



Train **O**perators to **P**revent
water pollution from **P**oint **S**ources

Information and Training presentation

About the TOPPS project

The project: Training the **O**perators to prevent **P**ollution from **P**oint **S**ources) began in November 2005, and ended in October 2008.

TOPPS is a multi-stakeholder project, covering 15 European countries, funded under the European Commission's Life Program and by ECPA - European Crop Protection Association. The project aims to develop European BMP Guidelines and promote the BMP principles through advice, training and demonstrations on a larger co-ordinated scale in Europe with the intention of preventing point sources and reducing losses of PPP to water.

After the project

ECPA further supports the dissemination of TOPPS – BMPs and intends to expand the country scope together with local partners in countries and their Crop protection association members

Compiled by Manfred Roettele

Content:

- A. Introduction
- B. Significance and perception of point source pollution
- C. Best Management Practices
 - 1. Cleaning
 - 2. Filling
 - 3. Remnant Management
 - 4. During application
 - 5. Storage
 - 6. Transport
- D. Summary

Plant Protection Products (PPP) are used to protect crops against



PESTS



DISEASES



WEEDS

if used correctly most PPP do not cause problems in water


- Few active ingredients are found regularly at levels of concern
- Particularly in surface water but locally also in groundwater



**MITIGATION MEASURES CAN LARGELY AVOID
PPP – POLLUTION OF SURFACE WATER**

EU – Pesticide legislation stronger focus on water protection

- new Directive for Pesticide authorization
- Water Framework Directive
- Sustainable Use Directive



More education and training requirements for advisers and farmers

Obligatory sprayer testing

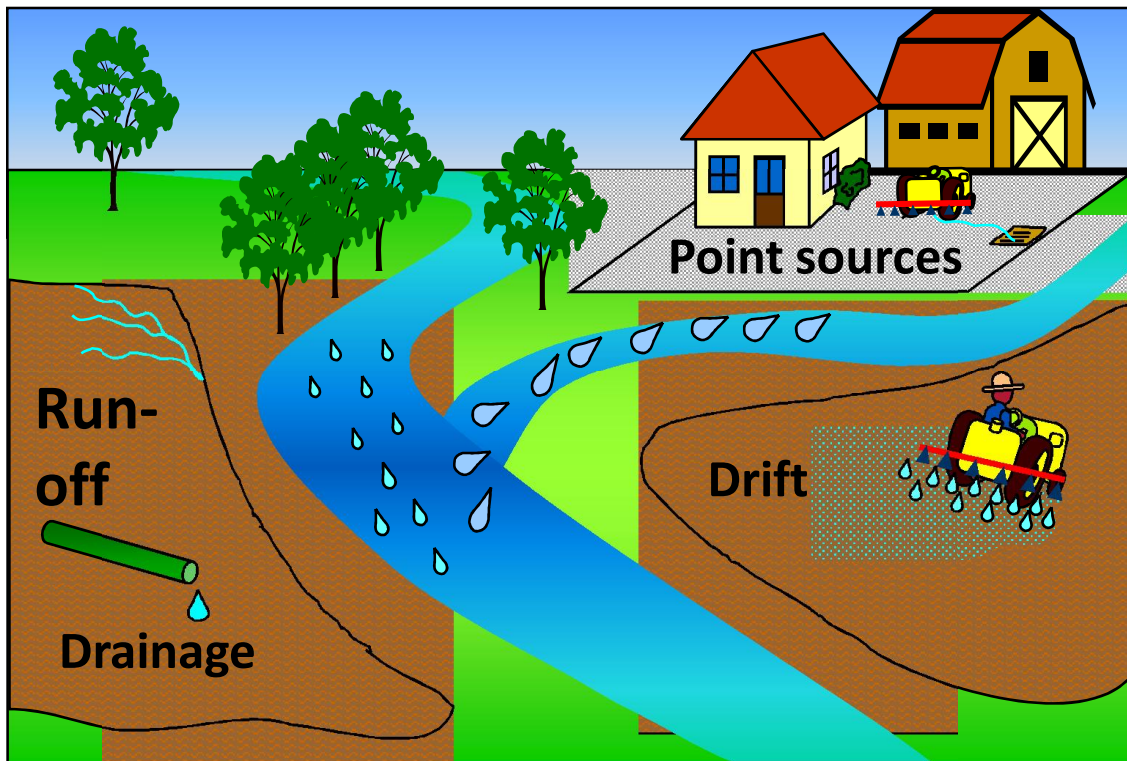
National action plans

River basin management plans

More water monitoring

Directives need to be transferred into national law in the next years

Two main entry routes into surface water: point + diffuse



5 %
Drift
30 %
Run-off

> 50 %
Point
source

Diffuse
entries
can be
reduced

Point
sources
can be
largely
avoided

Neu ?

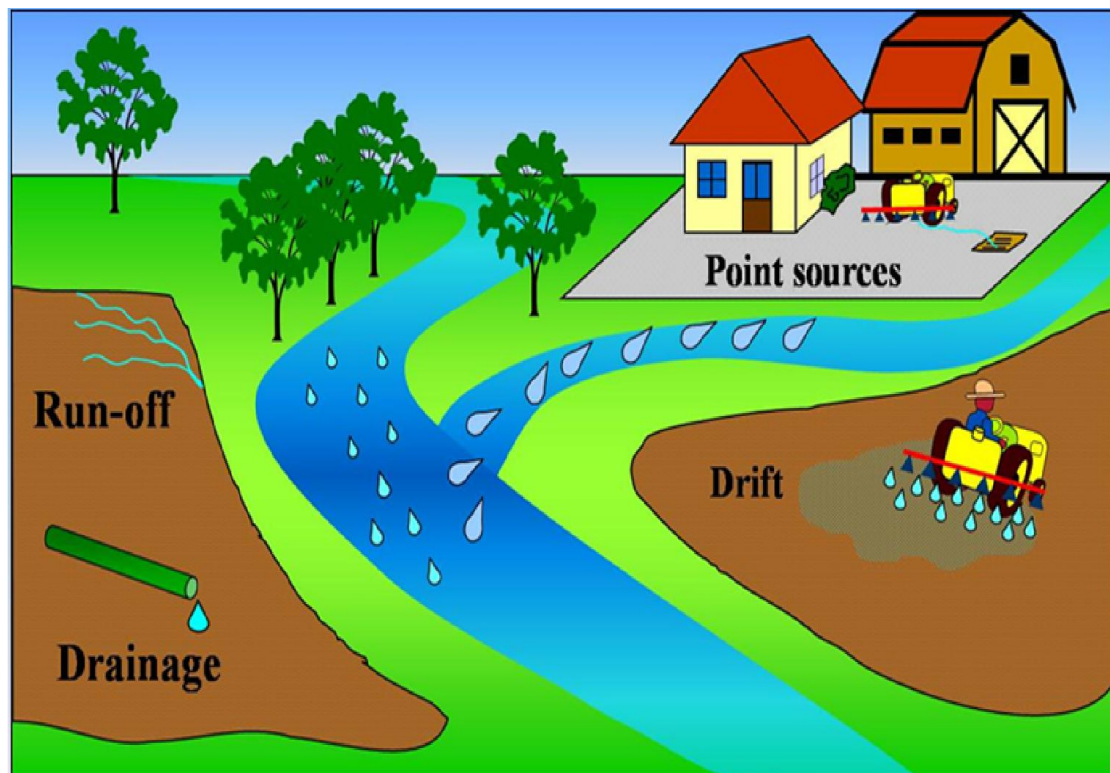
Entry routes of PPP into surface water

Point sources

Handling on farm
(filling, cleaning,
remnant management)

Diffuse sources

Field run off
Drainage
Drift



How do you perceive the significance of PPP entry routes into surface water ?

Point source



Diffuse source

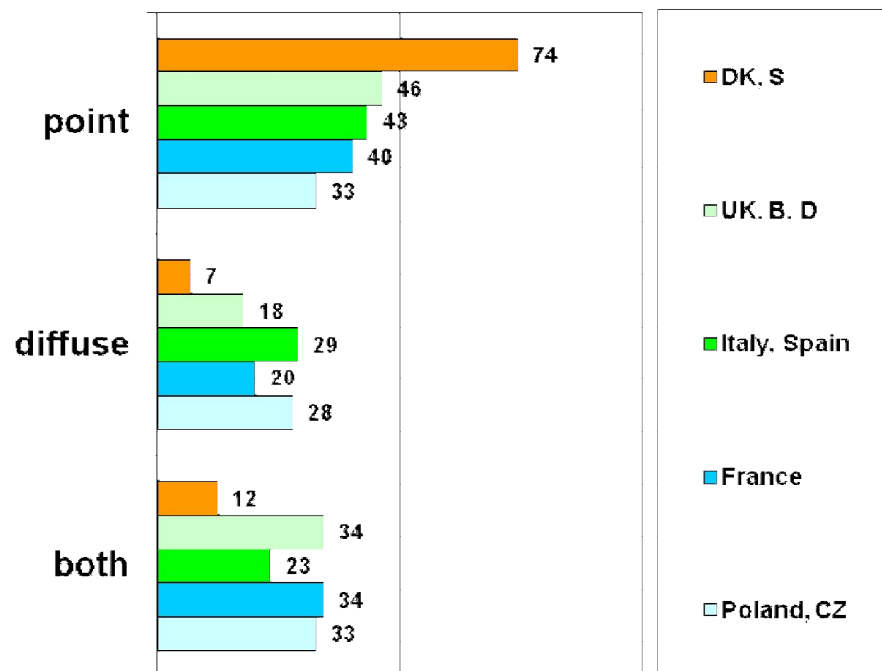
Perceived significance of point sources by advisers, water managers, stakeholders

TOPPS stakeholder survey 2007

- Point sources are perceived the major contamination source
- 74% in Nordic region see point source the most important entry route of PPP into water
- ***Answers suggest that there is not sufficient information about the importance of point sources !***

But > 80% consider point sources the entry route which can be easiest avoided

What is the most important entry route ?



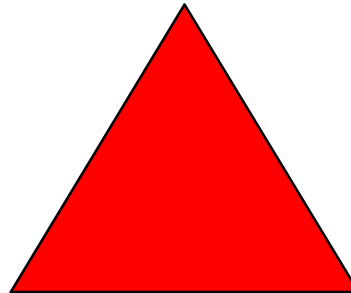
Stakeholder survey 10 countries (n = 600)

Mitigation measures to protect water need to concentrate on three perspectives

Correct behavior

Best Management Practice (BMPs)

Education + Training + Advice



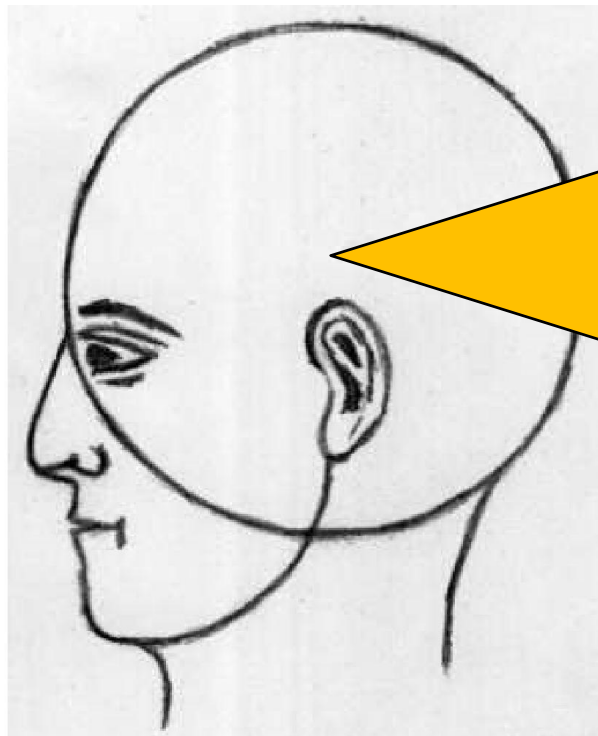
Techniques

- Equipment
- Tillage practices
- Crop rotation
- Crop selection
- Others

Infrastructure

- Filling / Cleaning places
- Biofilter / Biobed
- Storage facilities
- Empty container recycling
- Buffer strips
- Others

Behaviour change means change of mind set



Problems and
their solutions
only exist in
our minds

Awareness of operators is a reflection
on the efficiency of information and
advice received

CREATION OF AWARENESS IS FIRST FOR A CHANGE

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1160 Brussels , Belgium
www.ecpa.be

Edgmond, UK
TF108NB ,
www.harper-adams.ac.uk

Arvalis – Institut du Végétal
Station d’expérimentation
91720 Boigneville, France
www.arvalisinstitutduvegetal.fr

**Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forêts
CEMAGREF**
361, Rue Jean François Breton
Montpellier CEDEX
www.cemagref.fr

Danish Agricultural Advisory Service, National Centre - DAAS
Udkaersvej 15
Aarhus N, Denmark
www.landscentret.dk

Institute for Land Reclamation and Grassland Farming - IMUZ
Falenty-Aleja Hrabaska 3
Raszyn, Poland
www.imuz.edu.pl

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B. Significance and perception of PPP point source water contamination

Significance of point sources

Studies show that point sources are the most significant entry route of PPP into surface water

> 50 %

Few studies available from

Germany

Belgium

United Kingdom

Separation of entry routes often difficult

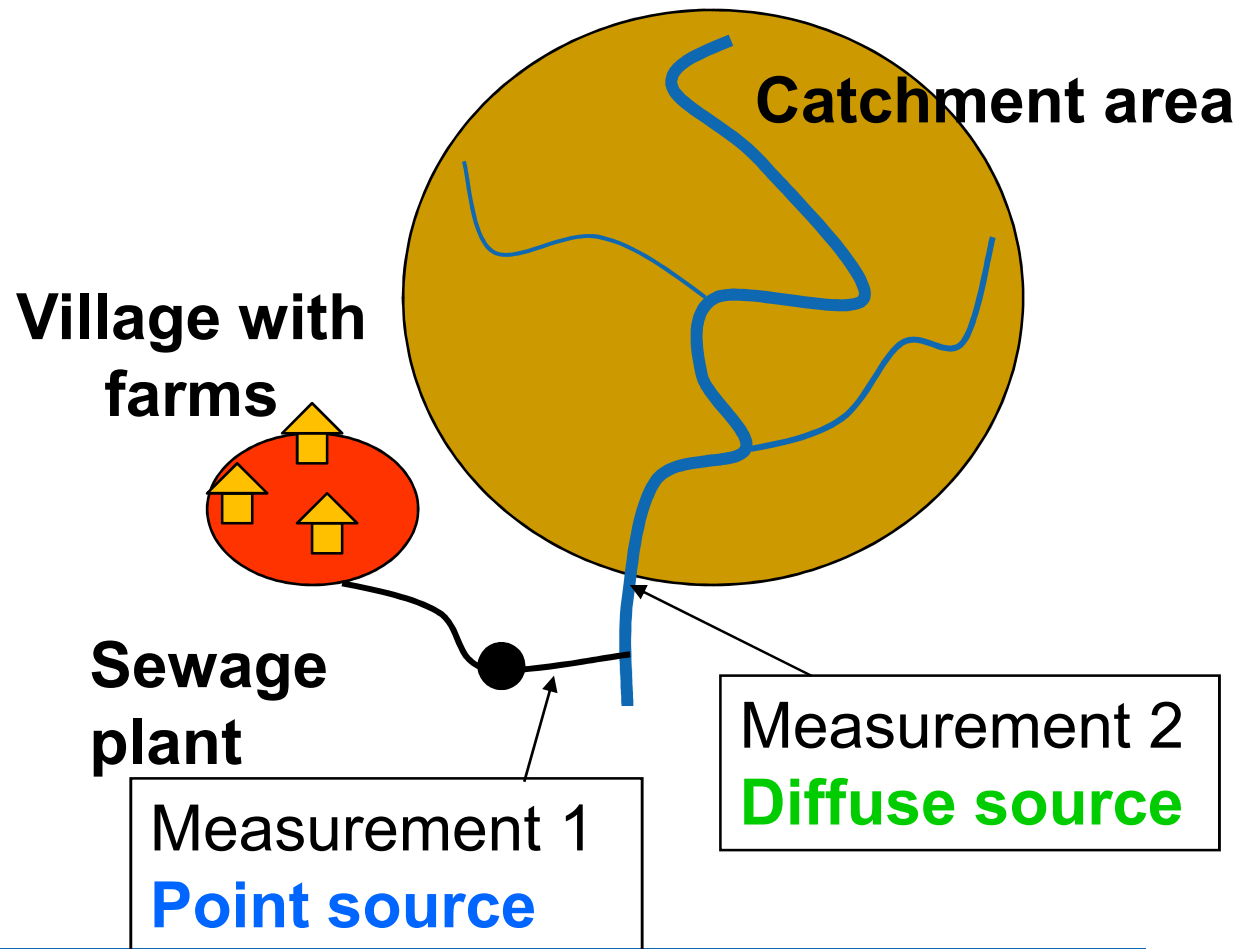
Study method

Example Germany : University Giessen

Farms are located in the village
Waste water from the farm and farmyard is collected through the waste water system in the sewage plant

Measurement 1
measures the PPP contamination coming from the farm (point source)

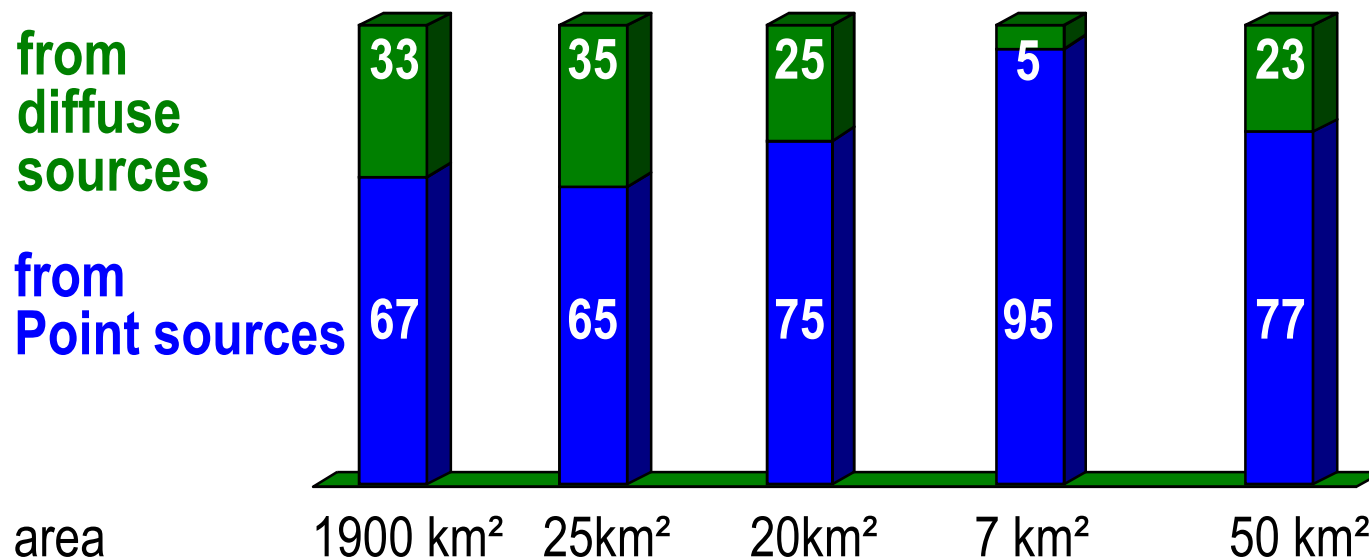
Measurement 2
measures the PPP contamination in the river, which comes from the field (diffuse source)



Study results

Example Germany : University Giessen

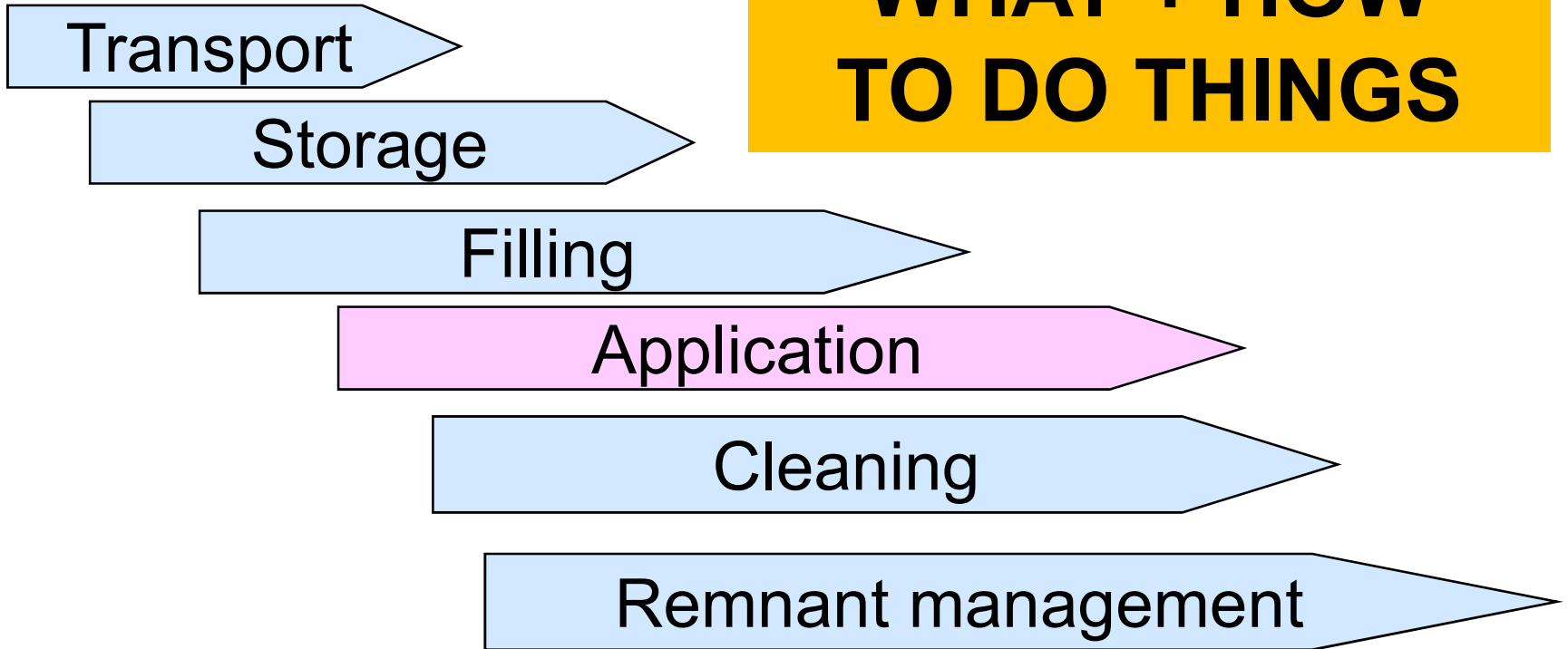
5 Catchment areas in Hessen/Germany



POINT SOURCES CONTRIBUTE > 50 %

TOPPS - Best Management Practices (BMPs) to avoid point sources were developed along the relevant working processes

**WHAT + HOW
TO DO THINGS**

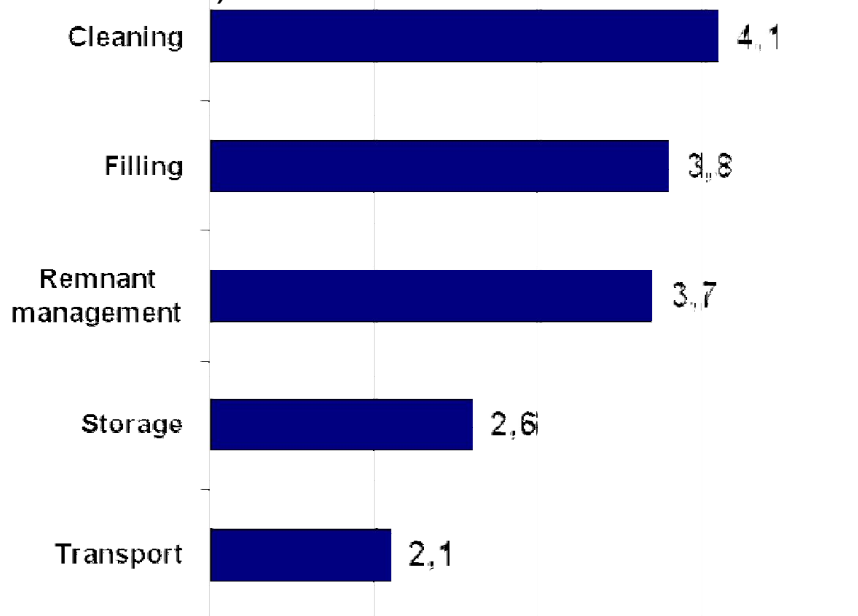


How would you
evaluate the
different work
processes on their
risk for point source
pollution

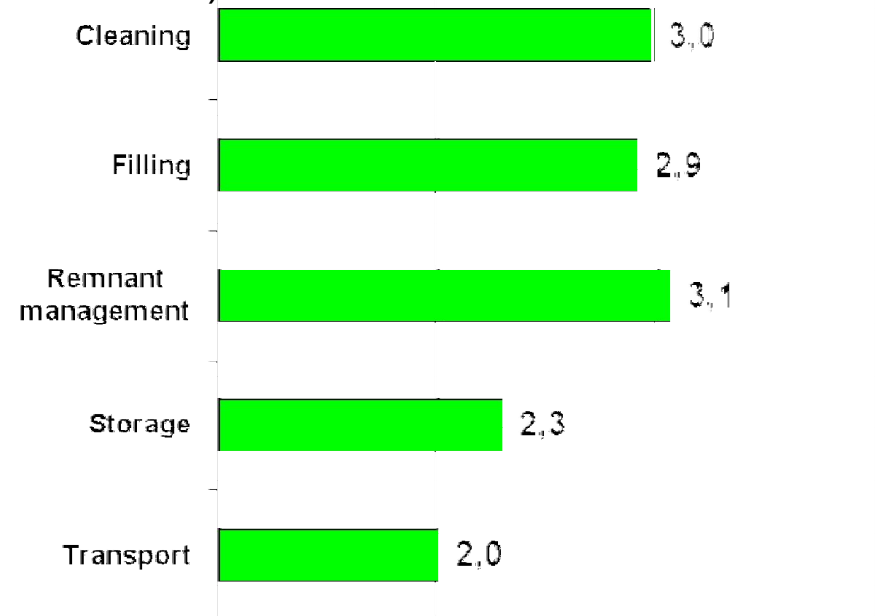


Perceived risks of working processes by stakeholders and farmers for point source pollution

Stakeholders survey n=600 (10 EU countries)



Farmers surveys(6 catchments/countries n=843)



Farmers surveys: BE, DE, DK, FR, IT, PL)

If you know the risk you can do something about it

Averages can be misleading.....

Example of different risk perceptions by operator groups / knowledge is different (TOPPS farmer survey)

In surveys about 20 to 50 % of the operators could evaluate the risk of different work processes for point source pollution + / - correctly.

Challenge: Information and training should reach most farmers / operators

Group 1

Evaluates the risks rather correctly

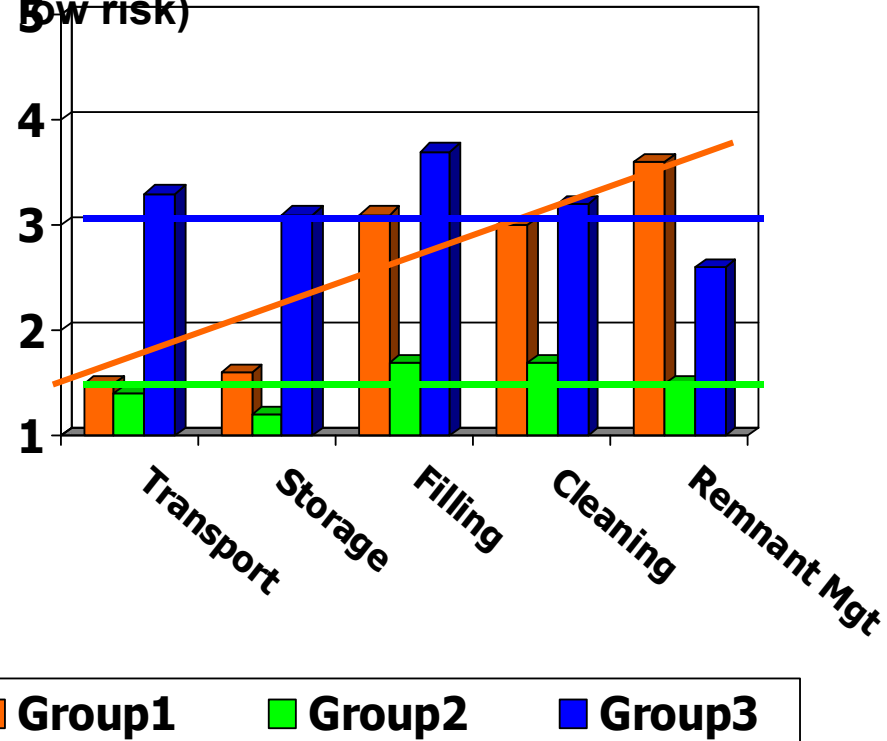
Group 2

Evaluates the risks very low but not differentiated

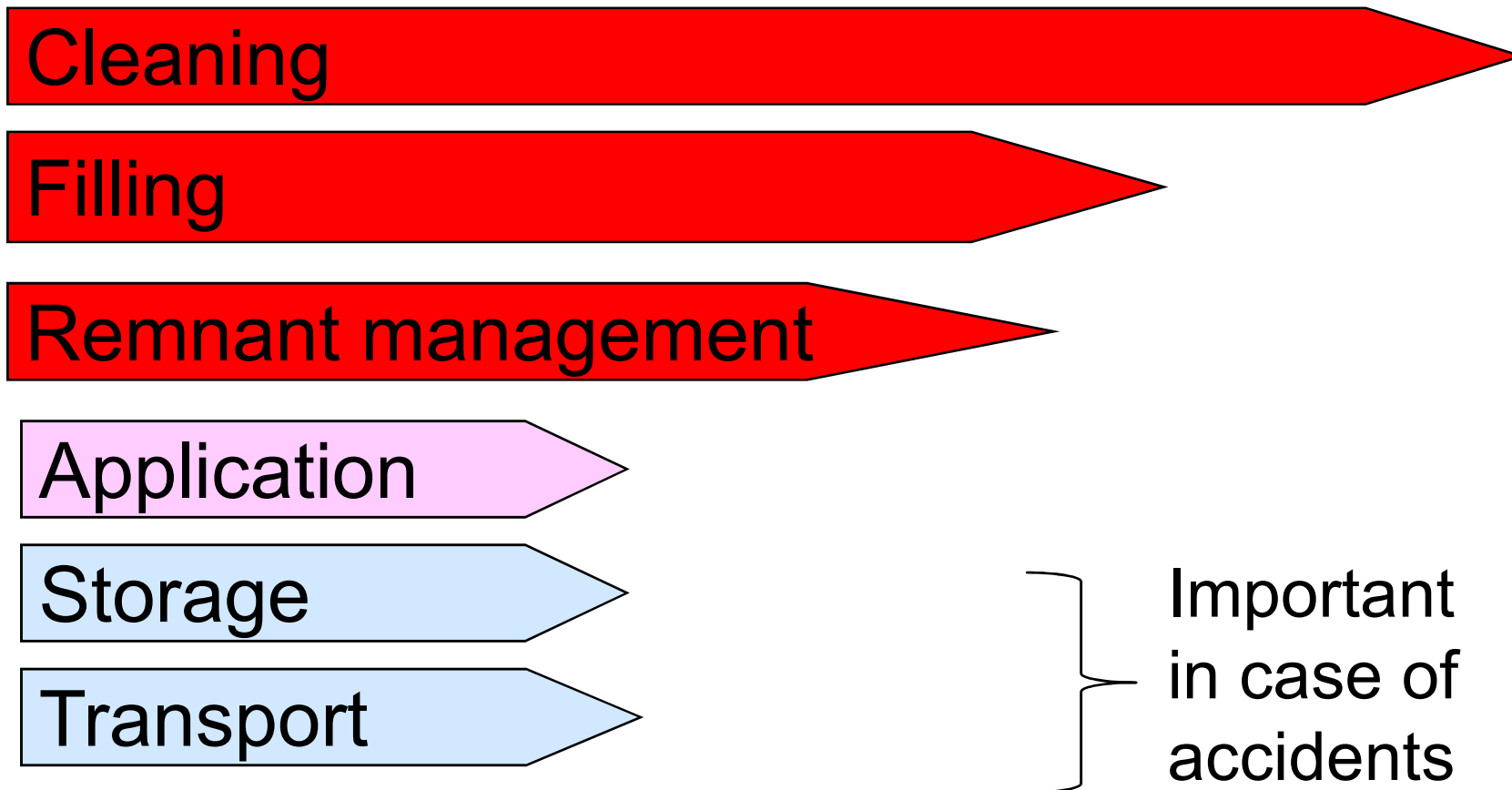
Group 3

Evaluates the risks high but not differentiated

Farmers perception of point source risks by work processes. (scale 5 high, 1 low risk)



Risk evaluation by TOPPS – Experts



C. Best Management Practice (BMPs)

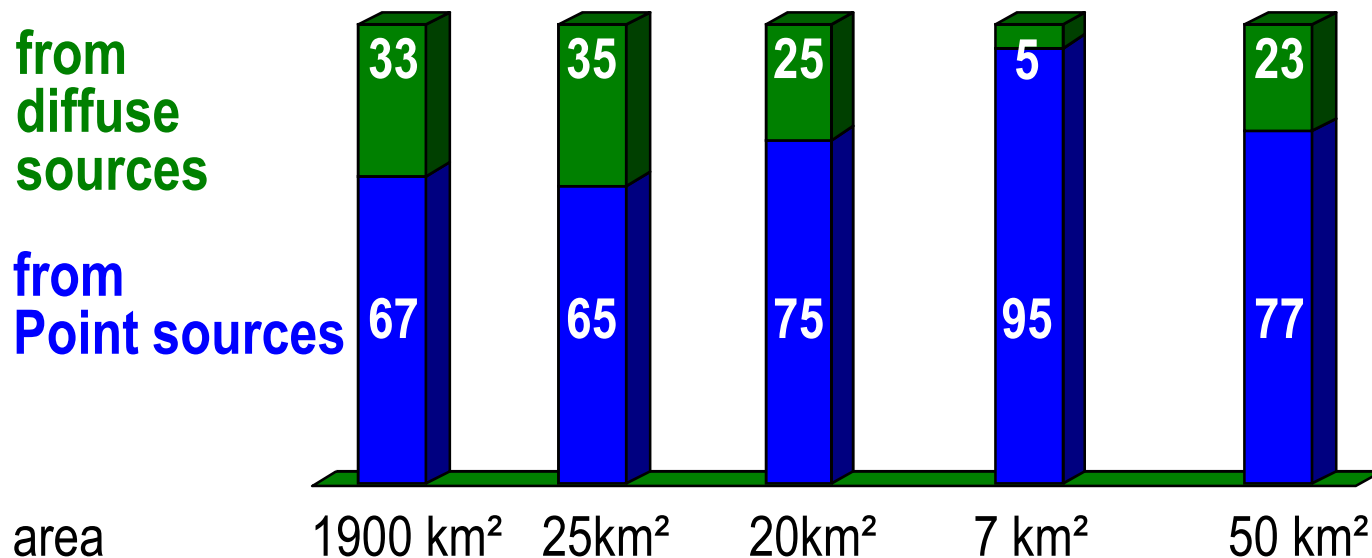
**WHAT + HOW
TO DO THINGS**

Correct cleaning / rinsing of sprayers is most important aspect to reduce the risk for PPP – point source pollution

What we know from research

Example: Germany University Giessen

5 Catchment areas in Hessen/Germany

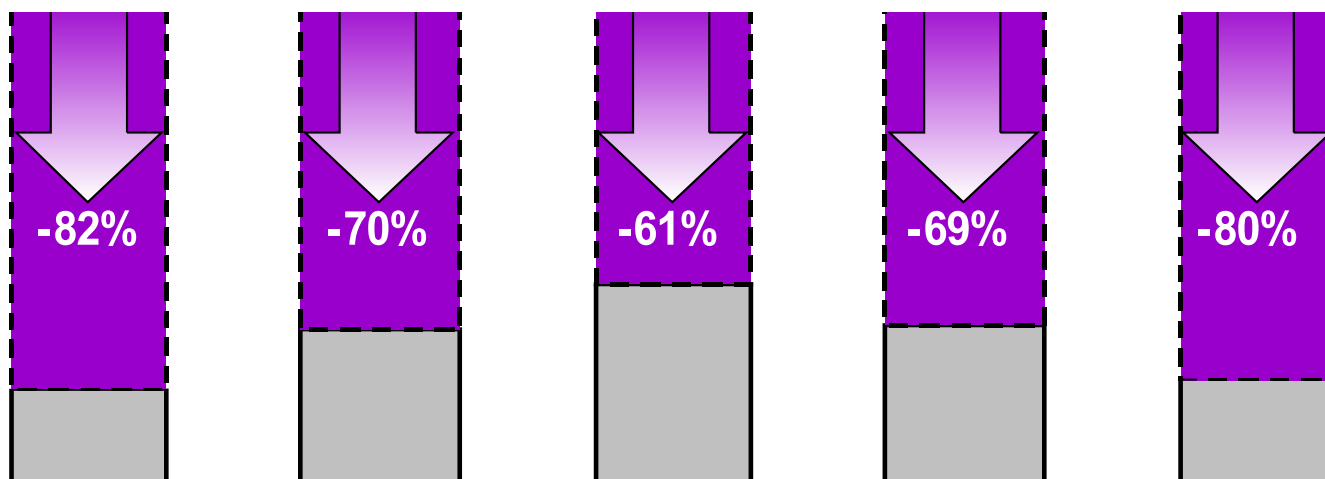


POINT SOURCES CONTRIBUTE > 50 %

What we know from research

Example Germany: University Giessen

Rel. reduction of PPP pollution in 5 catchments sewage plants



Cleaning of sprayers was done in the field
Result: Point source pollution could be reduced by about 70%

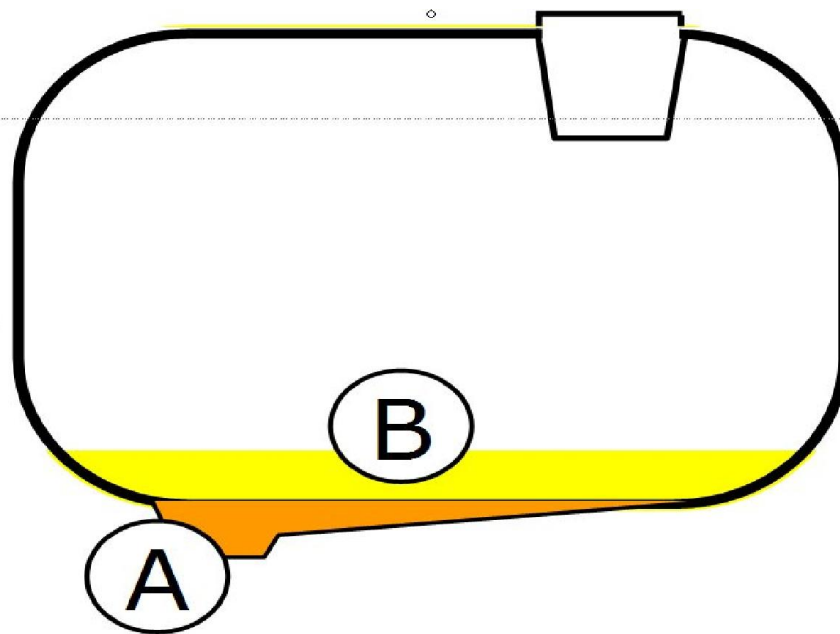
Why is cleaning of sprayers in the field so important ?

Due to technical limitations there will always be a residual spray volume left in the sprayer even when air blows at the nozzles

(Volume A – pump does not suck completely, remnants in pipes and devices)

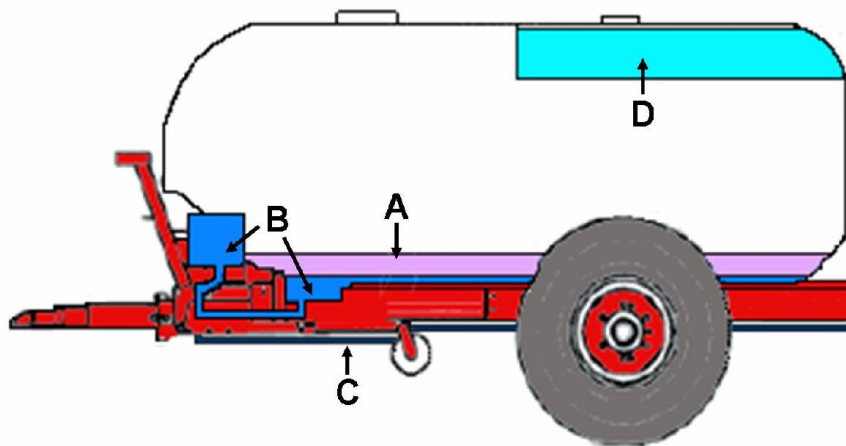
If the needed spray volume is not calculated precisely or the sprayer is malfunctioning more than the technical residual volume can remain in the sprayer after the application

(Volume B – Left over)



**AVOID LEFT OVER SPRAY AND FOLLOW BMPs FOR
INSIDE CLEANING / RINSING**

Residual volumes definitions



A: Left over spray (more than is needed for a area)

Total residual volume

Spray mixture which remains in the sprayer, which cannot be delivered with the intended application rate

(B+C)

Indicated: 25% drop of pressure shown at manometer

B: The dilutable volume is defined as the part of the total residual that remains in the tank or that can flow back to the tank during normal sprayer operation

C: non dilutable volume is part of the total residual that cannot flow back to the tank during normal operation of the sprayer.

D: Rinse water tank should be 10% of nominal tank volume or 10 times dilutable volume (EN 12761)

EN – Standards for total residual volumes

Current standards for Fieldsprayers

Total residual volume in l (EN 12761-2)				
Tank		Boom		Total litres
Tank volume	0, 5 %	length m	2l / m	
800	4	15	30	34
3000	15	21	42	57
4200	21	36	72	93

Current standards for Orchard/Vine sprayers

Total residual volume in l (EN12761-3)		
Tank volume	%	Total litres
400	4%	16
800	3%	24
1500	2%	30

Standards serve as an guideline for application techniques requirements

If the cleaning / rinsing is not done properly some of these residual volumes may end up in the water

Arable Farmers clean their sprayers 7 to 10 times / season*

*TOPPS farmer surveys

Residual volumes: worst case risk if residual volume ends up in water without prior cleaning / dilution (assumption based on standards EN 12761)

Model calculation

Assumption: 250l / ha and 1000 gai / ha

Fieldsprayer	Residual		
	Spray l	g ai	10 cleanings
800 l	34	136	1360
3000 l	57	228	2280
4000 l	93	372	3720

Fieldsprayers

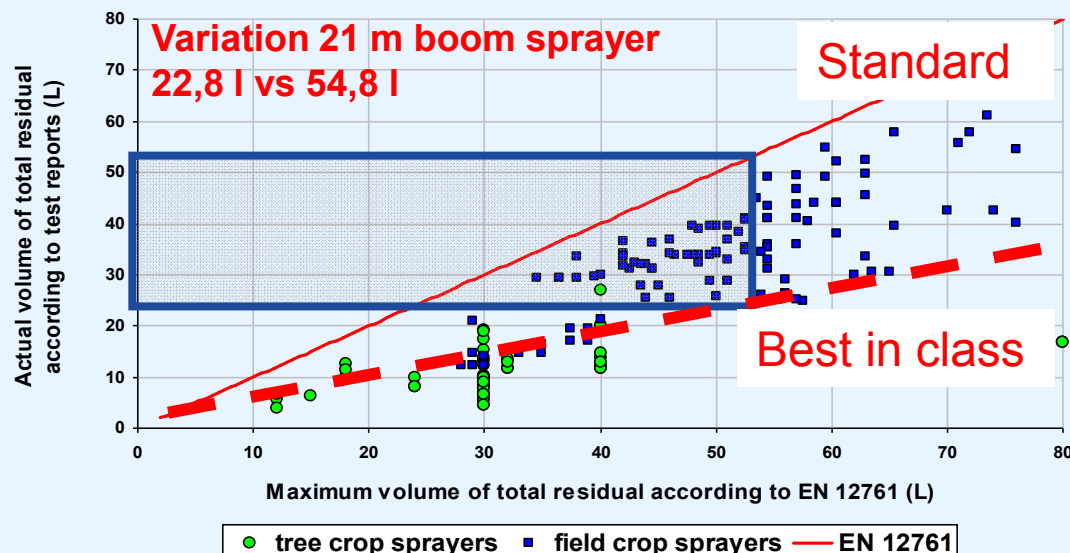
Assumption: 250 l/ha and 2000 gai / ha

Orchard sprayer	Residua		
	l	g ai	10 cleanings
400 l	Spray l	128	1280
800 l	16	192	1920
1500 l	24	240	2400
	30		

**Orchard/Vine
sprayers**

Best sprayers have 50 % less residual volume than required by the standard EN 12761

Actual volume of total residual of 163 sprayers according to test reports compared with the maximum volume of residual stated by the European Standard EN 12761 (for 25 tree crop sprayers the total dilutable volume was used due to missing data)



Sprayer - tests

All tested sprayers reached the standard but

Technical solutions available are already much better than the standard

ENTAM
European Network for Testing Agricultural Machines

Sprayers with lowest residual volumes mean reduced losses of biological efficacy, lower risk of damages in following crops, lower risk for PPP - water pollution



Do you know the
technical residual
volume which remains
in your sprayer



In TOPPS surveys we have seen that the perception of residual volumes is weak and varies strongly

Recommendations:
Residual volumes after application should be diluted with clean water and sprayed out in the last treated field

Required:
Clean water tank

Follow the recommended procedure in detail

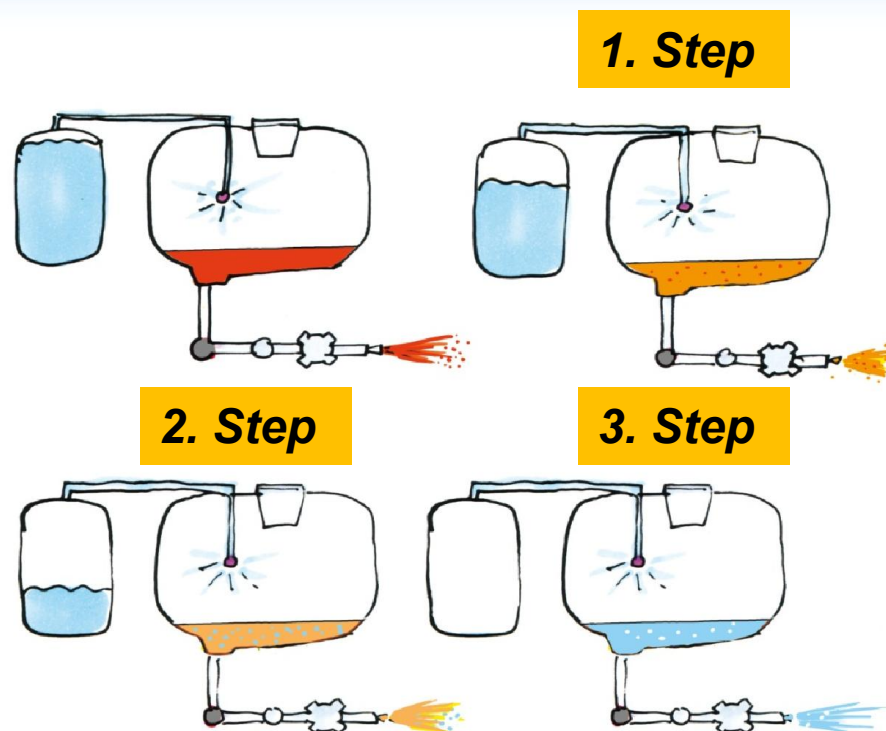
Principle:
Bring only the minimal amount of contaminated residual liquid back to the farm if any.

Check your local regulation !
Regulations vary in EU
Example: If dilution of residual volume achieves 1 % all residual liquid can remain in the field (FR)

Triple rinsing procedure

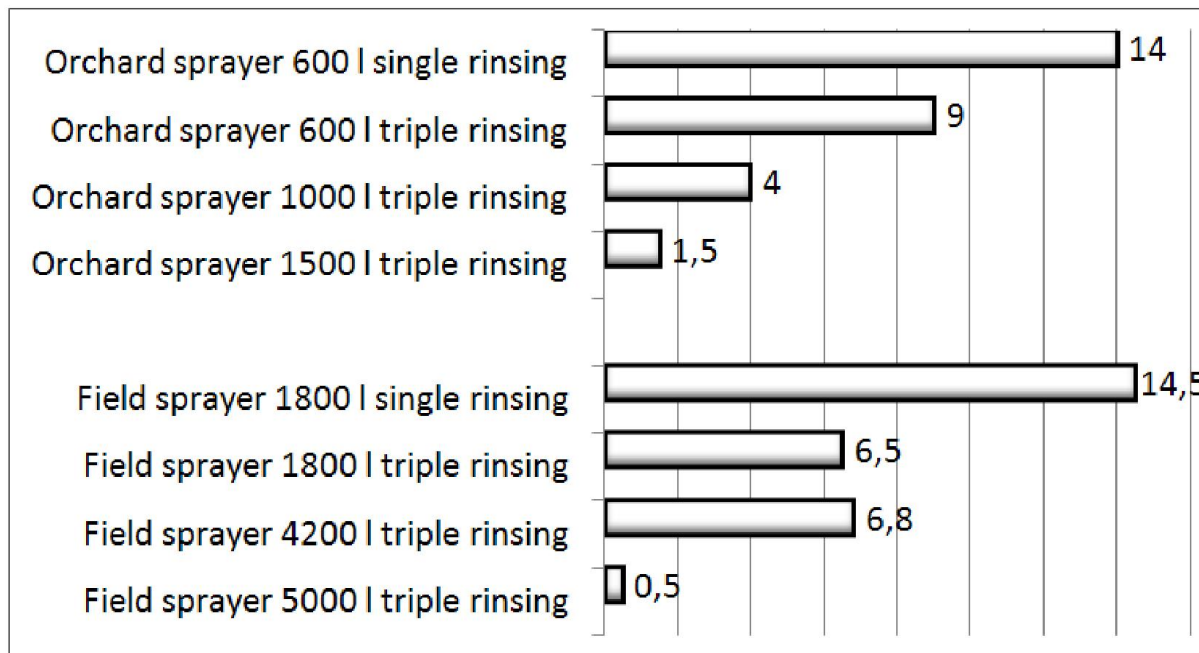
Rinse water is added to the residual volume in the sprayer in 3 steps

After each step the diluted residual liquid should be sprayed out in the last treated field



If not automated this procedure needs some time, because each rinsing step requires the operator to step down from the tractor etc.

Residual volume concentrations (%) depend on sprayer design and rinsing procedures



Measured in tank sump : Wehmann JKI

ASK MANUFACTURERS WHEN PURCHASING A NEW SPRAYER

Continuous rinsing procedure

(TOPPS – clean)

Second pump delivers rinse water through inside rinse nozzle into spray tank.

Sprayer pump pushes diluted liquid continuously out

Procedure can be operated from tractor (faster / more convenient)

Second pump should deliver water volume of about 90% of total nozzle output capacity for best results

Faster, more convenient for operator



Upgrading kits available

Small sprayers: Second pump propelled by tractor electric system

Bigger sprayers : Second pump propelled by tractor hydrolic system
(cost ca. 600 to 1500 .- €)

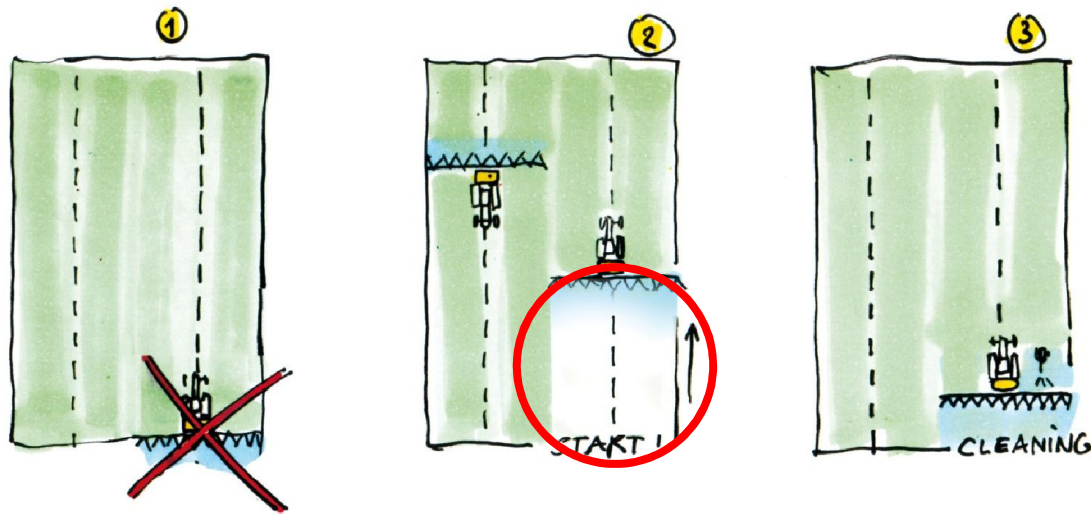
Inside cleaning nozzle improves internal cleaning effect

Rotating nozzle

Tank design and number of rinse nozzles should be optimized that rinse water could reach all areas of the spray tank



Diluted residual volume should be sprayed on an area which was left untreated



1a. Cleaning - inside

Draining of undiluted residual volumes is a big point source risk

Draining of diluted residual volume only when no contact to water (in field or collected)

Draining of residual volumes on hardsurfaces on farm yards should be avoided at all

Cleaning of sprayers should to be done on biological active surface, but make sure that no washing water reach surface or ground water (keep a safe distance)



Outside PPP
contamination
especially for
sprayers
operating with air
support can be
high



Outside contamination

Orchard/Vine sprayers

Outside contamination of orchard sprayers were measured between 0,33 to 0,83% of the applied amount in Italy (Balsari et al 2006)

In Belgium active ingredients on orchard sprayers were found between 82,5 and 207 g ai / ha in a spray season (Debaer et al. 2008)

TOPPS recommends to clean sprayers from the outside in the field (Cleaning device required)

or clean the sprayers on farm when washing water is collected or cannot reach water

Never park sprayers in the rain

Outside cleaning device and cleaning in the field

Example: 25 l washwater 4 bar remove deposits 97,5 % after 10 hours (dry) 25 l washwater removes 70% or 125 l of washwater remove 97,5% (Debaer 2008)

High pressure cleaners were most effective



Outside contamination

Fieldsprayers

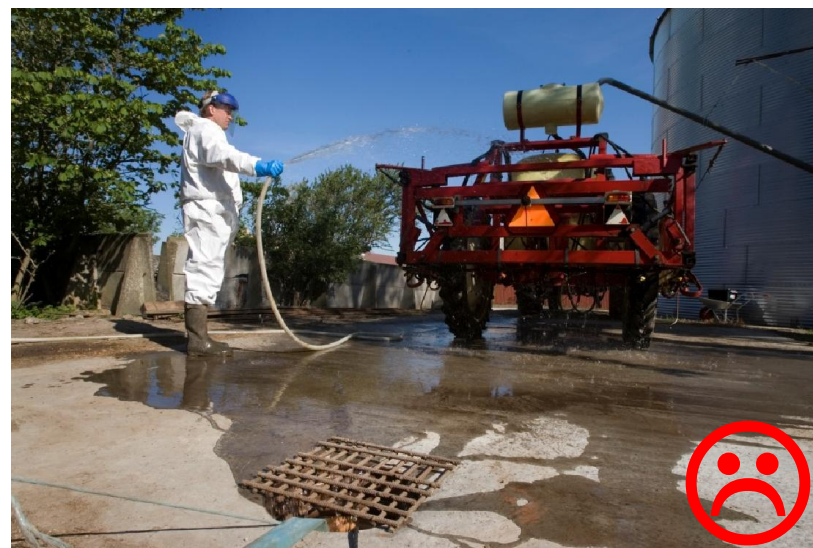
Outside contamination measured 0,01 to 0,1 % of applied amount, air assisted fieldsprayer 0,47% (Wehmann 2006),

Model calculation

Assumption: 1,5 kg ai / ha and year contamination about **0,15** to 1,5 gai/ha

for air assisted fieldsprayer about 7,5 gai/ha

(100 ha > than 15 gai / year)



Not correctly managed empty packages can be an important point source risk

Clean

Store

Disposal

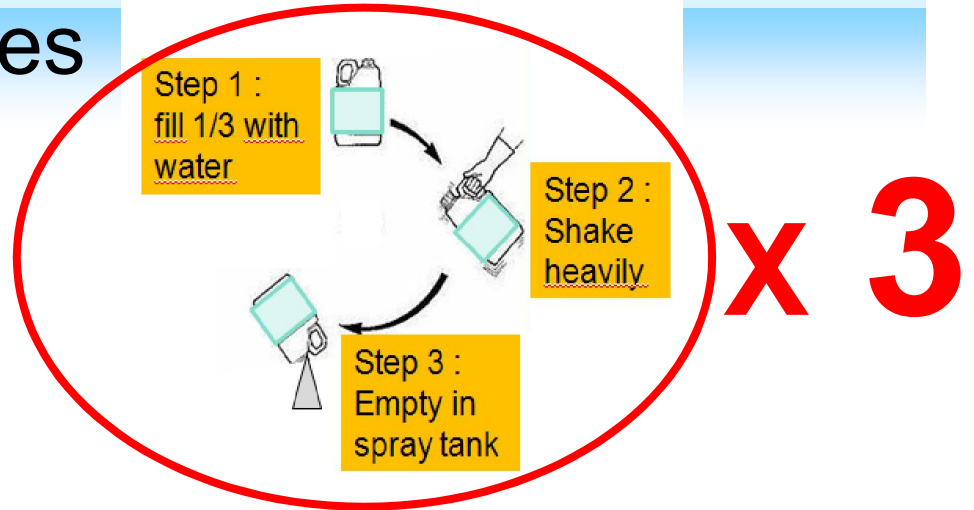


How to clean packages

two options

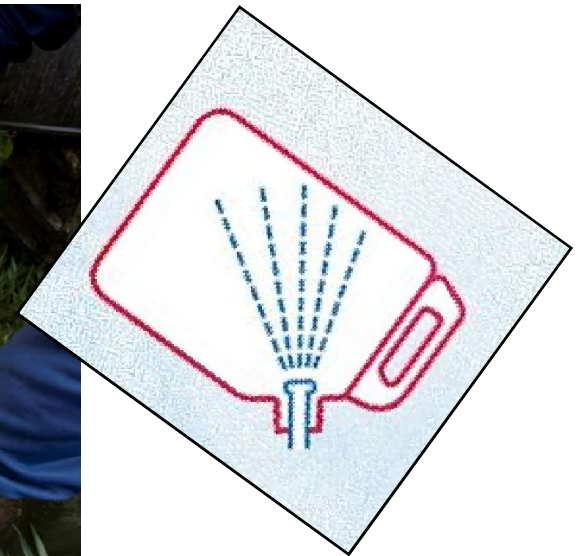
Triple rinsing

Fill container with 1/3 of water
 Close container and shake heavily
 Empty rinse water into spray tank



Execute procedure 3 times

Use container rinse nozzle in the induction hopper
 High pressure



Do not forget the seals !

Research showed that not cleaned and thrown away seals can be an important point source

Clean seals

Put seals in induction hopper and rinse with clean water

Clean seals with water and put them in a cleaned empty container or in a separate bag

check detailed requirements with your packages collection scheme



1c. Cleaning - packages

Store cleaned empty packages in a dry and protected place



Do not burn or bury empty containers



Disposal of empty packages

Follow label
recommendation

Follow approved local
regulations

Use a empty container
collection service

**Here we can include
some info from the
local recovery
scheme**

Filling requires precautionary measures to avoid spilling and overflow of the tank

Two options

- **filling in the field**
- **filling on the farm yard**

Two aspects

- **Filling of concentrated PPP**
- **Filling of water**

More than 85 % of farmers fill sprayers on their farm mostly on hardsurfaces (TOPPS surveys)

On farm

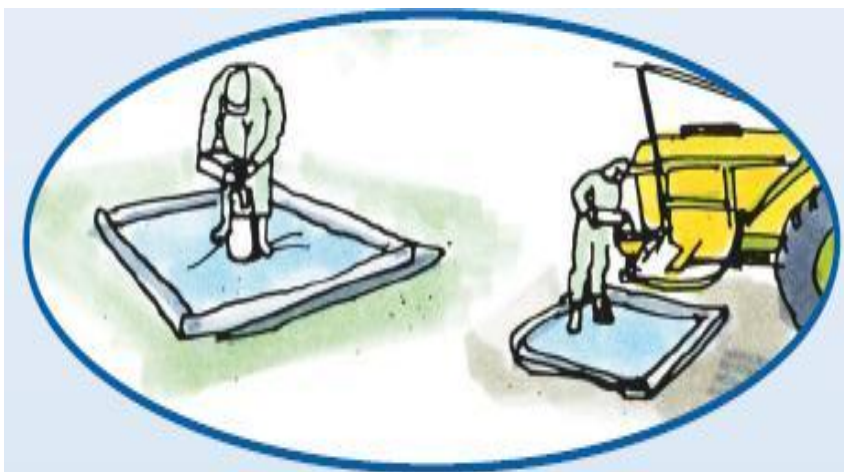
(investment in precautionary measures)

- Fill on dedicated place
- Fill only if precautionary measures taken to collect any spills
- Avoid any drainage to surface water

In the field

(low investment)

- Vary site of filling place
- Keep adequate distances to water bodies



... When did you last spill your coffee



Working with liquids mean, spills happen

but you can prepare for it



... ONE SPILL IN THE WATER IS TOO MUCH

How to manage spills?

Reduce risk for spills

Induction hopper with rinsing nozzle for container cleaning.
 PPP is transported into spray tank without climbing on the sprayer



How to manage spills?

Collect spills

- Fill on a **filling place** where you can collect spills and overflow (slurry tank, collection tank, check local regulations)
- Treat collected spills or overflow in **biofilter** (check local regulation)
- Fill on an **biobed**, where spills and overflows are collected and degraded (check local regulations)

(further information see section remnant management)



Filling place connected to slurry tank:LWK-NRW
H.Kramer



Visavis Schweden

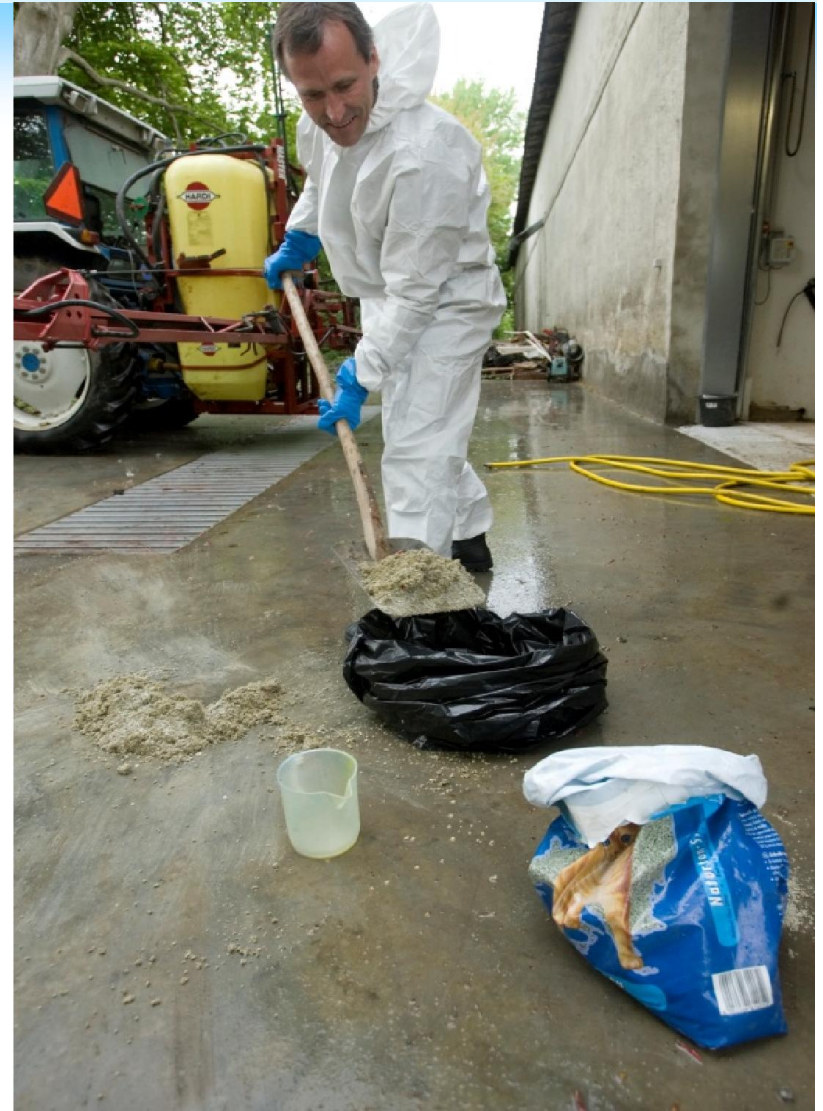
How to manage spills?

Absorb spills

Be prepared
have absorbent material at
hand in case you need it

Sand
Cat litter
Other

Collect contaminated
absorbent material and
distribute it in the field, or in
biobed, biofilter



Filling water in sprayer tank

Precautionary measures
to protect water source

Select a secure filling
place

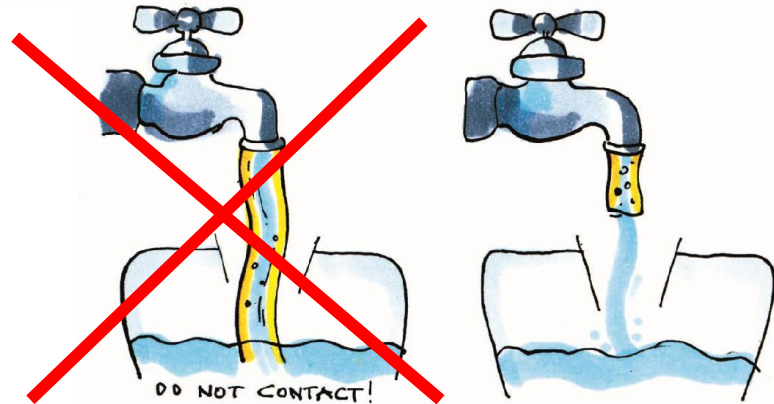
Fill correct amount of
water

Avoid tank overflow



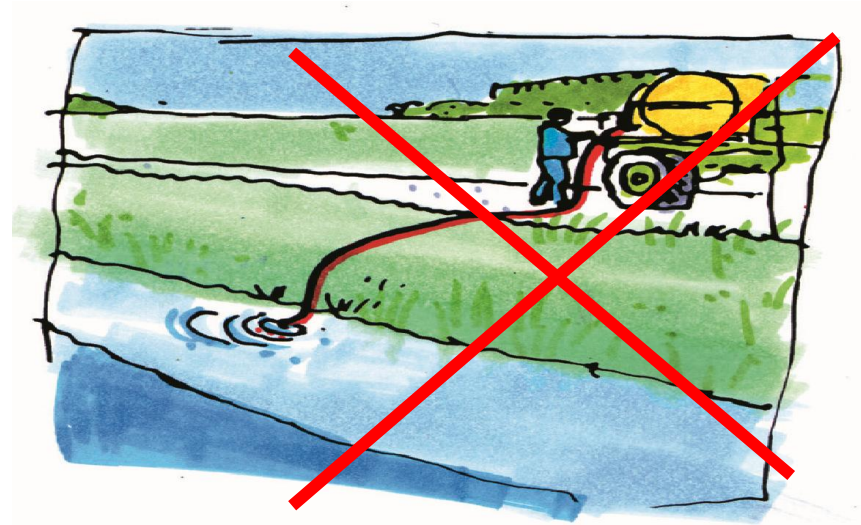
Precautionary measures to protect water source

Never get your water network directly connected with spray liquid (prevent backflow – valve)



Do not source water directly from a ditch or well

Always use an intermediary tank to ensure direct contact to water body is not possible

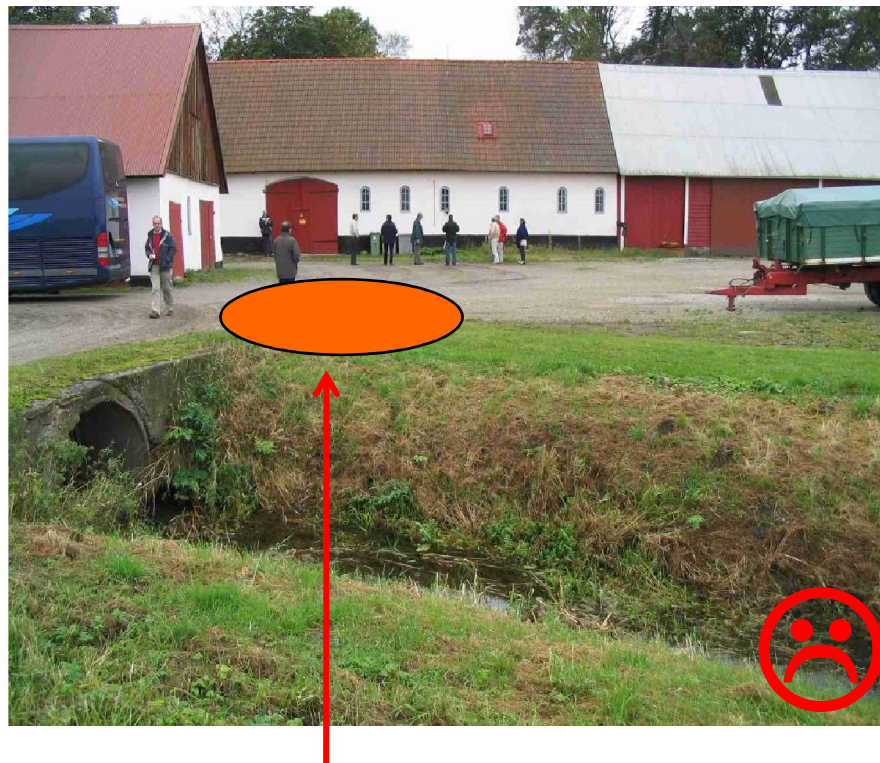


Select a secure filling place

Select a filling place where contact to water is avoided (Examples)

- filling place where overflow can be collected (Biobed, Slurry tank)
- filling place in the field, which is distant from surface water

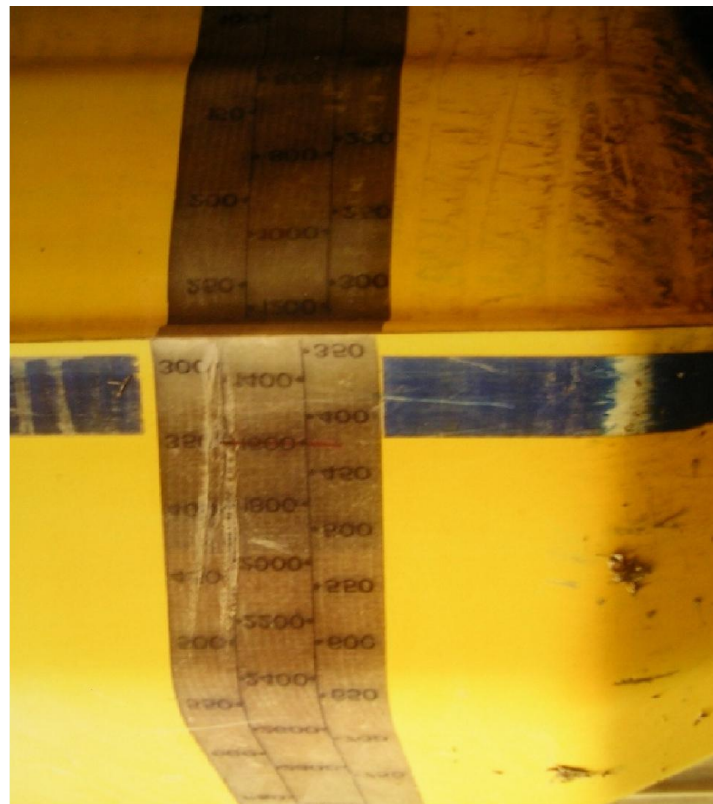
Always check your local distance requirements



This was the sprayer filling place !

Fill correct amount of water in the sprayer

- calculate exactly the spray volume you need to spray your field
- use a calibrated sprayer where you know exactly the spray output for the selected spray parameters
- be sure the amount of water you fill into the sprayer is correct. Often the measuring scales at the tank are not easy readable and as research has shown not very precise



CORRECT SPRAY VOLUME MEANS: MINIMUM SPRAY VOLUME LEFT AT THE END OF THE APPLICATION

Avoid tank overflow

When you fill the sprayer be fully concentrated
(no other side activities !)

Technical installations can mitigate the risk of sprayer overflow

- Tank full alarm
- Filling from an intermediary tank with defined water volume
- Flow meter with automatic water shut off



If the filling and cleaning process is executed as recommended the amount of remnant is very small (PPP- diluted contaminated liquid)

Where do remnants come from ?

- if diluted residual volume cannot be left completely in the field a diluted amount of residual volume will be brought back to the farm
- in sprayers a small volume of liquid cannot be drained completely even if the tank bottom valve is open
- if outside cleaning cannot be done in the field, cleaning may occur on a hard surface on the farm. Contaminated washing waters are a remnant
- Filters , nozzles and other devices on the sprayer which need maintenance can deliver a remnant

What to do with remnants ?

- Remnants can be collected in the slurry (DK, DE)
- Remnants can be collected and treated in a biofilter or biobed (biological degradation) (UK, BE, FR, SE,)
- Remnants can be collected and distributed in a field (if dilution of spray is reduced to 2% - DK)
- Remnants can be treated through other chemical / physical treatments



Regulations in countries are very different. Check with your local authorities what recommendation to follow

3. Remnant Management

Biobeds / Biofilters are considered cost effective solutions for remnant management

(FR, BE, SE, UK ongoing research in other countries)

Principle:

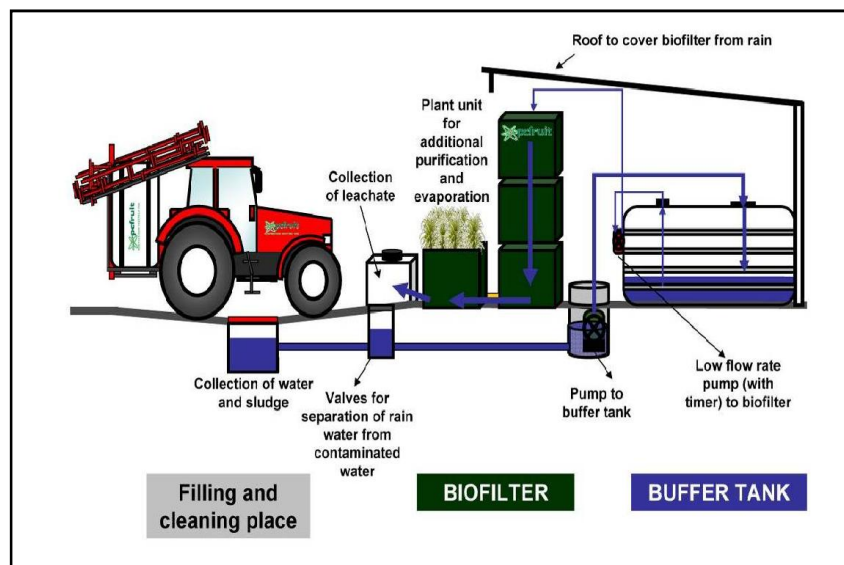
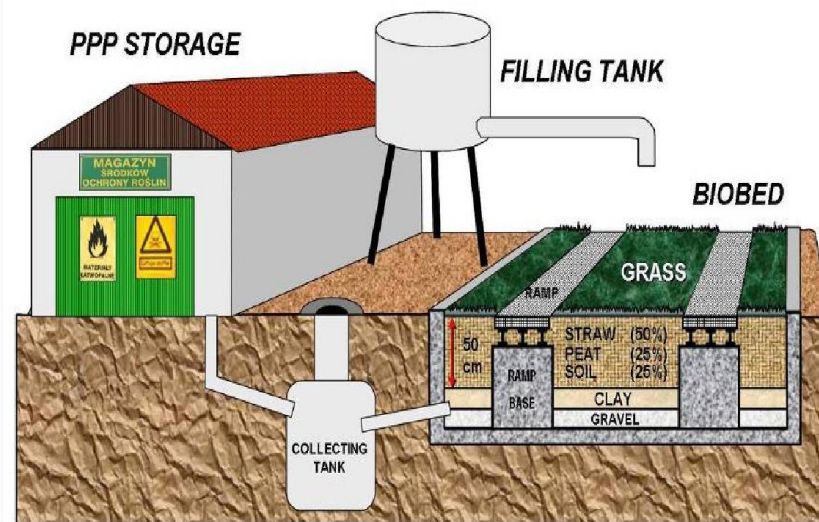
Biodegradation of PPP –
remnants

Biomatrix

Straw or other C – source

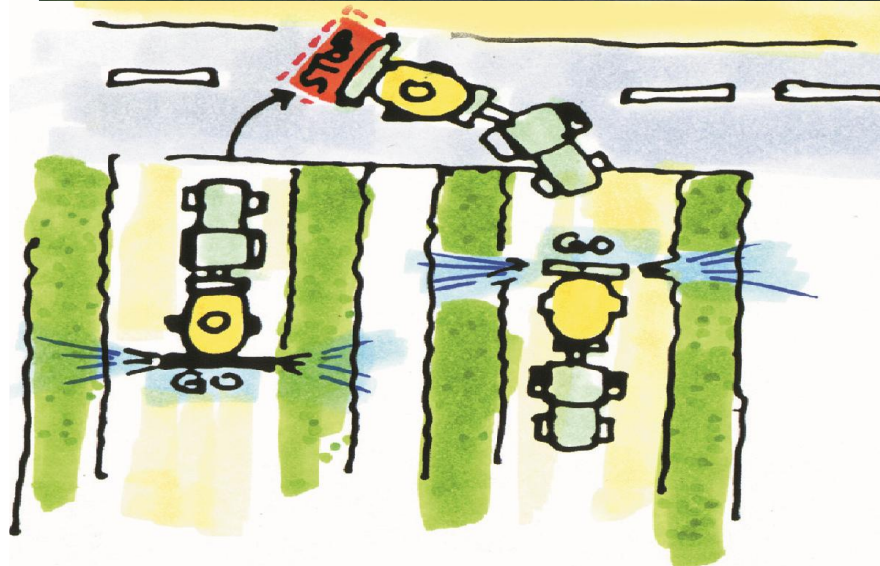
Peat, soil from the field

Details: www.TOPPS-life.org
Biopurification brochure



4. During application

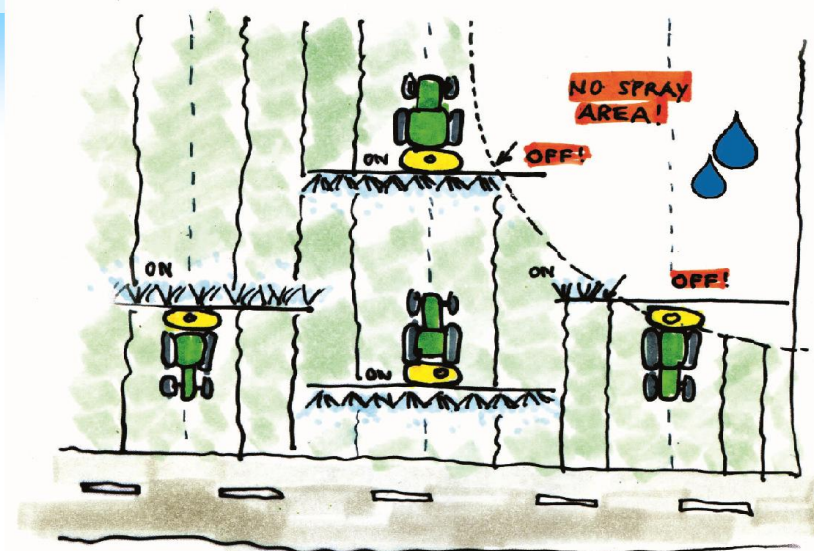
- Do not overspray ditches / water courses
- Do not overspray buffer strips
- Do not spray on field - roads / hard surfaces
(Research showed that this is a significant point source risk especially in Vine / Orchards)
- Switch off your sprayer before turning



4. During application

Carefull planning and full concentration during application avoid point sources

- Consider sensitive areas for water before application and mark them
- Be sure that wells / water sources are well protected



Not well located, constructed and maintained stores for PPP can pose a high risk to water

Depending on the amount of needed storage room different options can be selected

Storage room

Storage container

Storage cupboard

Aspects to consider

Location

Construction

Precautions



Check always local situation and regulation

Location

Away from risky areas
flood, fire, damage protected

Protected against frost and
high temperatures $< 40^{\circ}$
no direct sun light

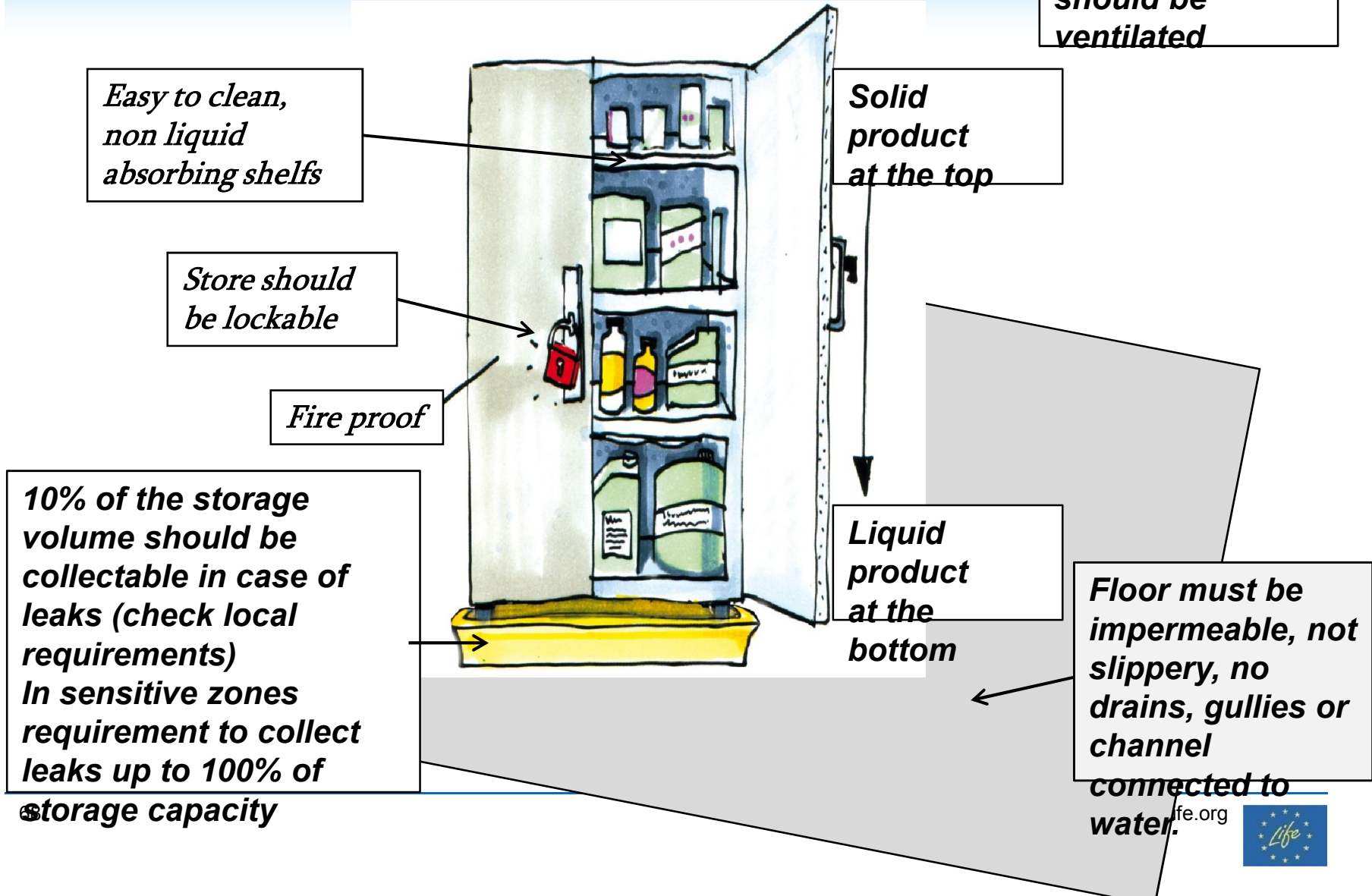
Labour efficient and easy
accessible

Measuring facility in or close to
storage

Appropriate mixing and
loading site close to storage



Construction



Storage
Cupboard, Container, Room



Precautions

Emergency plan
Telefon numbers
List of stored products

First aid

Fire extinguisher



Storage marked, no smoking

Do not store other materials than PPP in a PPP-store

Barrier to avoid leakages out of the storage room

Transport

Two aspects to consider

- from distributor / retailer to farm
- from farm to the field



from distributor / retailer to farm

Supplier of PPPs are well aware of legal obligations when transporting Plant Protection Products (ask for advice)

- get bigger amounts of PPP delivered by your retailer
- if you transport yourself respect the maximal loads you can transport
- transport only PPP - packages in good conditions, in original containers and good readable labels
- transport PPP in a container / box which can collect any spills or leaks (Transportbox)
- **in case of an accident have a mobile phone and emergency telefon numbers at hand**



From farm to field

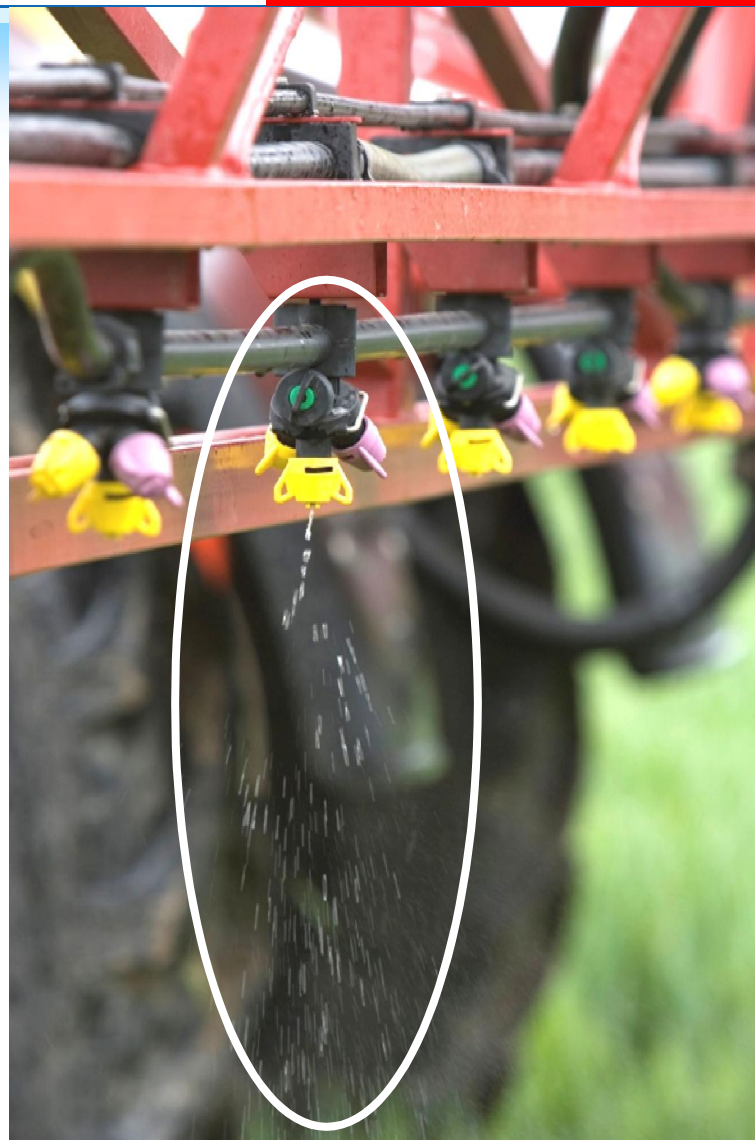
Plan and select a route to the field which has the least risk for an accident

If you fill PPP in the transport PPPs in a stabil, closed and fixed transport box

Make sure that the sprayer is not leaking

Tank lid of sprayer must be tight and closed.

have a mobile phone and emergency telephone numbers at hand



D. Summary



- **Point sources are the major entry route of PPP into water**
- **Point sources can be avoided**
 - ❖ Correct use of PPP
 - ❖ optimized equipment and infrastructure
- **Reduction of Point sources concern every operator of a sprayer**
- **Reduction of point sources is not complex and can be implemented fast (Fast wins)**

Diffuse sources can be reduced by appropriate behavior and targeted mitigation measures at catchment and field level (complex)

Run off from field

- Buffer strips
- Cropping / tillage practices

Drift

- Bigger spray droplets (nozzles)
- Air support
- correct Sprayer adjustment

Drainage

- Buffer strips
- Application timing
- Wetlands