Development of a risk assessment procedure for pesticide application equipment within the framework of article 8 of the EU Directive 2009/128 and development of specific inspection procedures

Marie Stas, David Nuyttens, Bruno Huyghebaert, Johan Declercq, Guillaume Defays, Ingrid Zwertvaegher, Olivier Mostade, Donald Dekeyser
Belgian project SIRA-APESTICON → consortium: \( \text{ILVO} \) and \( \text{cra-w} \)

Objectives:

- to develop and validate a Risk Assessment (RA) protocol according to the Directive 2009/128

- to apply the Risk Assessment protocol on the PAE in use in Belgium

- to develop inspection protocols according to the RA method for the PAE in use not subject to exemption and not subject to inspection for the moment
Determination of the Risk

\[ \text{RISK} \text{ related to a hazard} = \text{HAZARD severity of harm} \times \text{PROBABILITY of occurrence of that harm} \]

Concepts from literature review
- Adaptation to the study case
- Limited by the available data
Risk Assessment related to the use of PAE

Risk before the inspection
- technical dysfunctions

Inspection

Risk after the inspection
= Residual risk

Exemption?

Risk reduction

Risk Assessment completed
Determination of the Risk

Assumptions/simplifications in the Belgian project (SIRA-APESTICON):

- Limit of the hazard situation is the use of the PAE = before (preparation) during the application after (cleaning)
- Hazard situation is related to technical dysfunctions (defects) of the PAE
- Subjects to hazard situations are user, consumer and environment
- Use of the PAE following the Good Agricultural Practices
RISK related to a hazard = HAZARD: severity of harm \times PROBABILITY of occurrence of that harm
∑ Risk of every defects = risk for one machine
Risk of one defect:

\[ \text{RISK for one machine} = \sum \text{Risk of every defects} \]

\[ \text{HAZARD: severity of harm} \times \text{PROBABILITY of occurrence of that harm} \]

Example:
- Risk relative to a leak, to the environment
- Over-dosage, toxic effect on the environment
- Occurrence of technical defects
- Occurrence of a leak on the PAE

**SIRA-APESTICON**
- dependent of technical state of the equipment
- Impact of technical defects on human health and environment
- Occurrence of technical defects

**Example:**
- Occurrence of a leak on the PAE

**Problem statement**

**Objectives**

**Risk assessment concept**

**Risk assessment method**

**First results**
Risk related to a hazard

SIRA-APESTICON
→ dependent of technical state of the equipment

Example:
Risk relative to a leak, to the environment

\[ \sum \text{Risk of every defects} = \text{risk for one machine} \]

Risk related to a hazard

HAZARD: severity of harm

SIRA-APESTICON
→ Impact of technical defects on human health and environment

Example:
Over-dosage, toxic effect on the environment

\[ \times \]

PROBABILITY of occurrence of that harm

SIRA-APESTICON
→ Occurrence of technical defects

Example:
Occurrence of a leak on the PAE

\[ \times \]

Partition technical part of risk vs human part of risk

\[ \times \]

\[ = \]

One type of equipment

Belgian Scale

Risk related to pesticide application
1. Determination of all PAE potentially used in Belgium: 29 PAE (→ 23 priority)

2. Technical description of these 23 priority PAE

3. International inquiry about this issue (PAE inspection, RA, scale of use)

4. International reviewing related to the available inspection protocols

5. National inquiry about the scale use of the 23 priority PAE in Belgium (cfr D. Nuyttens presentation)
6. Determination of all dysfunctions and consequences for each 23 priority PAE

<table>
<thead>
<tr>
<th>Technical defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>RISK related to a hazard</td>
</tr>
<tr>
<td>SIRA-APESTICON → dependent of technical state of the equipment</td>
</tr>
</tbody>
</table>

- List of the **dysfunctions** (= inspected parameters)
- Determination for each dysfunction the **consequence** (= harm) and the **extent** (point, localized, global)

\[
\text{RISK} = \text{HAZARD: severity of harm} \times \text{PROBABILITY of occurrence of that harm}
\]

- SIRA-APESTICON → Impact of technical defects on human health and environment
- SIRA-APESTICON → Occurrence of technical defects
6. Determination of all dysfunctions and consequences for each 23 priority PAE

7. Determination of the occurrence of each dysfunction

\[
\text{RISK} \quad \text{HAZARD: severity of harm} \quad \text{PROBABILITY of occurrence of that harm}
\]

\[
\text{SIRA-APESTICON} \quad \text{SIRA-APESTICON} \quad \text{SIRA-APESTICON}
\]

\[
\rightarrow \text{dependent of technical state of the equipment} \quad \rightarrow \text{Impact of technical defects on human health and environment} \quad \rightarrow \text{Occurrence of technical defects}
\]

Expert judgment

Targets: human health and environment
8. Determination of the severity of harm

\[ \text{RISK related to a hazard} = \text{HAZARD: severity of harm} \times \text{PROBABILITY of occurrence of that harm} \]

- Based on the sprayer inspection in Belgium: Cycle (2011-2013)
Based on the national data given to EUROSTAT: **quantity of pesticides sold** yearly (average for 2011-2012-2013)

- **Distribution** of the a.s. (254) **regarding the PAE**
- **Scale of use** of the PAE (cfr. D. Nuyttens presentation)
9. Determination of the scale of use of each 23 priority PAE

10. Determination of the partition Technical vs Human part of risk

- Based on an European enquiry (experts of PAE inspection)
Risk related to a hazard

SIRA-APESTICON → dependent of technical state of the equipment

Example: Risk relative to a leak, to the environment

Hazards:

HAZARD: severity of harm

SIRA-APESTICON → Impact of technical defects on human health and environment

Example: Over-dosage, toxic effect on the environment

Probabilities:

PROBABILITY of occurrence of that harm

SIRA-APESTICON → Occurrence of technical defects

Example: Occurrence of a leak on the PAE

Risk variation following defects

New inspection protocols

Literature and expert knowledge

29 PAE descriptions
Validation of the method

Application on the PAE already inspected:

- Field crop sprayers
- Orchard sprayers
- Fixed and semi-mobile sprayers
- Disinfection equipment

2 analyzes:

1. Risk reduction of defective parameters (only) 1 machine

2. Risk reduction of defective parameters + «correct» parameters (residual risk) all machines in Belgium (of 1PAE type)
1. Risk of defective parameters (only) for 1 machine

- Before inspection:
  - Gravity before: 9.4, -58%
  - Gravity after: 4.0

- After inspection:
  - Gravity before: 10.0, -67%
  - Gravity after: 3.3

- Before inspection:
  - Gravity before: 13.5

- After inspection:
  - Gravity before: 4.9

2. Risk of defective parameters + residual Risk of « correct » parameters for all machines in Belgium

- Before inspection:
  - Gravity before: 1.293,789, -6%
  - Gravity after: 1.210,435
  - Gravity after: 1.248,201, -8%

- After inspection:
  - Gravity before: 1.145,171
  - Gravity after: 1.789,858
  - Gravity after: 1.658,630, -7%

- Before inspection:
  - Gravity before: 1.789,858
  - Gravity after: 1.658,630

- After inspection:
  - Gravity before: 1.789,858
  - Gravity after: 1.658,630

* Scale of use

Before inspection:
gravity_before*occurrence

After inspection:
gravity_after*occurrence
1. Risk of defective parameters (only) for 1 machine:

   - **Before Inspection:**
     - Operator: 7.3 → 3.1 (-58%)
     - Consumer: 8.0 → 2.6 (-67%)
     - Environment: 10.8 → 3.9 (-64%)

   - **After Inspection:**
     - Operator: 3.1
     - Consumer: 2.6
     - Environment: 3.9

2. Risk of defective parameters + residual risk of «correct» parameters for all machines in Belgium:

   - **Before Inspection:**
     - Operator: 67.325 → 63.380 (-6%)
     - Consumer: 66.264 → 61.292 (-8%)
     - Environment: 96.444 → 90.004 (-7%)

   - **After Inspection:**
     - Operator: 63.380
     - Consumer: 61.292
     - Environment: 90.004

Before inspection:
- gravity_before*occurrence

After inspection:
- gravity_after*occurrence

**Scale of Use:**
- Before inspection: gravity_before*occurrence + gravity_after*(1-occurrence)
- After inspection: gravity_after*occurrence + gravity_after*(1-occurrence) = gravity after

* Scale of Use
Problem statement

Objectives

Risk assessment concept

Risk assessment method

First results

1

Risk of defective parameters (only)  1 machine

Before inspection:

gravity_before*occurrence

After inspection:

gravity_after*occurrence

2

Risk of defective parameters + residual Risk of « correct » parameters  all machines in Belgium

Before inspection:

gravity_before*occurrence +gravity_after*(1-occurrence)

After inspection:

gravity_after*occurrence +gravity_after*(1-occurrence) =gravity after

* Scale of use
**Problem statement**

**Objectives**

**Risk assessment**

**Risk assessment method**

**First results**

---

### Fixed and semi mobile sprayers

#### Risk of defective parameters (only)

1 machine

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before Inspection</th>
<th>After Inspection</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>6.2</td>
<td>2.6</td>
<td>-59%</td>
</tr>
<tr>
<td>Consumer</td>
<td>7.0</td>
<td>2.3</td>
<td>-67%</td>
</tr>
<tr>
<td>Environment</td>
<td>9.3</td>
<td>3.3</td>
<td>-64%</td>
</tr>
</tbody>
</table>

#### Risk of defective parameters + residual Risk of « correct » parameters

all machines in Belgium

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before Inspection</th>
<th>After Inspection</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>58.650</td>
<td>56.133</td>
<td>-4%</td>
</tr>
<tr>
<td>Consumer</td>
<td>56.218</td>
<td>52.997</td>
<td>-6%</td>
</tr>
<tr>
<td>Environment</td>
<td>80.258</td>
<td>76.171</td>
<td>-5%</td>
</tr>
</tbody>
</table>

Before inspection:

\[
\text{gravity\_before} \times \text{occurrence} + \text{gravity\_after} \times (1 - \text{occurrence})
\]

After inspection:

\[
\text{gravity\_after} \times \text{occurrence} + \text{gravity\_after} \times (1 - \text{occurrence}) = \text{gravity\_after}
\]

* Scale of use
To be done:

• RA application to all PAE in use in Belgium

• Global analysis
  Every PAE type gets a relative part of the total risk from PAE in Belgium
  → decision about the Directive 2009/128

• Systemic development of inspection protocols
Thanks for your attention