

*From Denmark to Brussels*

# The Harmonised Pesticide Load Indicator (HPLI)

as a Model for Risk-Based EU Pesticide Governance

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# Structure of my thought

HRI-1 — The governance failure

DK PLI — A decade of policy success

HPLI — Methodological updates for a Harmonised PLI

EU-wide — Governance implications

# HRI-1 — The governance failure

## *A Mandate Without a Scientific Metric*

### **The mandate**

#### **SUD 2009/128/EC**

Requires MS to use ‘appropriate indicators’ to measure progress

#### **Farm to Fork (2020)**

50% reduction in pesticide use and risk by 2030

#### **Instrument deployed**

HRI-1 (Commission Directive 2019/782)

### **The observation**

HRI-1 “does not show how successful the directive has been in achieving the EU objective of sustainable use of PPPs.”  
— **EU Court of Auditors (2020)**

### **Sales Volume ≠ Risk**

No standardisation by application rate. Bias up to 10,000× across active substances (UBA, 2023).

### **Arbitrary weights**

Four category weights (×1, ×8, ×16, ×64) described by the German EPA as “*not scientifically or empirically proven*” — a position endorsed by multiple MS.

### **Bans dominate the trend**

Reclassifying a banned substance retroactively inflates every prior year to ×64. Banning glyphosate alone (even if replaced by an equivalent) would nearly fulfil France's 50% Ecophyto target (Garnault et al., 2024).

# DK PLI — A decade of policy success

## *Why the PLI?*

Over a decade of policy success

Bonini's optimum

Multi-scale and multi-use

Scientific

# DK PLI — A decade of policy success

## *Three Compartments of Intrinsic Hazard*

### **Environmental Fate**

Persistence and transfers

### **Ecotoxicity**

Non-target organisms

### **Human toxicity**

### **Load Score**

Hazard per kg or L of pesticide

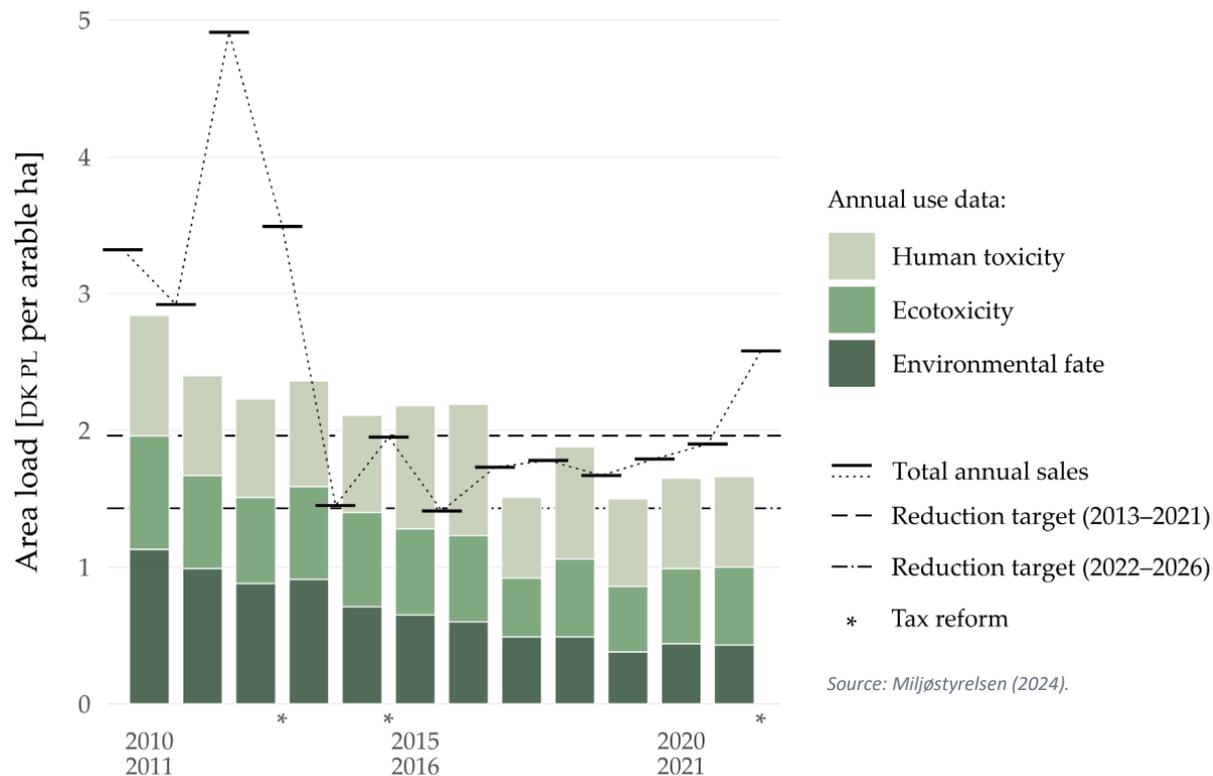
→ Pesticide tax, Pesti-Score

### **Risk Score**

= Load Score × Pesticide Use

→ Hazard per ha treated, Pesticide Load at territorial level

# DK PLI — A decade of policy success



Source: Miljøstyrelsen (2024).

**- 42 %**

Load reduction in 10 years

**Use ≠ Risk**

Use increase while risk decrease

**1 % — 839 %**

Effective *ad valorem* tax range

# DK PLI — A decade of policy success

## *Beyond the Homo Economicus Model*

### Farmers

**74% stockpiled**  
ahead of the 2013 tax

**46% changed active substances**  
24% reduced doses

**Only 7% adjusted crop rotations**

**Demand inelastic to price alone**  
yield risk & professional norms dominate

### Advisors

**Focus on control efficacy**  
and resistance management,  
not on minimising tax

**Shift toward technical optimisation**  
rather than systemic redesign

**Key intermediary role**  
in translating price signals into practice

### Agrochemical industry

**No significant product innovation**  
specific to the Danish tax

**Small market size**  
insufficient incentive for reformulation

# DK PLI — A decade of policy success

## *Four Conditions for Success*

### **Data infrastructure**

Mandatory electronic pesticide used registers at field-, crop- and substance-level

### **Transparency**

Methodology and data publicly documented to enable external scrutiny and methodological updates

### **Polluter pays principle**

Rates high enough to generate meaningful signals; differentiation by load rewards lower-hazard choice

### **Political durability**

Collected tax revenue re-invested in agricultural sector (+ to fund further pesticide reduction policies)

# HPLI — Methodological updates for a Harmonised PLI

## *Five Key Methodological Updates*

### **Consistent hazard assessment at the active substance level**

*Reg. (EC) 1107/2009 at active substance level*

**DK PLI:** human health at product level (including coformulants)

**HPLI:** Standardises all three compartments at active substance level (via PPDB); removes dependence on formulated product labels (industrial confidentiality barrier).

### **Precautionary treatment of missing data**

*Art. 191(2) TFEU; Art. 1.4 Reg. (EC) 1107/2009*

**DK PLI:** missing data assigned null hazard

**HPLI:** Two pathways: conservative threshold substitution for taxation (incentivises data provision); group-average substitution for (comparative) risk assessment

### **Updated metric selection using data coverage thresholds**

*Up-to-date, transparent, reproducible substance perimeter*

**DK PLI:** hazard metric selection based on data availability in late 2000s

**HPLI:** includes latest scientific knowledge by applying a 60% coverage threshold across PPDB metrics; leads 5 env. fate, 4 terrestrial ecotox, 5 aquatic ecotox, 6 human tox for all EU a.s.. Regional versions possible.

### **Absolute normalisation using (regulatory) thresholds**

*Piecewise linear curves approximating non-linear dose–response*

**DK PLI:** wors hazard bounds (per metric) based on 2007 Danish substance authorisations.

**HPLI:** Fixed lower/upper hazard bounds based on regulatory / scientific literature thresholds, leading stable and comparable scores across time and MS.

### **Statistically grounded intra-compartment weighting**

*Weights stable across regulatory contexts; regional contextualisation documented*

**DK PLI:** weights defined by stakeholders' negotiations

**HPLI:** Inverse-correlation weighting via Spearman matrix on full PPDB dataset (metrics capturing unique information receive higher weights). Regional versions possible.

# EU-wide — Governance implications

## *The HPLI as a Governance Multi-Tool*

### **NAP Monitoring & Binding Robust Targets**

HPLI-based baselines embedded in National Action Plans (SUD Art. 4).  
Legally and scientifically verifiable progress against harmonised metric (and against other MS if used at wider scale).  
Based on use data (unlike HRI-1), resistant to stockpiling and ban-substitution artefacts.

### **Legal Accountability (Courts & Audit)**

HPLI as evidentiary benchmark (consistent indicator trends can ground legality challenges), e.g. for Aarhus access.

### **Post-Market Surveillance**

Continuous tracking of substance-level load concentration.  
DK: Lambda-cyhalothrin: 0.2% of sales volume; 23% of total load (Miljøstyrelsen, 2024).  
UK: substitution of neonicotinoid shifted hazard on other non-target organisms (Tzilivakis, 2026).

### **Pesti-Score (Market Design & Decision-Making Tool)**

A-to-E hazard classification on product labels (analogy: Nutri-Score). Placed on product labels, addressing information asymmetry between farmers/advisors and producers. At EU scale, creates upstream reformulation incentives (even without tax) that the Danish domestic market was too small to generate.

# EU-wide — Governance implications

## *Regulatory Obstacles: from Proposal to Instrument*

### Minimum — Replace HRI-1

Revise Commission Directive 2019/782 to replace the HRI-1 computation with the HPLI methodology.

MS continue reporting harmonised scores; the EU Court of Auditors' 2020 recommendation is fulfilled.

Immediate legal basis: SUD Art. 15 + Annex IV revision.

### Ambitious — Binding SUD/SUR Targets

Revised Sustainable Use framework: MS demonstrate HPLI-based progress in NAPs, with binding quantitative reduction targets.

SUR (COM/2022/305) stalled; HPLI provides the credible metric the SUR lacked.

### Data infrastructure exists

Reg. (EU) 2022/2379 (SAIO)

Reg. (EU) 2023/564 (electronic use records)

Reg. (EU) 2023/2674 (FSDN)

Provide legal basis for crop/substance-level use data across MS

### Institutional architecture

Independent HPLI stewardship body: procedural independence from regulated industry, civil society access, revision cycles aligned with NAP reviews (5y) or CAP reforms (7y). PPDB as open-access data foundation.

# Conclusions

## ✓ **The failure is structural**

HRI-1's deficiencies cannot be resolved by adjusting coefficients or freezing baselines. Its architecture is misaligned with the objective it is meant to serve.

## ✓ **The alternative is achievable**

Denmark demonstrates that a hazard-differentiated indicator embedded in binding policy is institutionally feasible. The 42% load reduction (with decoupled TFI) is precisely what EU policy aims to achieve but currently cannot measure. The HPLI enables an EU-wide adoption of the Danish example.

## → **The conditions have EU analogues but require political commitment**

Data (SAIO, FSDN), transparency (PPDB + independent body), revenue recycling. The obstacles are institutional inertia and distributional conflict, not technical or legal impossibility.

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### **Key references**

#### **This paper (preprint)**

Vandevoorde & Baret (2026). From Denmark to Brussels: The Harmonised Pesticide Load Indicator as a Model for Risk-Based EU Pesticide Governance. Workshop paper, UCLouvain Saint-Louis.

#### **Methodological companion**

Vandevoorde, Kudsk, Agnan & Baret (2025). [Five methodological updates of the Danish Pesticide Load Indicator to support EU-wide pesticide risk reduction policies](#). Env. Res. Let., **20** 124070.

#### **PhD dissertation**

Vandevoorde (2025). [Three tools for the reduction of pesticide impacts. A case study in the Province of Luxembourg](#). PhD thesis, UCLouvain, Belgium.