



Problem:

- Compacted clay limestone soil after a strong rain

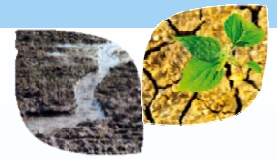


Solutions:

Apply measures to avoid / break compaction.

Consider a buffer at the end of the field to infiltrate the water.

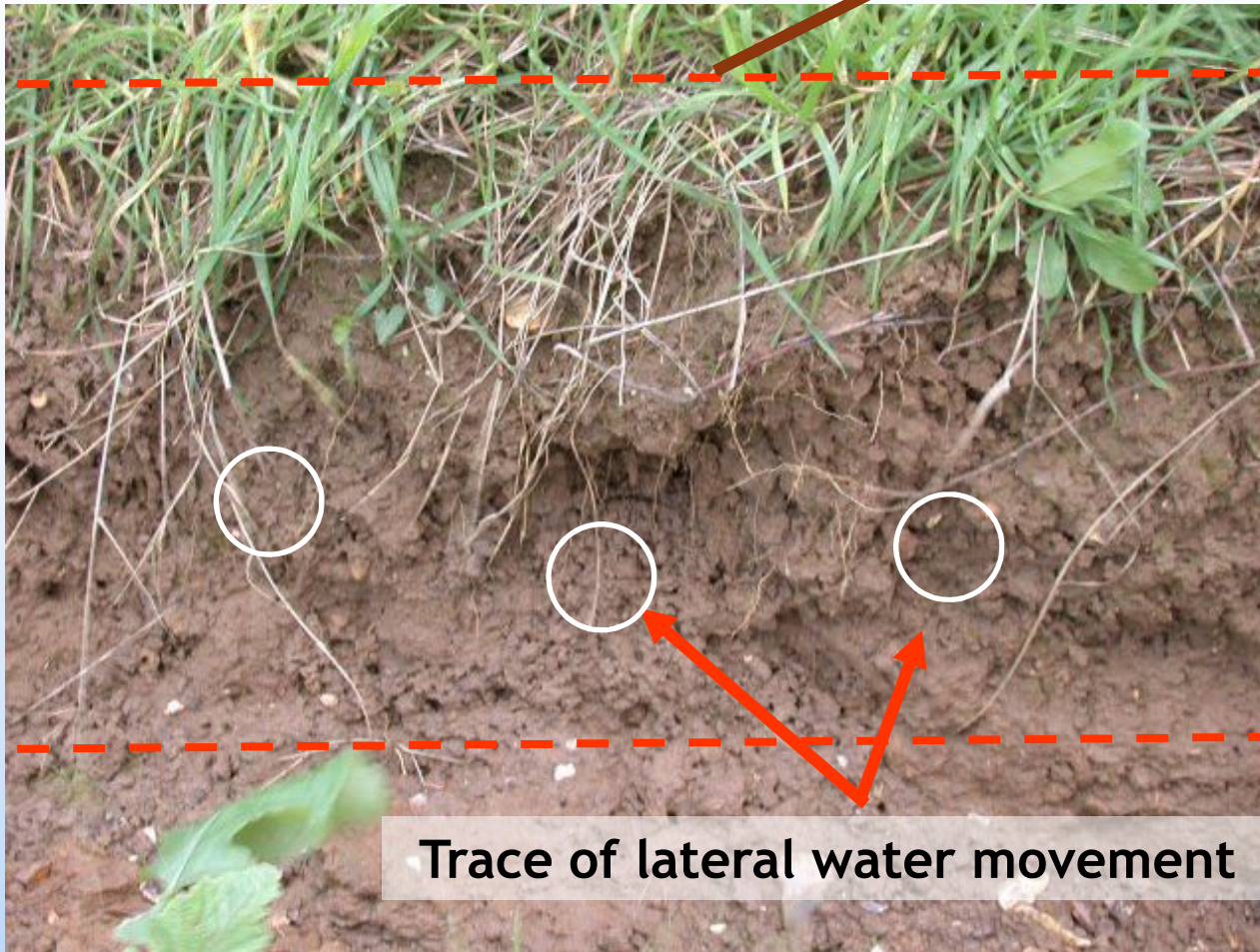




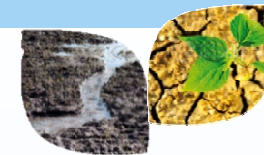
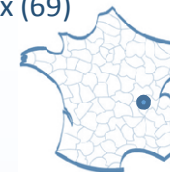
Lateral seepage

Top soil
water
pathway

Subsoil
water
pathway



Trace of lateral water movement



Collect runoff in ditch



Type of soil : capping silt

Problem:

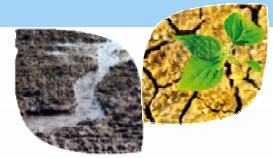
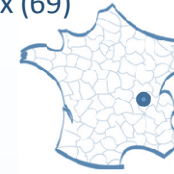
Rearrangment of the ditch to evacuate the runoff waters: Runoff coming from the field will fill quickly the ditch if no buffer or hedge implanted.



Solutions:

On field: Review tillage activity

Out of field: Implement a buffer zone and implement vegetation in the ditch



Maintenance of the ditch



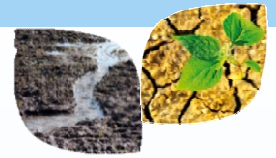
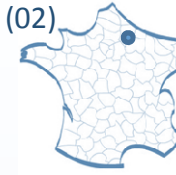
Problems:

Ditch was maintained but no vegetation left to stabilize the bank. Possible erosion of the bank due to runoff and upstream water arrival: fast deposition and need for a new maintenance.



Solutions:

Implement vegetation in the ditch, implement hedges to stabilize the bank



Erosion

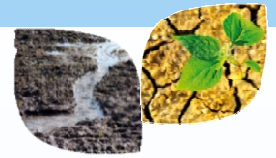


Problem:

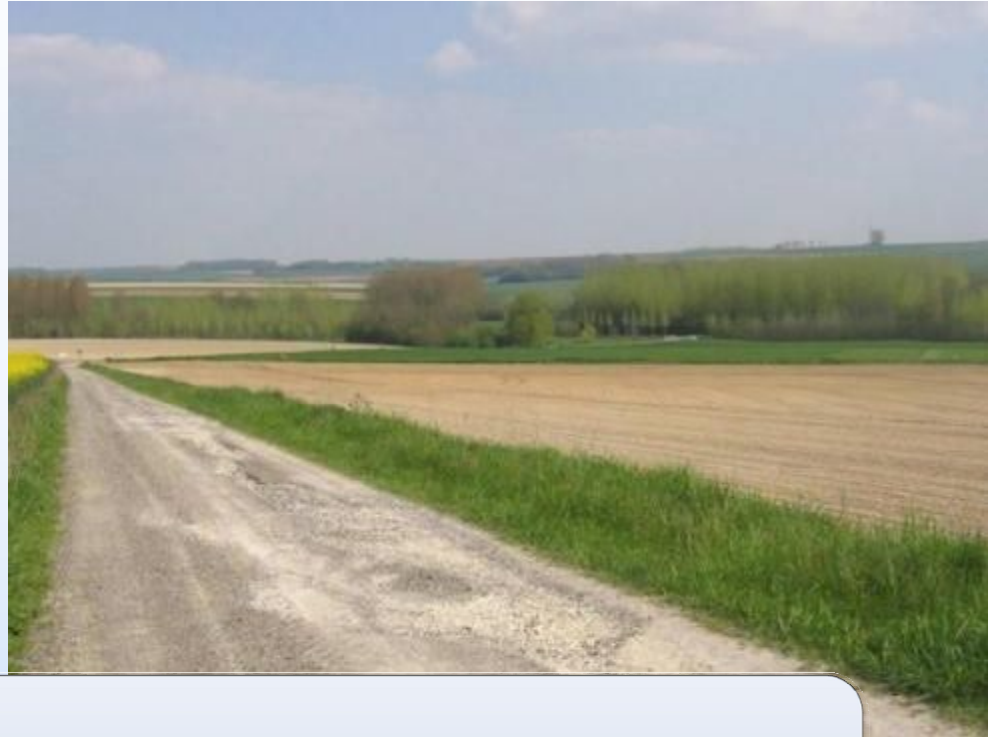
Regular collapse of the bank,
particularly where there are no trees /
hedges.

Solution:

Stabilize the bank



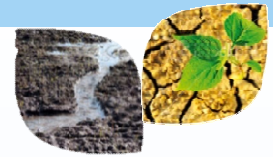
Runoff along the field road



Solutions :

- Apply measures to keep water in the field (enlarge buffer strip)
- Guide water to vegetalized ditch along the road





Signs for runoff



Problems:

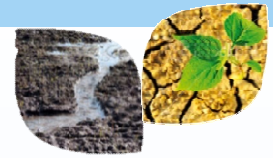
Water accumulation at the field edge
Rill erosion starting erosion.



Solutions:

Take measures to increase infiltration capacity in the field (tillage, organic matter others)
Reduce speed of water flow
Review efficiency of buffers and locate them better.

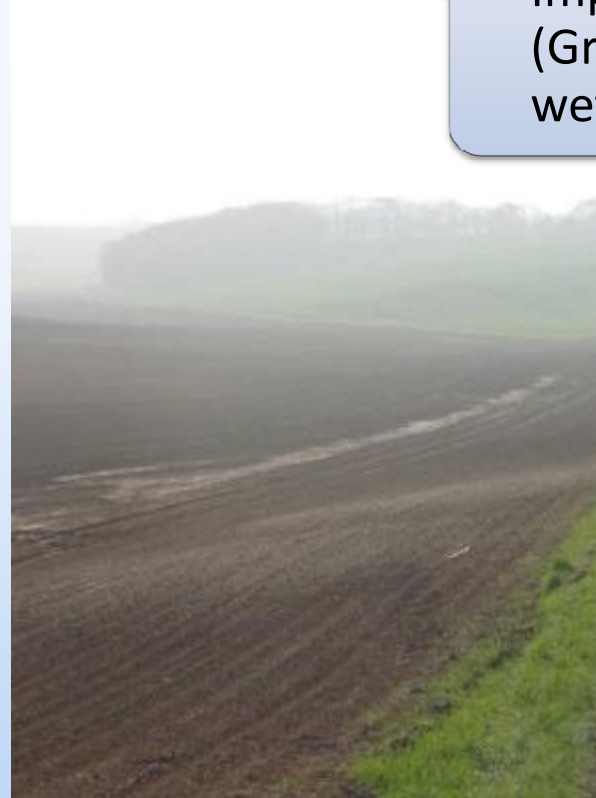


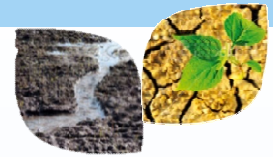


Runoff coming from the road

Solution:

- Implant retention area (Grass buffer zones or wetland).





Runoff sedimentation in tramlines compacted areas from heavy machinery



Solutions:

- Orient field activities across the slope
- Break compaction in tramlines
- Reduce field size



Runoff sedimentation in tramlines compacted areas from heavy machinery



Italy 2012

© 2012
Francesco Vidotto



Germany 2012



Poland 2012



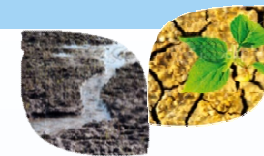
Solutions:

- Orient field activities across the slope
- Break compaction in tramlines
- Reduce field size
- Seed interrow in vineyard and hops



Germany 2012





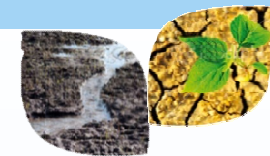
Sedimentation / erosion in a talweg



Solutions:

- Implement talweg buffer (Gras strip)
- Increase infiltration in the field / slow down waterflow

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Sedimentation in a talweg

Poland 2012



Poland 2012



Germany 2012



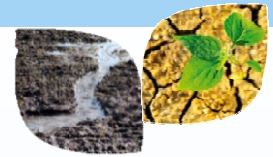
Denmark 2012



Italy 2012

Solutions:

- Implement talweg buffer (Grass strip)
- Increase infiltration in the field / slow down waterflow



Sedimentation and capping of soil



G.Le Hénaff - IRSTEA

Problems:

Clear sign of runoff

Sedimentation

Silt / clay soil vulnerable to capping
(surface penetration restriction)



Solutions:

Increase infiltration in the field /
slow down waterflow

Break crusted soil if silty soil

Increase organic matter

Improve soil structure



Traces of sedimentation and erosion



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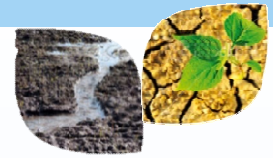


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Crusting and capping soil





Crusting soil





Erosion

Diffuse on slope or concentrated



AREAS, INRA, Chambres d'Agricultures, ARVALIS, ITB, ITV



Erosion gullies and sedimentation



JMM - ARVALIS

Problem:

Erosion gullies created by water coming from upfield via pipe



Solutions:

- Reprofile the pathway and the bufferstrip along hop field
- Enlarge the ditch and create retention pond
- If possible remove the pipe
- Buffer strip at the exit of the pipe



Details of erosion gullies



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Erosion gullies



JMM - ARVALIS



Accumulation of runoff



JMM - ARVALIS

Problems:

Starting on the top of the slope, collecting water from the road.

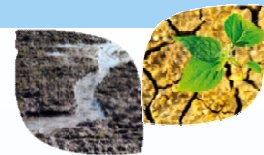
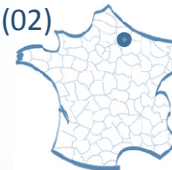
Runoff concentration between field, then joining the talweg.

Sedimentation and erosion gullies

Runoff traces



Pictures: JMM - ARVALIS



Concentrated water coming from uphill

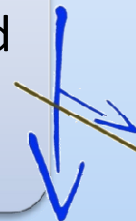


Problem:

Collection of water coming from a ditch network. Concentrated water exiting in the field generating erosion gullies.

Solutions:

Review organisation of the ditch.
Create grass buffer zones or wetland to intercept water

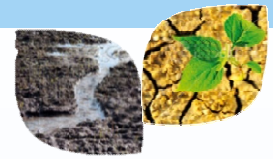




Concentrated runoff in tramelines



Pictures: JMM - ARVALIS



Effect of no tillage on runoff

Example 1

No tillage



Tillage



Geispitzen (68)



Example 2



Denmark 2012





Effect of tillage on crusting soil



Left : maize non « CRUST IS
NOT BROKEN »
Above: maize « CRUST IS
BROKEN »



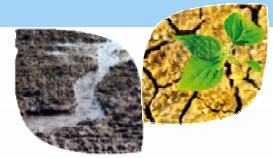
Effect of tillage on crusting soil

Hoeing machine



Rotary hoe





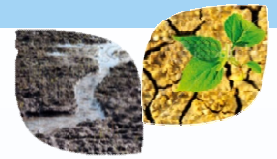
Effect of tillage on runoff

No tillage

Tillage



JMM - ARVALIS



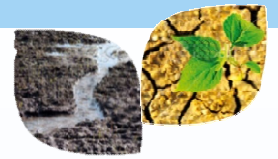
Grass between the rows in permanent crops



Germany 2012



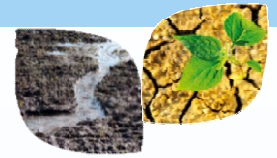
Arjolles (69)



Hydromorphy

DIAGNOSTIC

Ruoff by saturation

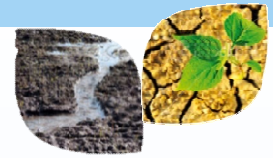


Problems:

- Mainly a problem during winter
- Soil cannot infiltrate enough water (Soil depth ?, soil texture)
 - Permeability restriction ?
 - Soil structure / water holding capacity / low organic matter
 - Soil compaction ?



Pictures: ARVALIS



Saturation in tramlines close to surface water



G. Le Hénaff - IRSTEA



JMM - ARVALIS

Solution:
Enlarge buffer zones





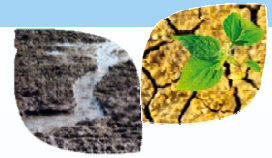
Traces of hydromorphy temporary water saturation



Context:

- Non permanent but regular soil saturation / flooding.
- Traces of manganiferrous concretions (black).
- Traces of rust (orange): mineral element are washed down.

Pictures: JMM - ARVALIS



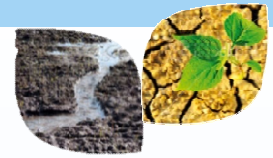
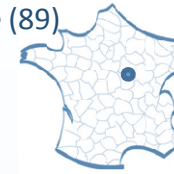
Traces of hydromorphy

Problems:

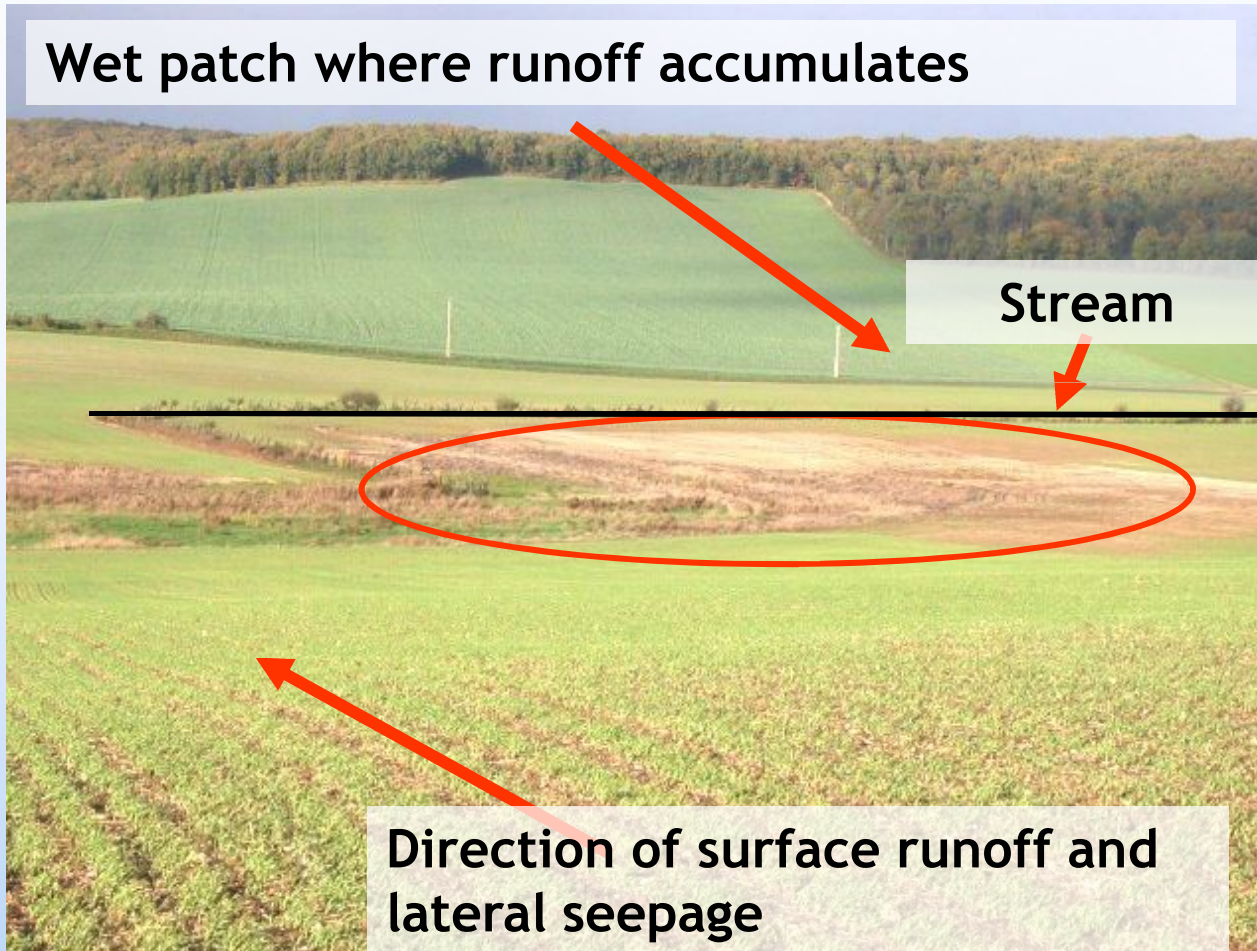
Gley: impermeable
unaerobic clay layer, 20 cm
deep: permeability break
down.



JMM - ARVALIS

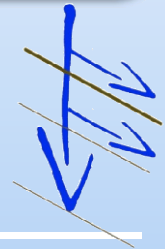


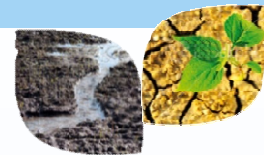
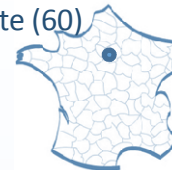
Hydromorphic area



Solutions:

- If not implemented apply no tillage
- Cut the slope with buffer zones. (Reduce field length)
- Check location and sizing of the buffer strip along the water stream





Wet patch due to alluvial aquifer

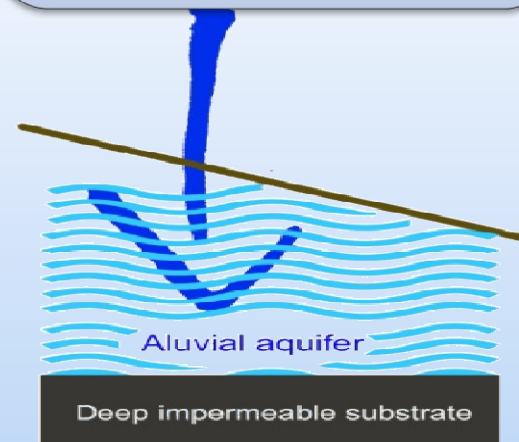
Residual water



Type of soil : Silt

Solution:

Do not apply pesticides / manure in autumn before alluvial aquifer comes up to the surface (consider to implement grass land)





Wet patch - Hydromorphic area



Problem:

Area difficult to crop and almost non productive



Solution:

Enlarge buffer zone / implement wetland

G.Le Hénaff - IRSTEA



Wet patch - Hydromorphic area



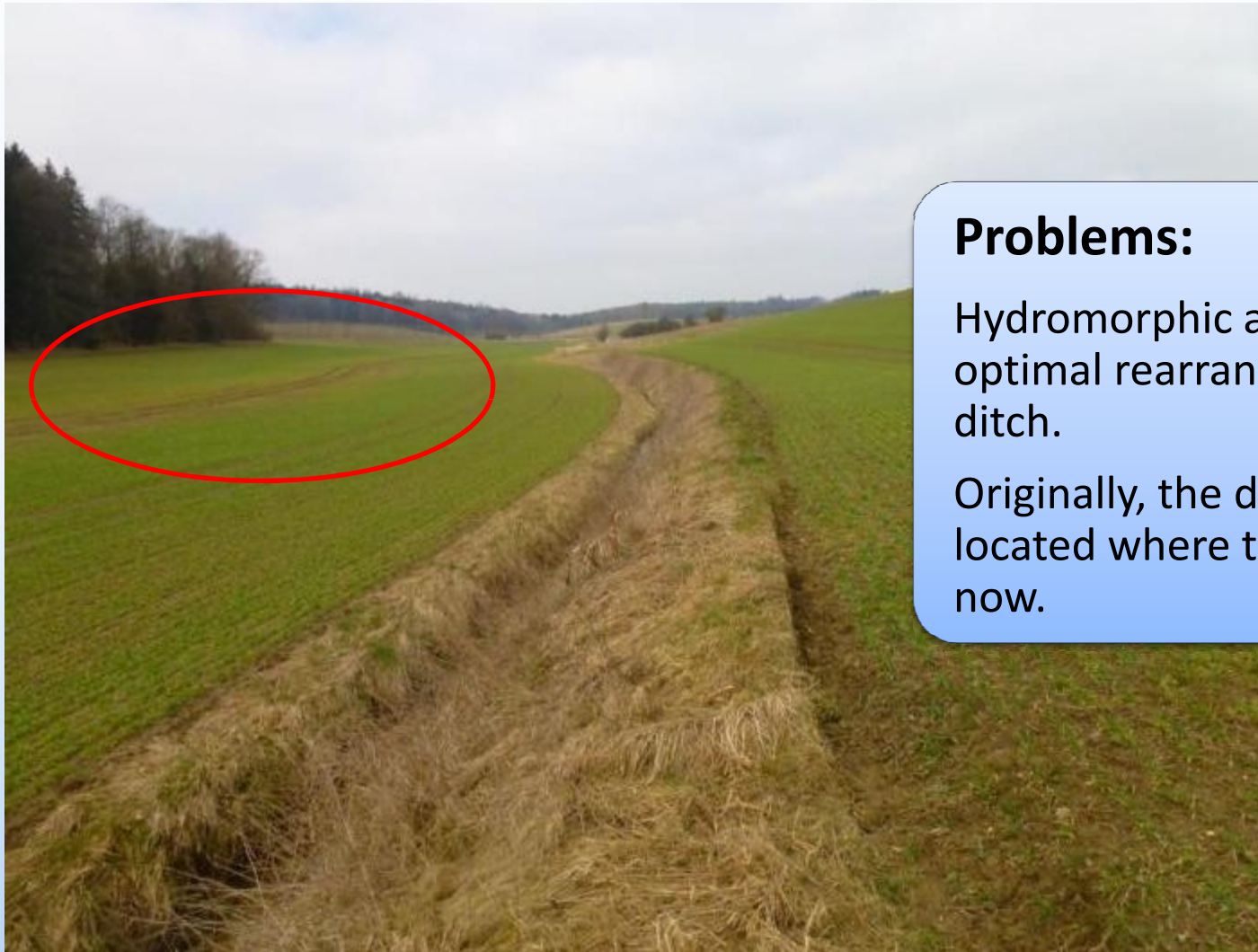
Problems:

- Wet patch in the middle of the slope possibly due to a damaged drain pipe.
- Eutrophication.

JMM - ARVALIS



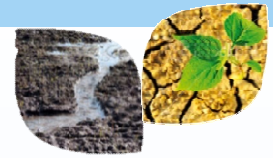
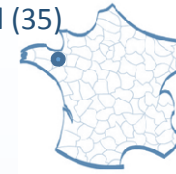
Wet patch - Hydromorphic area



Problems:

Hydromorphic area due to a not optimal rearrangement of the ditch.

Originally, the ditch was probably located where the wet patch is now.

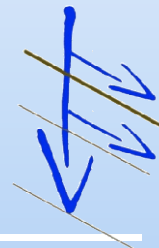


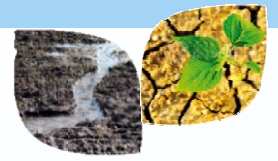
Hydromorphy in tramelines



Solutions:

- Remove compaction
- Do not enter the field if it is too wet





Drainage

DIAGNOSTIC



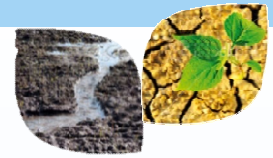
Erosion gullies due to the exit of a drainage pipe middle of the slope



Pictures: JMM - ARVALIS



G.Le Hénaff - IRSTEA



Drainage



Belgium 2012



Poland 2012



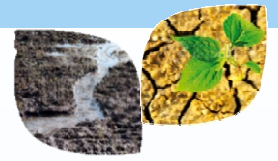
Seine et Marne (77)

Problem:

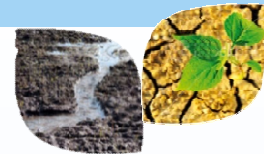
Exit of the drainage in a river: fast circulation and potential contamination

Solution:

Apply when soil is not saturated / drains are not flowing



Short cut DIAGNOSTIC



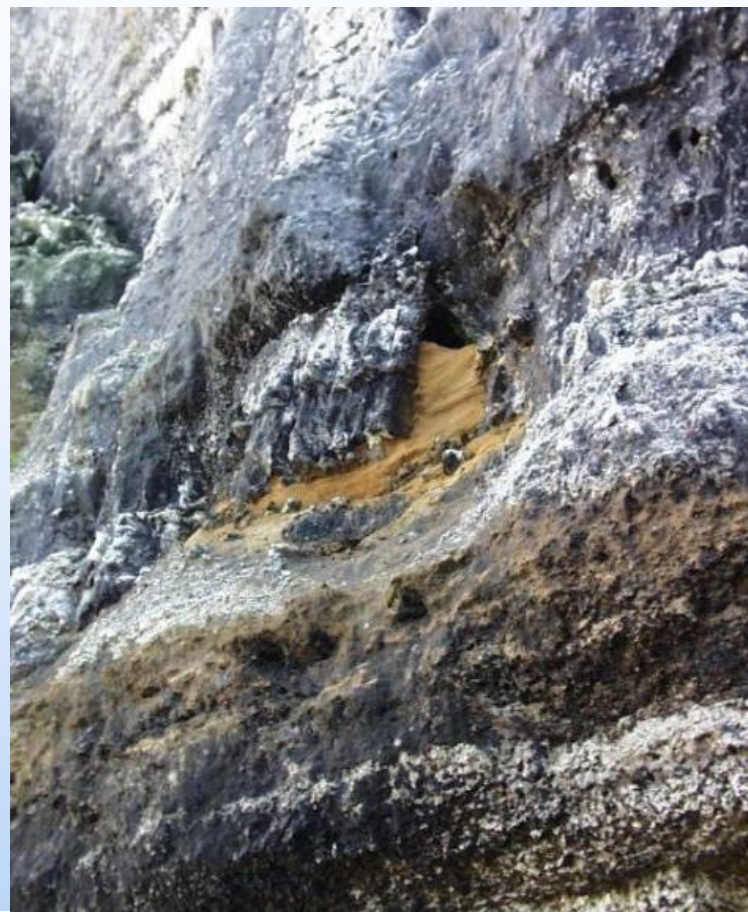
Short cut in karstic substrate in relation with dolines

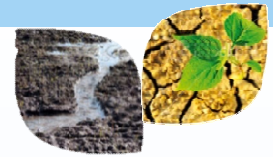
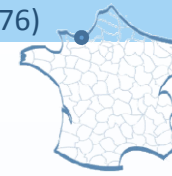


Karstic subsoil

Solutions:

Swallet must be protected by buffer zones





Short cut



Type of soil : silty capping soil

Problem:

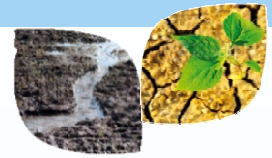
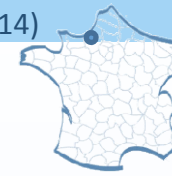
Runoff water going directly to ground water through pit (swallets, sinkholes).



Solution:

Swallets must be protected by buffer zones





Short cuts through the hedge

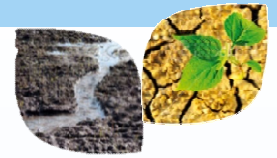
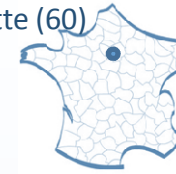


Problem:

Runoff going out of the field via holes dug by animals

Solution:

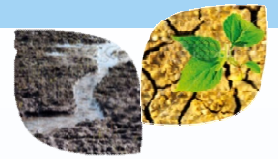
Implement buffer zone



Short cut such as swallet

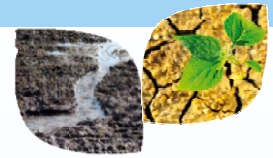
Short cut such as swallet must be protected form drift and spraying



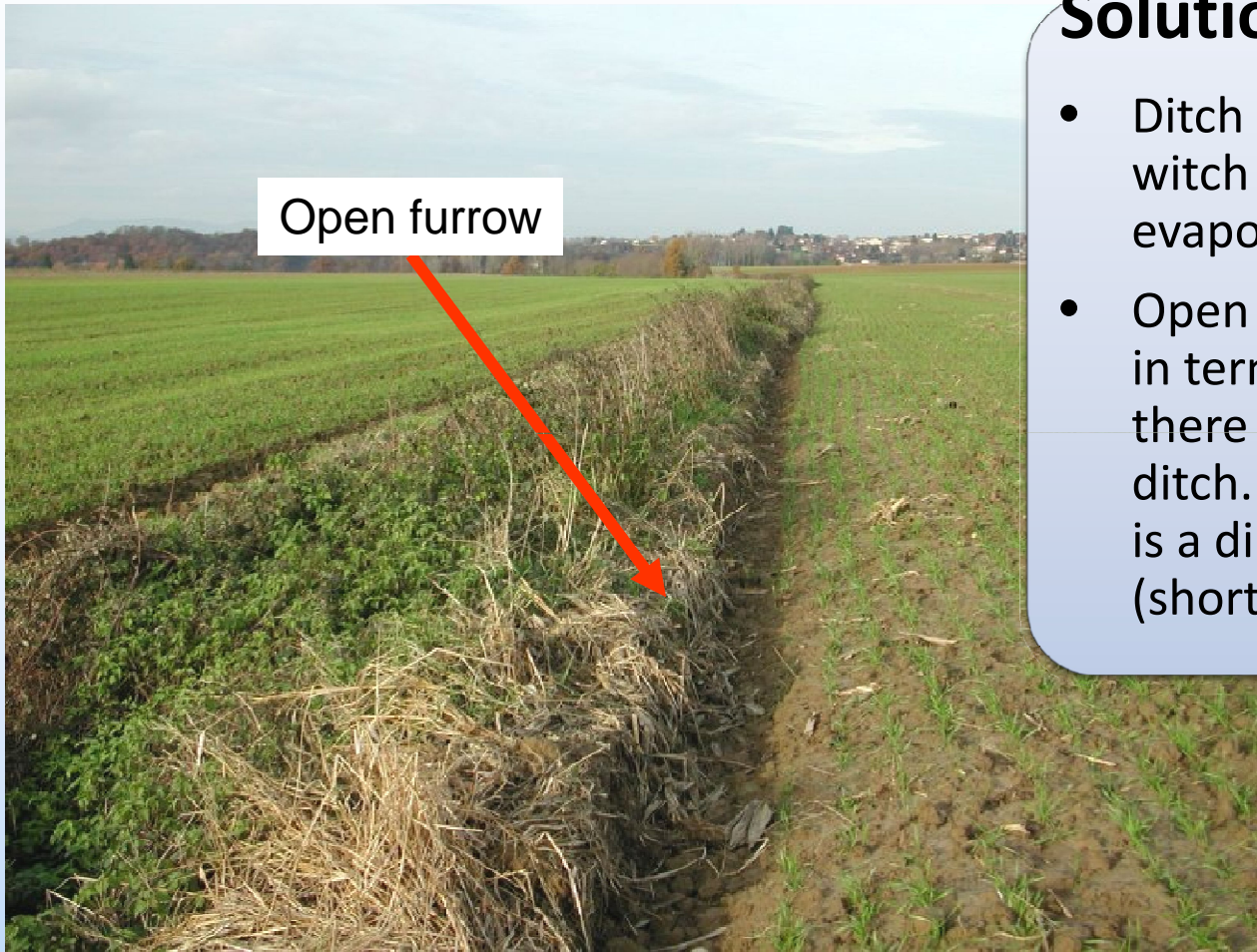


Buffer zones: wet and dry

DIAGNOSTIC



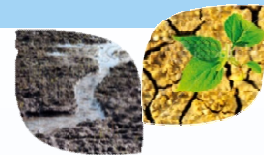
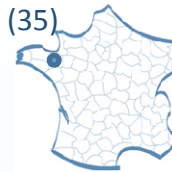
Maintenance of the ditch



Solutions:

- Ditch covered by vegetation with can be very efficient to evaporate and infiltrate water.
- Open furrow: Can be positive in term of evaporation if there is no direct link to a ditch. Can be negative if there is a direct link to the ditch. (shortcut).





Water course protection



Pictures: JMM - ARVALIS

Problems:

Positive points:

Hedge and buffer to protect the stream

Negative points:

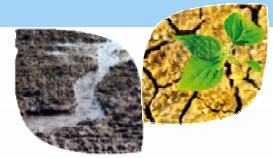
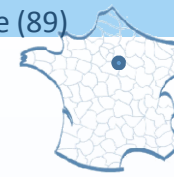
No maintenance.

Short cut through the buffer to evacuate accumulated water.

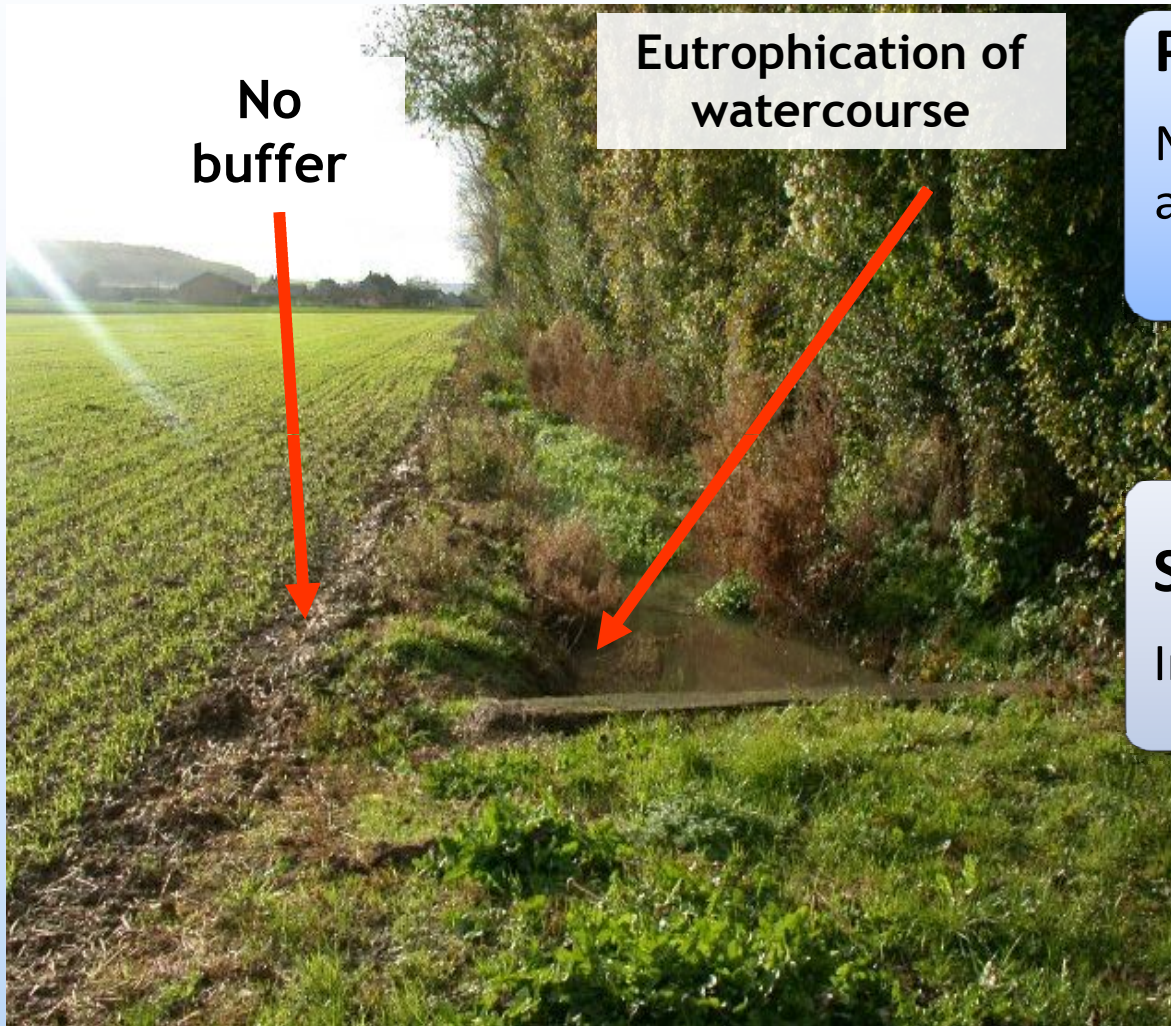
Solution:

Reprofile buffer if needed and maintain it





Water course protection



No
buffer

Eutrophication of
watercourse

Problem:

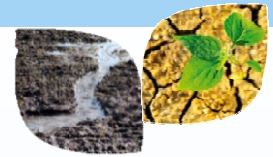
No buffer to protect from drift
and runoff



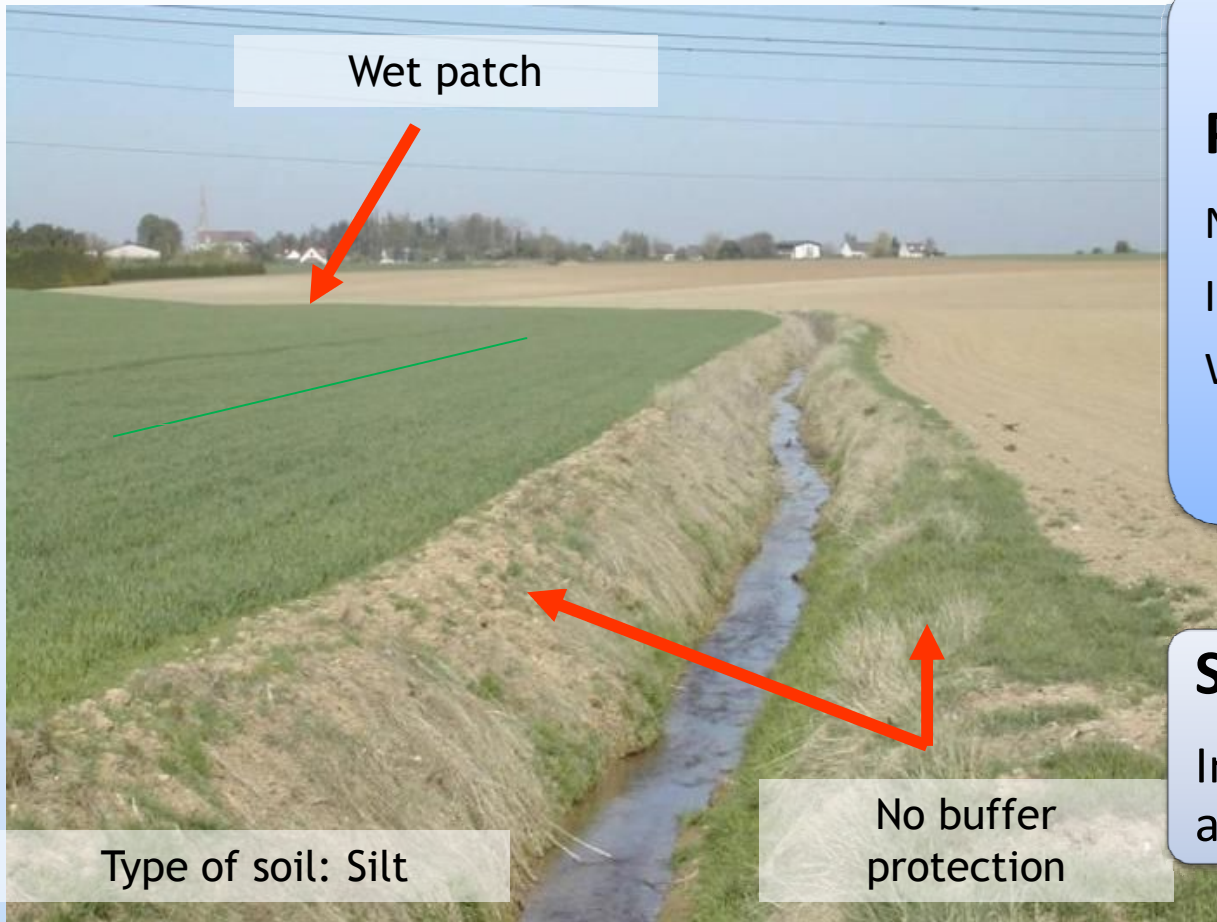
Solution:

Implement a buffer zones





Water course protection



Problems:

- No riparian buffer
- Important risk of drift
- Wet patch due to alluvial water



Solution:

- Implement riparian buffer along both verges of stream



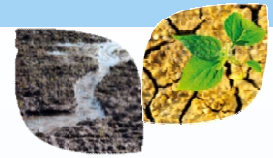
Compacted unefficient buffer zone



Source: IRSTEA

Solution:

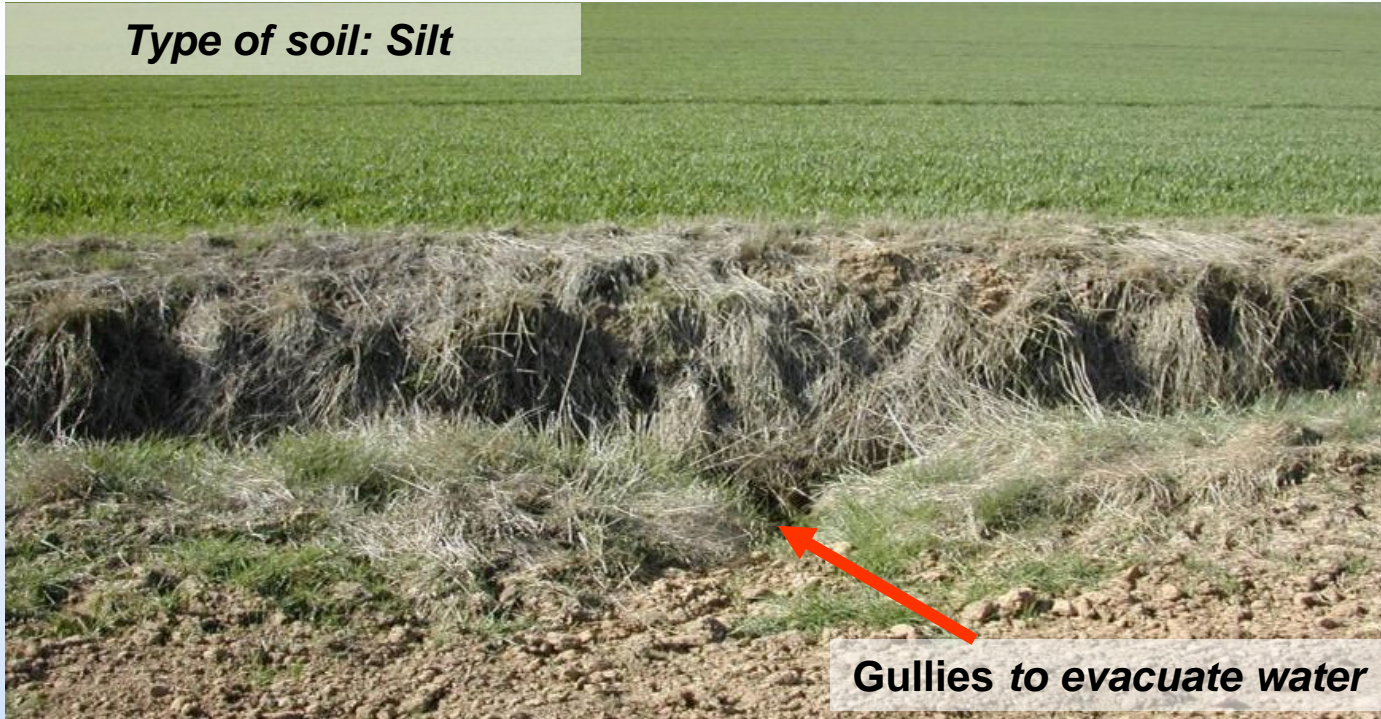
Do not drive over buffer zones



Short cut in buffer zones

Risk of direct contamination by pesticides

Type of soil: Silt



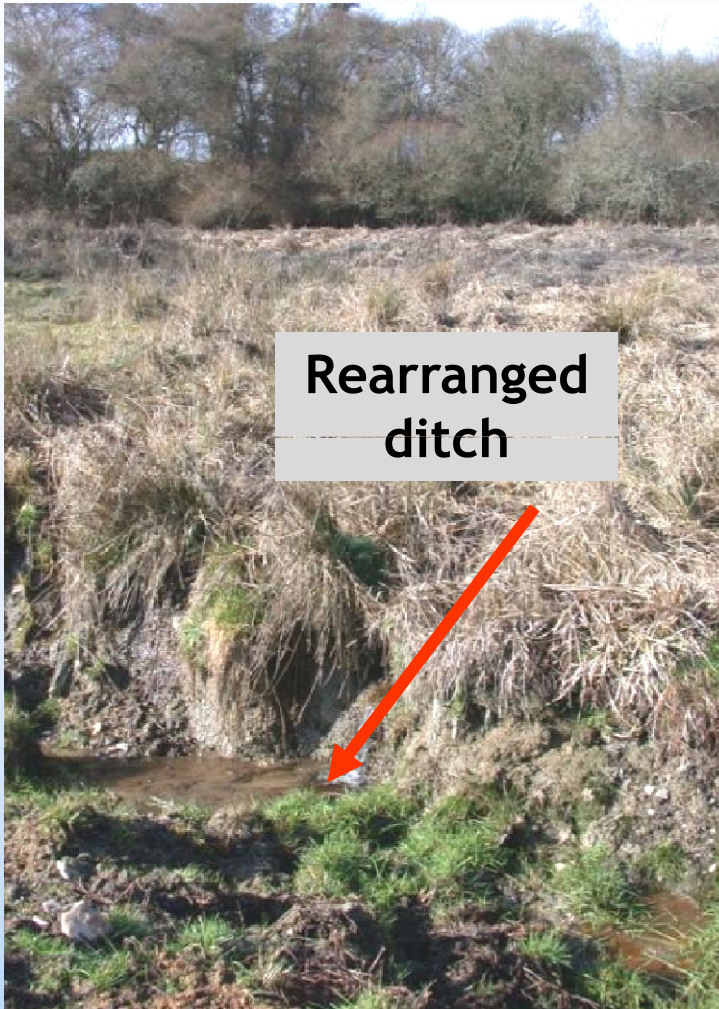
Solution:

Reprofile and enlarge buffer





Short cut in wetland



Rearranged
ditch

Problems:

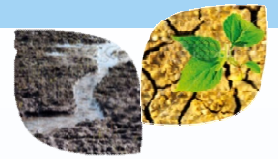
Ditch or gullies implemented in a wetland to collect water from uphill.

Not sufficient evaporation of the water in this wetland.



Solution:

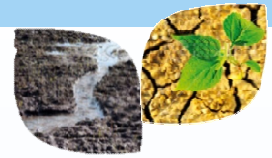
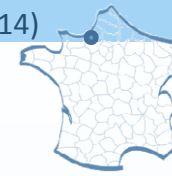
Remove the ditch and disperse water in the grassland



Saturation of the buffer zone

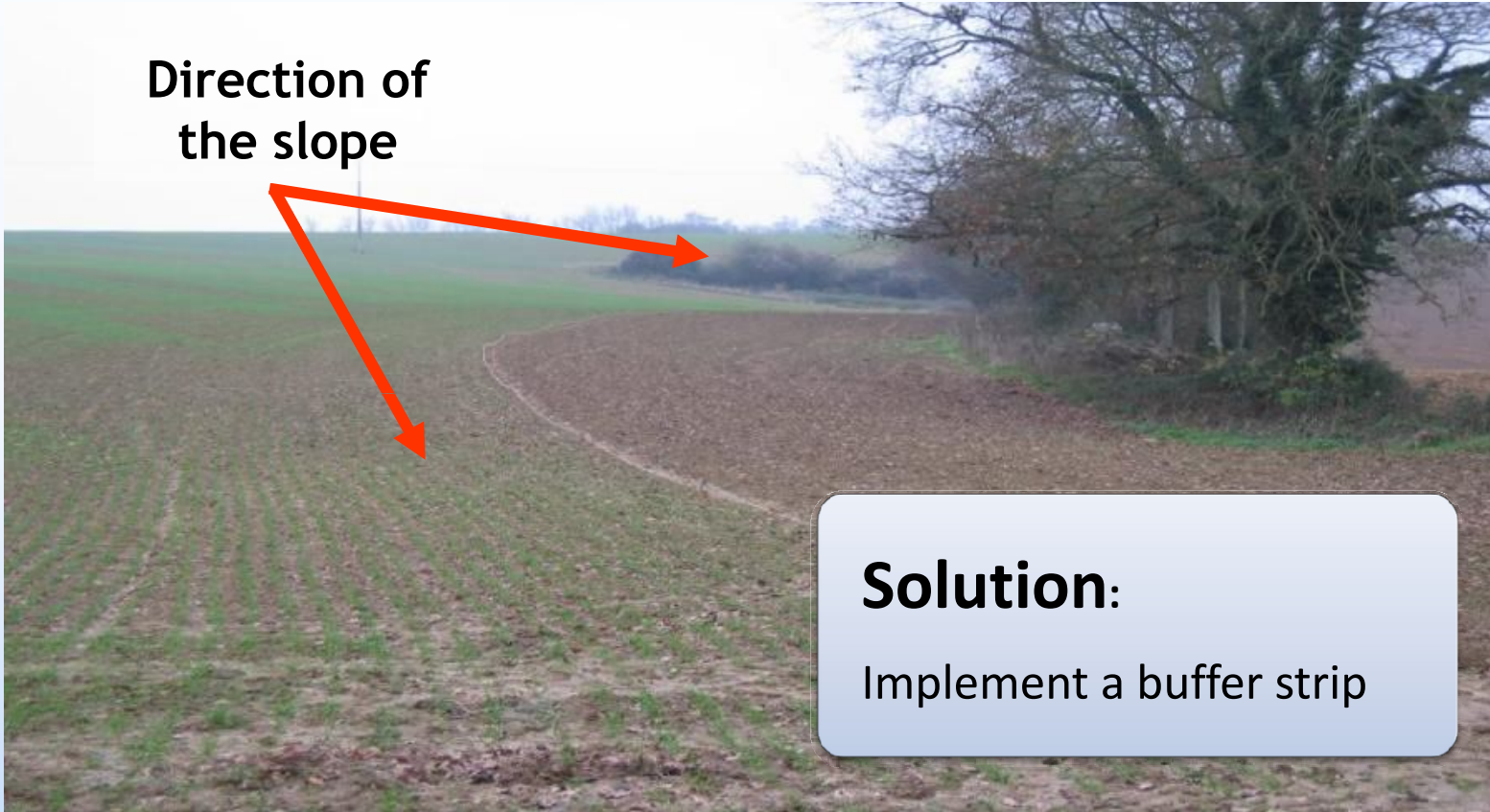


Source: IRSTEA



Water course protection

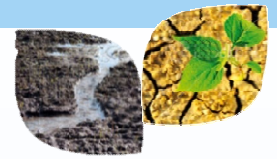
Direction of
the slope



Solution:

Implement a buffer strip





Different types of buffer zones



Edge of field



Grassland in talweg



Along road



Hedges network



Access area

Pictures: IRTSEA



Different types of buffer zones



Grass buffer along stream



Grass buffer + hedge along stream



Uncultivated land



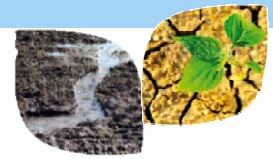
Poplar plantation



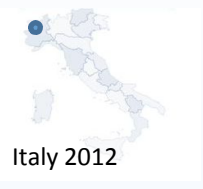
Riparian / woody filter strip

Pictures: IRSTEA

Erosion at the verge of field



© 2012
Francesco Vidotto



Italy 2012



Belgium 2012



Pictures: JMM - ARVALIS



© 2012
Francesco Vidotto

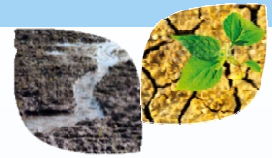


Spain 2012



Pictures: JMM - ARVALIS

Pictures: IRSTEA



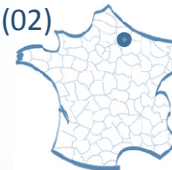
Water course protection different types of buffer

Solutions:

On side 6m buffer zone.
Other side, grassland
buffer.



Picture: ARVALIS



Location of buffer zones



Pictures: JMM - ARVALIS

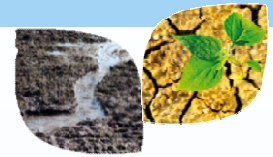
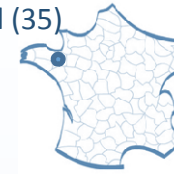
Problems:

Locate a buffer in field, middle slope to collect water coming from the top: very wet buffer (visible because of the moss).

Water infiltrates and limits the runoff downhill.

Issue: superficial soil under the buffer with risk of shortcut or fast infiltration.





Water course protection

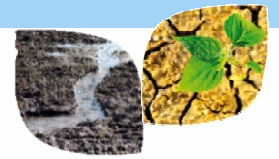


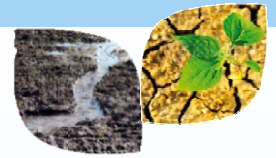
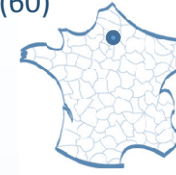
Solutions:

Implementation of buffer zones to protect water

Pictures: JMM - ARVALIS

Wetland

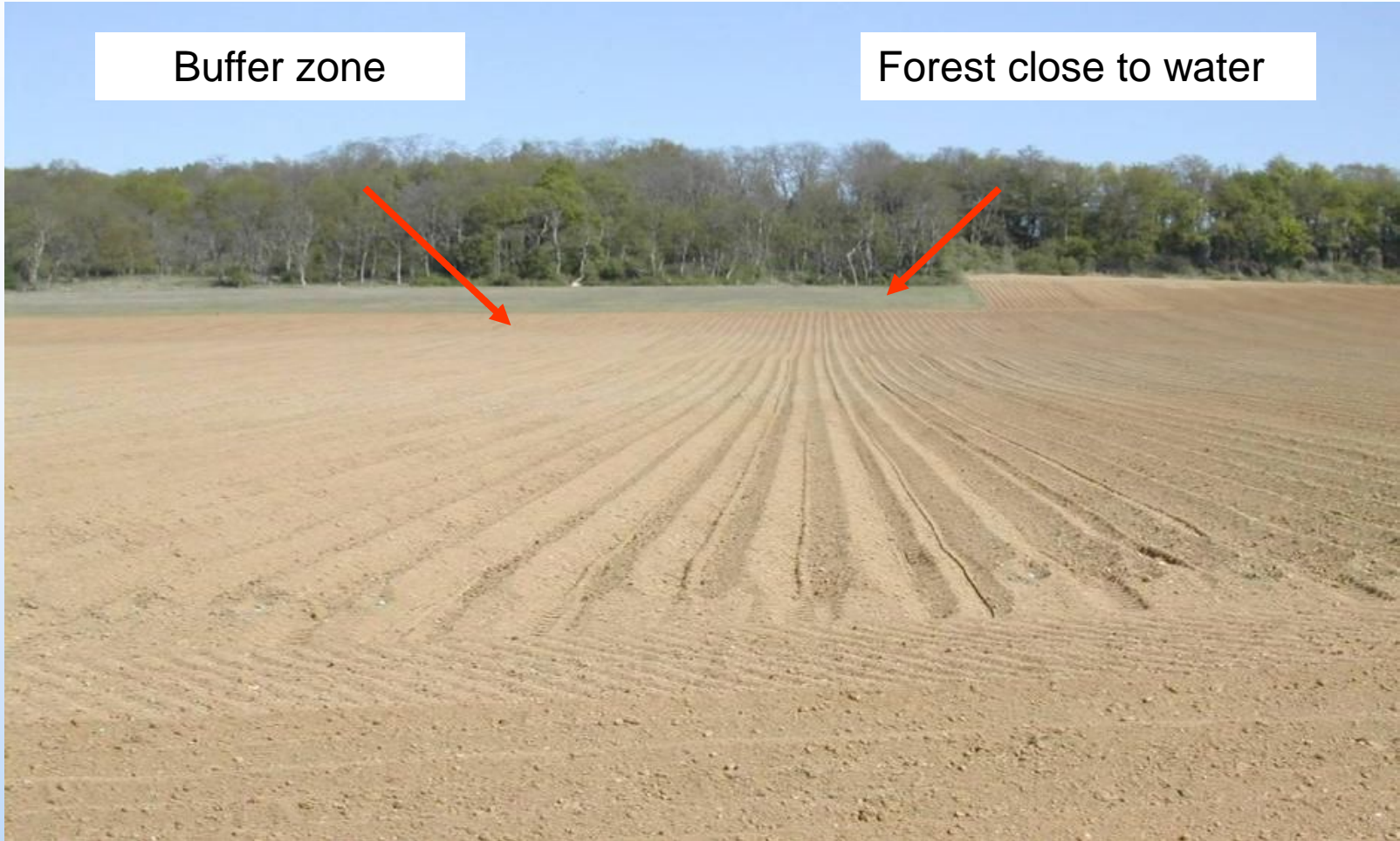


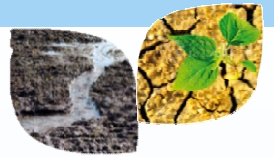


Water course protection

Buffer zone

Forest close to water





Open furrows often directly connected to stream

Stop direct connection through grass buffer zone

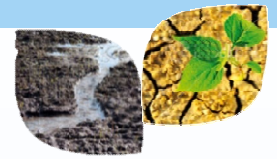


Solutions:

Implement appropriate buffer

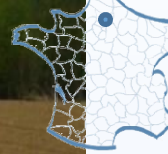
Reestablish the grass buffer zone

Pictures: JMM - ARVALIS



Protect water course and maintain verges

Grand Morin (77)



ARVALIS



Belgium 2012

G.Le Hénaff - IRSTEA

Solutions:

Implement buffer zones and stabilize verge