RUN-OFF

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

TOPPS
PROWADIS

Fieldmanual
Diagnosis / field audit

Runoff Risk Diagnosis

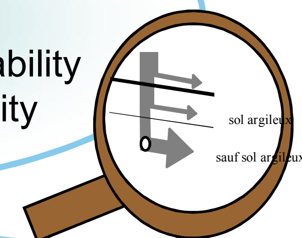
Methodology at catchment & plot scale

1 Data collection

Landscape, farm description, soil types, geology…
(incl. input by farmers)

2 Identification of water pathways and soil texture

Categorisation soil permeability and waterholding capacity



Concept

3 Assess agricultural practices

- Tillage, cropping and PPP use practices
- Spring/summer and winter/autumn season

4 Risk diagnosis

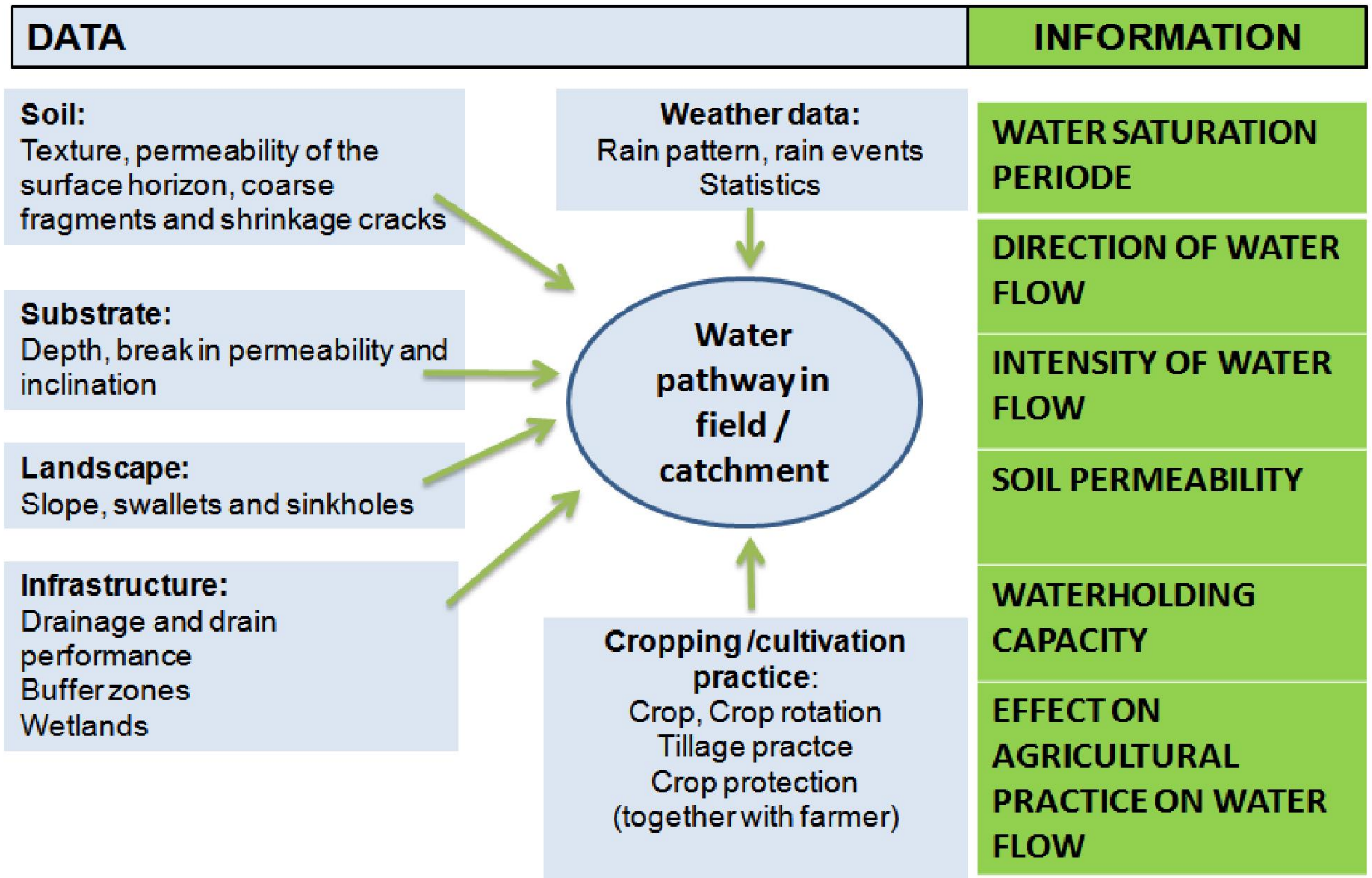
Assessing risks for diffuse and concentrated flow runoff

5 Propose adapted solutions

1. Soil management
2. Cropping practices
3. Vegetative buffers
4. Retention structures
5. Adapting PPP and timing
6. Opimized irrigation

Based on **AQUAPLAINE® concept,** *ARVALIS-Institut du végétal*

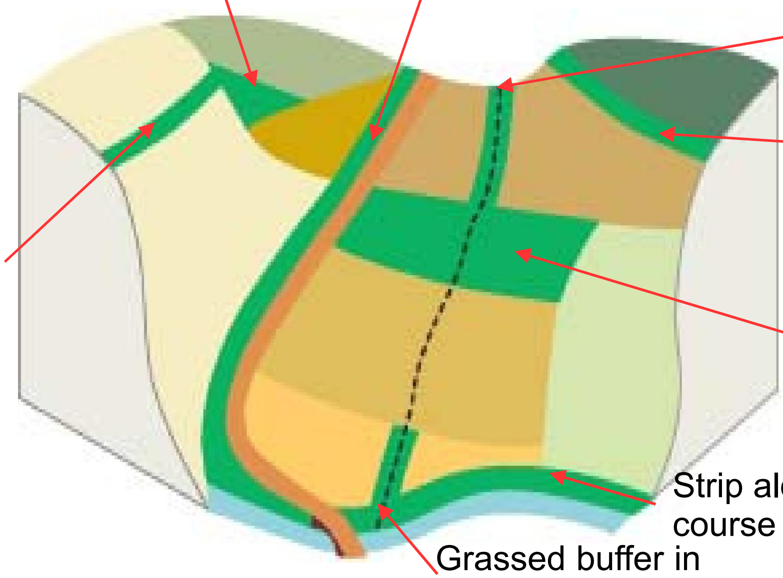
Data and Information needs for a diagnosis



DATA COLLECTION

Landscape factors: existing measures

e.g buffers, retention structures, hedges, woodland, slope length, steepness, field length, sizes

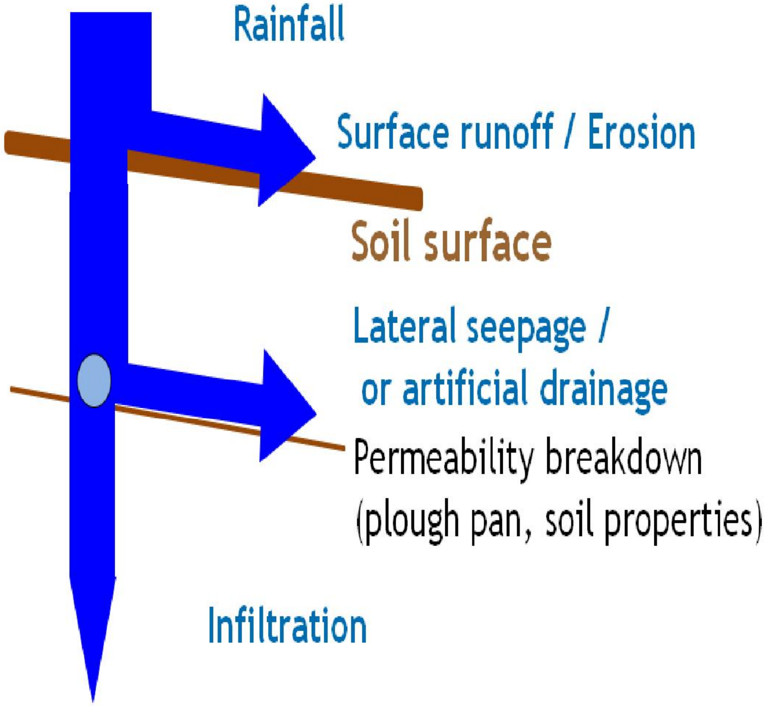


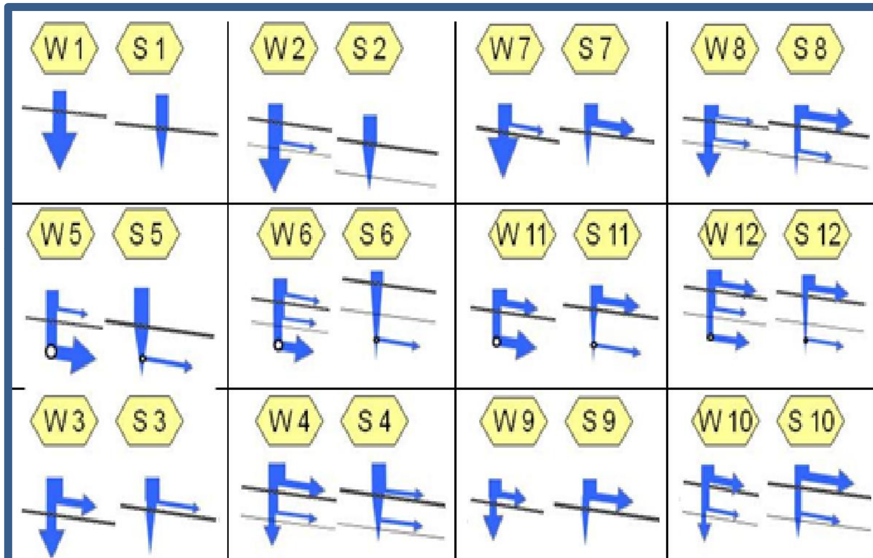
Retention structures: wetlands

Pictures: Corpen / Artwet

DATA COLLECTION

Identify the types of water flow, intensity seasonality and permeability



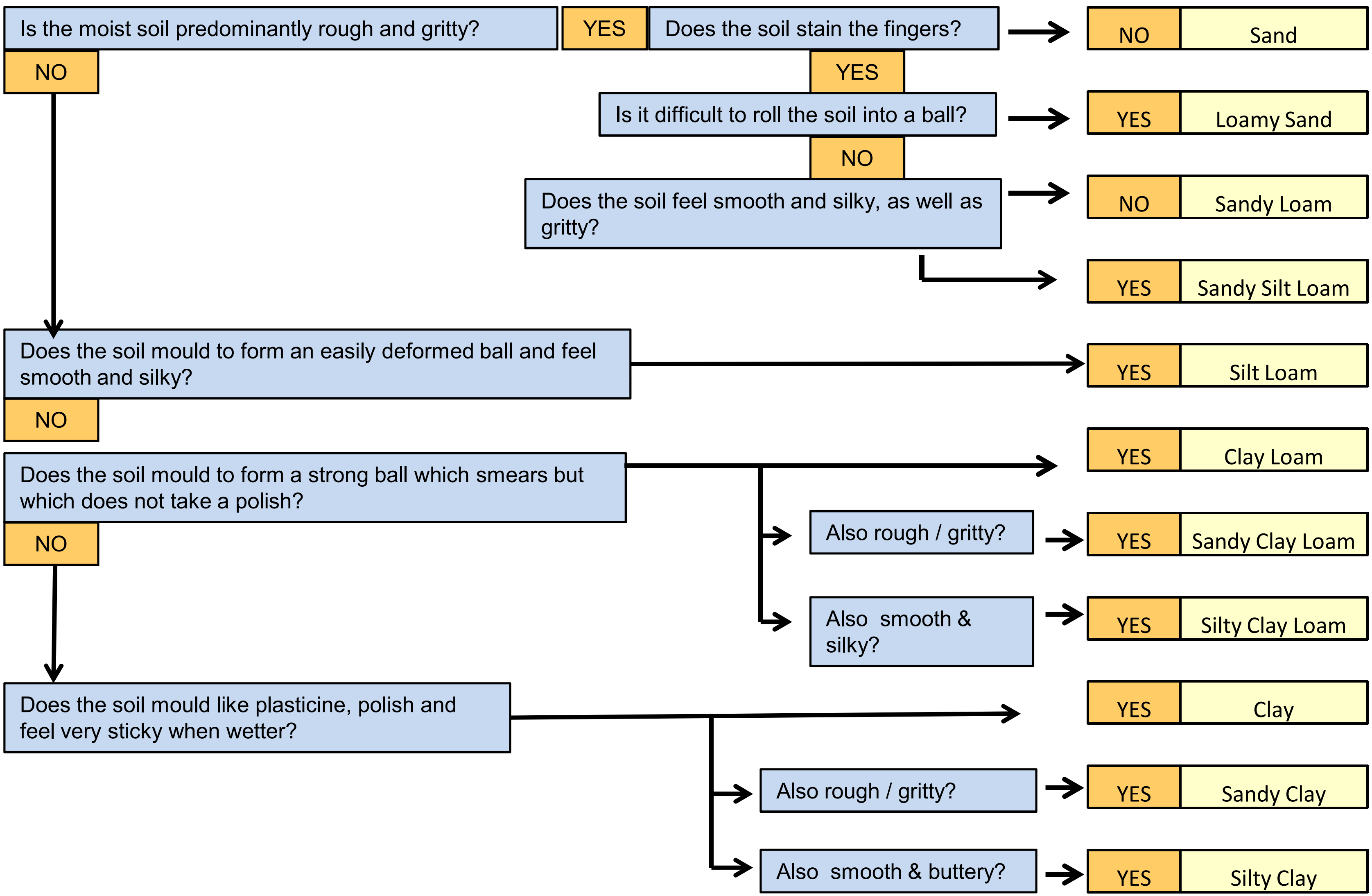


W = autumn, winter / S= spring , summer

Best time for a field diagnosis is winter and early spring

Picture: Arvalis

Determine soil texture



SOIL TEXTURE

Determine water holding capacity (WHC) (Example for orientation)

Jeremy will provide table

Example Calculation
(to be done per soil horizon):
a) Determine texture
b) Determine horizon depth
c) Read factor out of table

Example horizon:
sandy clay (SC), 100 cm deep

Factor out of table for SC:
1.35 mm WHC per cm of SC,

Calculate for 100 cm horizon:
1.35 mm x 100 cm horizon depth
= 135 mm WHC

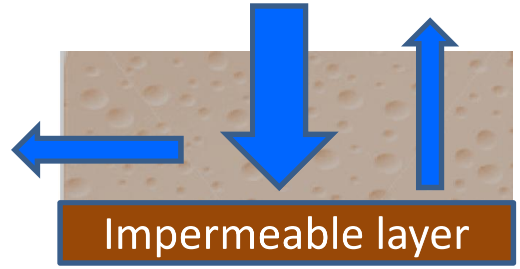
Last step: add WHCs of all horizons
(until 100 cm depth or impermeable layer)

Soils with Water holding capacities > 120 mm have very low water contamination risk

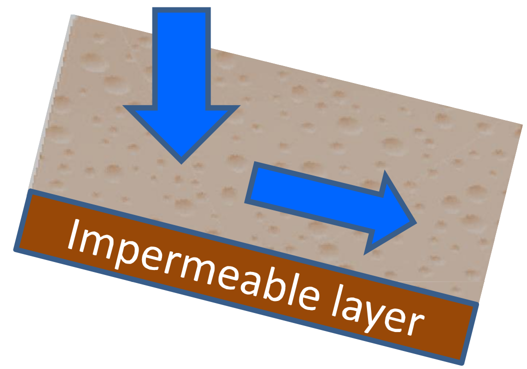
Soil permeability restrictions

Soil with a permeable topsoil over a subsoil of lower permeability.

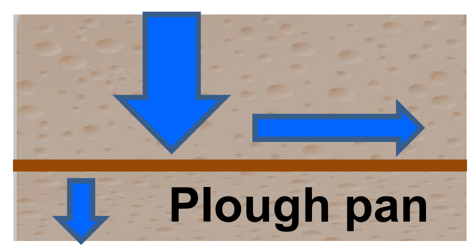
• Water logging in the soil profile as the water percolation into deeper soil layers is hampered by the subsoil horizon of lower permeability.



• Run-off occurs in the upper soil layers as subsurface runoff (also termed interflow or lateral seepage).

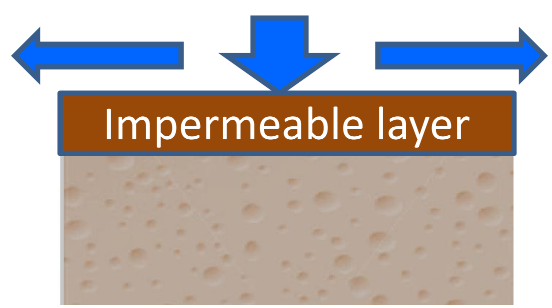


• Compaction of topsoil beneath ploughing zone - evidence of transient water saturation in soil (concretions, mottles).
Plough pans often occur if ploughing is executed at too much soil moisture.



Topsoil with restricted permeabilty

• Capping soils / crusted soils (soils with higher silt content) restrict infiltration of water into the subsoil layers



Symptoms for water saturation: Hydromorphic soils

Hydromorphy is a visible result from water saturation in the soil. Saturation occurs because of a lack of natural drainage (high groundwater), or due to a subsoil layer of low permeability.

Indicators:

•Green or grey colors visible in or below topsoil (indicator for water saturation); iron and manganese accumulation / concretions (reddish brown and black colors).

•Low-permeability subsoil (clayey or loamy subsoil, hard rock or rock rubble such as a granitic layer, schist)

•Soil remains wet for at least 2 to 5 days after rain

Symptoms for permeability restrictions: Plough pan

- Bilder plough pan

Symptoms for capping soil

Soil susceptible to capping:

- poor structural stability of soil surface (splash effect from raindrops)
- Soil forms crust at surface, which hinders infiltration of rain water
- Soils with large portions of fine sand and silt are typically susceptible to capping.

Indicators:

- fine layers of sediments are visible on soil surface layer
- Soil lacks medium and coarse sand particles
- Capping soils should not be confused with cracking soils, which also form a crust during summer but keep a high infiltration potential due to desiccation cracks (> 35% clay)

TOPPS PROWADIS

Agronomic Practices influence water flow
(Example)

Crop	Cultivation	Crop rotation	Tillage	Maintenance
Winter	Row crop	Cover crop	Ploughing	Passes on field
Spring	Broadcast	No cover crop	Reduced tillage	Tramlines
	Crop	Following crop	No tillage	Rough seedbed
				Fine seedbed






AGRONOMIC PRACTICES

Checklist of factors needed to apply risk diagnosis for assessing runoff risk

1	Proximity of field to the water body	Adjacent ☐	Not adjacent ☐	
2	Soil texture From soil map or estimation in field	Texture class ______		
3	Soil water holding capacity Estimable in field from soil texture by using table for WHC	<120mm ☐	>120mm ☐	
4	Slope of the land Using map or estimation in field	Low <2% ☐	Medium 2-5% ☐	High >5% ☐
5	Permeability of the topsoil Estimable in field from soil texture and presence of capping	Low ☐	Medium ☐	High ☐
6	Discrete subsurface restriction Presence of plough pan or other infiltration restrictions	None ☐	Pan or other ☐	Pan + other ☐
7	Landscape situation	Valley Floor / Concave Slope ☐	Upslope Concave / Straight Slope ☐	Tile Drained ☐
8	Transfer of runoff to downhill fields or water body	Downhill transfer unlikely ☐	Transfer likely but not to surface water ☐	Transfer likely to surface water ☐
9	Signs of any concentrated runoff in the field	Yes ☐	No ☐	
10	Presence of concentrated runoff in	Wheel tracks ☐	Field corner ☐	Field access area ☐
11	Presence of moderately concentrated runoff in	Rill ☐	Talweg ☐	
12	Presence of strongly concentrated runoff in	Gully not in talweg ☐	Gully in talweg ☐	
13	Hydromorphic characteristic of soil Verify presence of green/grey colours, iron/manganese concretions with redbrown and black colours, or low-permeability layer in the soil profile by using an auger.	Yes ☐	No ☐	
14	Soil infiltration capacity in buffer	High ☐	Low ☐	

RISK DIAGNOSIS

Diagnosis of concentrated Runoff & Erosion

<table>
<tr><th colspan="5">Scenarios for concentrated runoff</th><th>Risk classes & Scenarios</th></tr>
<tr><td rowspan="11">Runoff generated in the audited field?</td><td>No</td><td colspan="3">Runoff coming from uphill area in the catchment</td><td>C1</td></tr>
<tr><td rowspan="10">Yes</td><td colspan="3">Runoff Concentrating in Wheel tracks</td><td>C2</td></tr>
<tr><td colspan="3">Runoff concentrating in corner</td><td>C3</td></tr>
<tr><td colspan="3">Runoff concentrating in field access area</td><td>C4</td></tr>
<tr><td colspan="2" rowspan="2">Runoff moderately concentrated in rills</td><td>No hydromorphic soil</td><td>C5</td></tr>
<tr><td>Hydromorphic soil</td><td>C6</td></tr>
<tr><td colspan="2" rowspan="2">Runoff moderately concentrated in talweg</td><td>No hydromorphic soil</td><td>C7</td></tr>
<tr><td>Hydromorphic soil</td><td>C8</td></tr>
<tr><td rowspan="3">Runoff strongly concentrated</td><td colspan="2">Gully not in talweg</td><td>C9</td></tr>
<tr><td rowspan="2">Gully in talweg</td><td>High infiltration soil in buffers</td><td>C10</td></tr>
<tr><td>Low infiltration soil in buffer</td><td>C11</td></tr>
</table>

Risk Class & Scenario

If concentrated runoff is seen, risk is high.

Measures need to be taken. Scenarios are described by a letter
C = Concentrated
and by a number (see scenario descriptions in BMPs)

Take decisions from left to right to define scenario

TOPPS
PROWADIS

DIAGNOSIS OF RUNOFF FOR SATURATION EXCESS

Proximity to Surface Water	Drainage Status	Topographic Position	Subsoil Permeability	WHC*	Risk Class & Scenario
Field Adjacent to Water Body	Not Artificially Drained	Bottom of slope (concave)/Valley bottom (see scenario A)	Plough pan + Permeability disruption	ALL WHCS	S 4
			Plough pan OR Permeability disruption	<120 MM	S 4
				>120 MM	S 3
			No plough pan & Permeability disruption	<120 MM	S 3
				>120 MM	S 2
		Upslope/ Continuous slope	Plough pan + Permeability disruption	ALL WHCS	S 4
			Plough pan OR Permeability disruption	<120 MM	S 3
				>120 MM	S 2
			No plough pan & Permeability disruption	<120 MM	S 2
				>120 MM	S 1
	Artificially Drained	All Positions	Plough pan + Permeability disruption	ALL WHCS	SD 3
			Plough pan OR Permeability disruption	<120 MM	SD 3
				>120 MM	SD 2
			No plough pan & Permeability disruption	<120 MM	SD 2
				>120 MM	SD 1
Field Not Adjacent to Water Body	Not artifically Drained	Transfer of runoff to downhill field?	YES — Runoff reaches water body?	YES	T 3
				NO	T 2
			NO		T 1

* WHC = Waterholding capacity

Risk Class & Scenario

Risk classes are shown by colours
Scenarios are described by a letter
T = Transfer
S = Saturation excess
SD = Saturation excess + artificial drainage and by a number
(see scenario descriptions in BMPs)

Take decisions from left to right

HIGH RISK
MEDIUM RISK
LOW RISK
VERY LOW RISK

RISK DIAGNOSIS DASHBOARD

TOPPS
PROWADIS

DIAGNOSIS FOR RUNOFF FOR INFILTRATION RESTRICTIONS

Proximity to Surface Water	Permeability of the Topsoil	Steepness of Slope	Risk Class & Scenario
Field Adjacent to Water Body	LOW	STEEP (>5%)	I 7
		MODERATE (2-5%)	I 6
		SHALLOW (<2%)	I 5
	MEDIUM	STEEP (>5%)	I 4
		MODERATE (2-5%)	I 3
		SHALLOW (<2%)	I 2
	HIGH	STEEP (>5%)	I 3
		MODERATE (2-5%)	I 2
		SHALLOW (<2%)	I 1

Proximity to Surface Water	Transfer of ru-noff to downhill		Runoff reaches water body?		Risk Class & Scenario
Field Not Adjacent to Water Body		YES		YES	T 3
				NO	T 2
		NO			T 1

Risk Class & Scenario

Risk classes are shown by colours
Scenarios are described by a letter
T = Transfer
I = Infiltration restriction
and by a number (see scenario descriptions
Take decisions from left to right

- HIGH RISK
- MEDIUM RISK
- LOW RISK
- VERY LOW RISK

RISK DIAGNOSIS DASHBOARD

Topsoil permeability assessment

DIAGNOSTIC
LOW PERMEABILITY • capping soils or • clayey & loamy soils (>30% clay, < 30% sand) or • swelling clay (> 25%)
MEDIUM PERMEABILITY • non capping soils and • other soil textures
HIGH PERMEABILITY • Non capping soils and • Sandy & sandy loam soils (< 20% clay, > 65% sand) or • Loamy & silt soils (sand + silt > 65%) & good aggregate structure & high organic matter content (>3%) or • Non swelling clays (< 25%)

TOPSOIL PERMEABILITY

Runoff Mitigation Measures

Toolbox for practical and adaptable mitigation

Mitigation measure toolbox

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
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	• Adapt application timing • Optimize seasonal timing	• Adapt product and rate selection
Optimized irrigation	• Adapt irrigation technique	• Optimize irrigation timing and rate

TOOLBOX MITIGATION MEASURES

- First
  Prevent runoff where it starts: use
  In field mitigation measures
- Second
  If field measures are not sufficient, use additionally **out of field** measures
- Combine measures to realize synergistic effects

Runoff Mitigation Measures

Toolbox for practical and adaptable mitigation

In field measures / out of field measures / in + out of field measures

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
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	• Adapt application timing • Optimize seasonal timing	• Adapt product and rate selection
Optimized irrigation	• Adapt irrigation technique	• Optimize irrigation timing and rate

SELECT EFFECTIVE MEASURES

TOPPS PROWADIS

Mitigation measure toolbox (Example)

Select risk adapted measures !

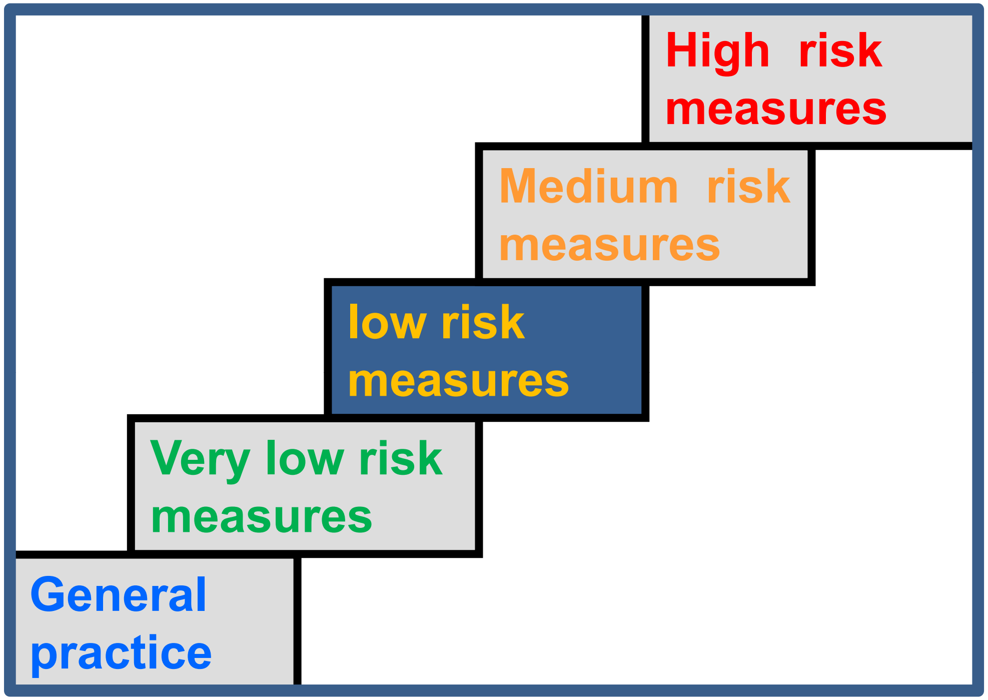
Soil management	• Reduce tillage intensity • Manage tramlines • Prepare rough seedbed • Establish in-field bunds	• Manage surface soil compaction • Manage subsoil compaction • Do contour tilling/disking • Increase organic matter
Cropping practices	• Use Crop rotation • Do strip cropping • Enlarge headlands	• Use annual cover crops • Use perennial cover crops • Double sowing
Vegetative buffers	• Use in-field buffers • Establish talweg buffers • Use 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

General practice	Very low risk measures	low risk measures	Medium risk measures	High risk measures

SELECT EFFECTIVE MEASURES

TOPPS PROWADIS

BEST MANAGEMENT PRACTICE (BMP) = Diagnosis & adapted measures



BMP recommendations are a set of measures, which are able to mitigate runoff in the context of environmental, economic and social needs

REALIZE THE SYNERGIES

TOPPS PROWADIS

Document diagnosis results in Fieldforms

Location /Practices

- Catchment name
- Field number
- Tillage system
- Cropping pattern
- Crop rotation

Water pathways

- Map fields in catchment
- Determine water pathways
- Type of runoff
- Proximity to surface water

Soil characteristics

- Texture
- Waterholding capacity
- Permeability
- Soil depth
- Substrate

Landscape factors

- Slope steepness
- Slope length
- Surface roughness
- Wet patches, dolines
- Buffer zones / types

Before starting a Diagnosis download field forms and short guide from www.TOPPS-life.org

DATA DOCUMENTATION

Field forms : Document observations made in the field
Download field forms from www.TOPPS-life.org

TOPPS PROWADIS

Farm form

Field name and N°:
Crop in place and rotation:
Tillage system:
Resistant weed : *Yes / No*

Drainage network:

Which one:

Field map (draw) / Water ciculation / Landscape

Landscape characteristics

Upstream water arrival: yes / no
Runoff concentration: yes /no
Proximity to waterbody, ditch or spring: yes/no
Important slope: < 2%, 5%, >10%
Buffer zone downhill: yes /no
Nature of buffer zones: grassy/ hedge /woodland
Preferential pathways (doline, swallet): Yes / no
Wet patch: yes/no

Pedological caracteristics

Location or horizon 1

Texture :
% of clay:
Gravels and stones:
Depth:
Capping soil:
Cracks in soil

Location or horizon 2

Texture :
% of clay:
Gravels and stones:
Depth:
Capping soil:

Geological caracteristics

Geological substrate:
Geological substrate permeability:
Karstic substrate:

Total depth:
Water holding capacity: <120mm/>120mm
Permeability disruption (clay area, etc..):
Hydromorphy evidence:

Diagram of water pathway in winter

Diagram of water pathway in spring

Diagram of water pathway in summer

REMARKS :

Version: 20120727
Methodology coming from aquaplaine, ARVALIS – Institut du végétal

TOPPS PROWADIS

Legend :

	Soil
	Geological substrate or permeability breakdown
	Drain
	The thickness of the arrows symbolizes the proportion of water flow in the relative direction.
	This symbol means that water infiltrates and fills up the water holding capacity of the soil. There is no transfer

Version: 20120727
Methodology coming from aquaplaine, ARVALIS – Institut du végétal