Evolution of P-Loss Risk Assessment Tools

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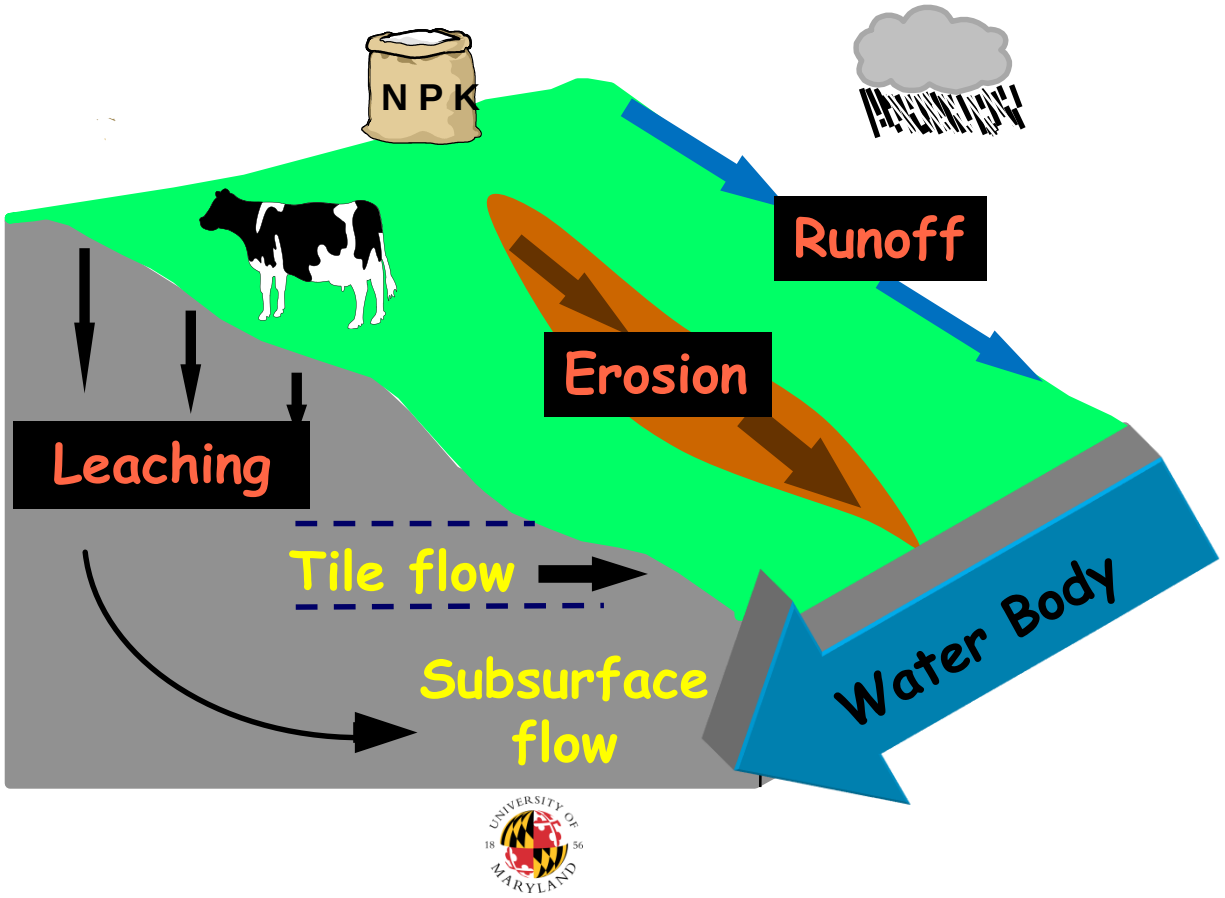
Eutrophication is a Water Quality Impairment Linked to Agricultural Land Uses

- Nitrogen and/or phosphorus over-enrichment of surface waters
- Results in excessive algal growth
- The limiting nutrient for algal growth
  - Phosphorus in fresh waters
  - Nitrogen in saline waters
- In coastal estuaries, the limiting nutrient changes with water mixing, location and season

Impacts of Eutrophication

- Low to no oxygen in deep and/or unmixed waters (“hypoxia” and “anoxia”)
- Decreased water clarity in shallow water
- Non-useful species or inadequate population distribution of phytoplankton for filter feeder consumption
- Increased number and severity of harmful algal growth

Assessing P Losses:
P Sources and Transport Pathways



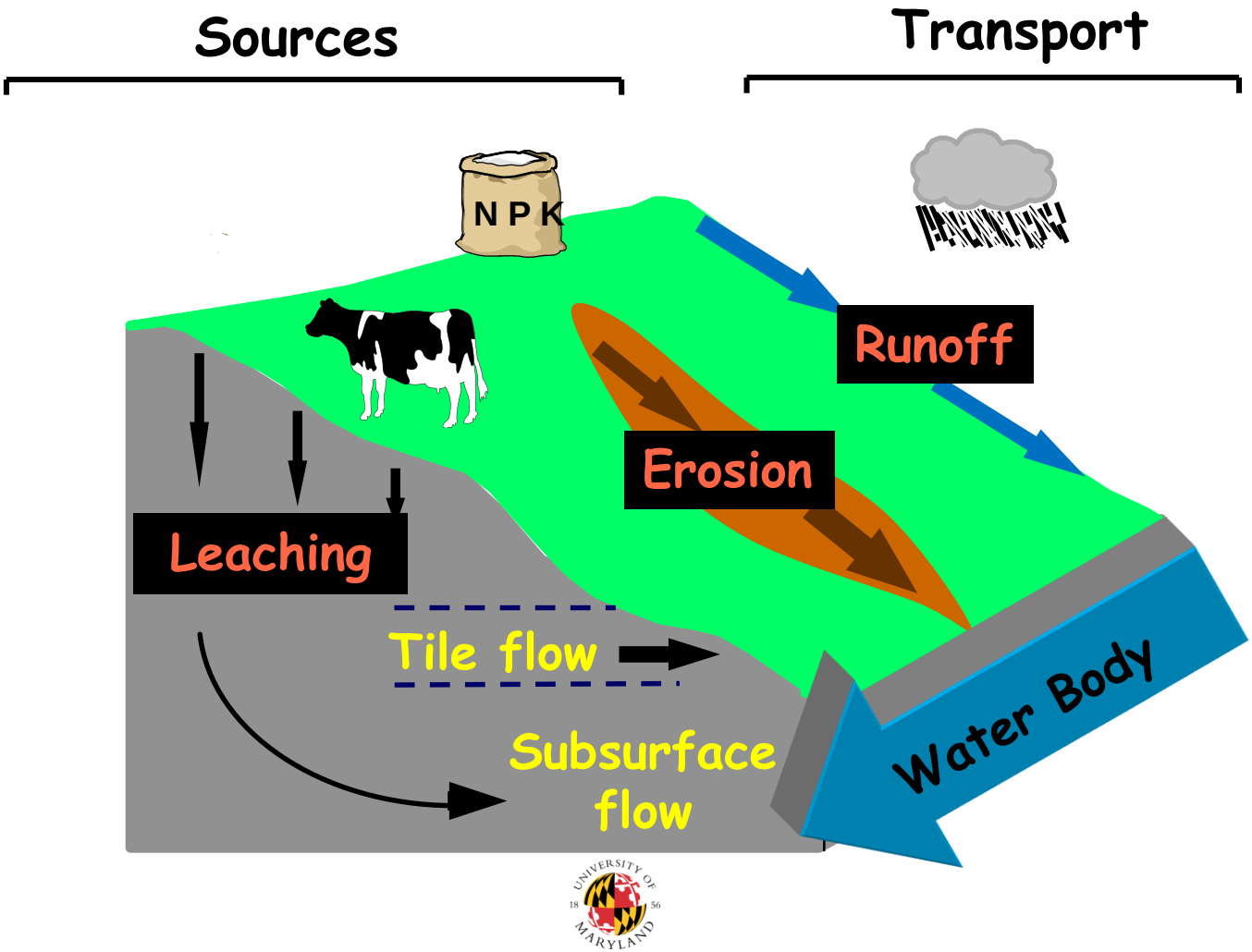
P-loss Risk Assessment Concept

- Lemunyon and Gilbert, 1993.
  - Journal of Production Agriculture, Volume 6, Number 4, pages 483-486

- Phosphorus Index
  - Based on site-specific landform characteristics and management
  - Each site characteristic assigned a relative P-loss risk rating
    - Scale = None (0), Low (1), Medium (2), High (4), Very High (8)
  - Site characteristics assessed (weighting factors)
    - Soil erosion (1.5)
    - Irrigation erosion (1.5)
    - Runoff class (0.5)
    - Agronomic soil test P level (1.0)
    - Fertilizer P application rate (0.75)
    - Organic P application rate (1.0)
    - Fertilizer P application method (0.5)
    - Organic P application method (1.0)

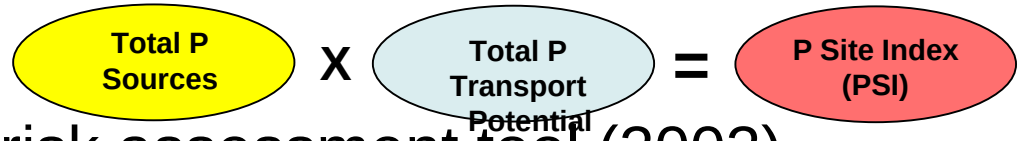
- Site vulnerability for P loss = sum of weighted risk ratings

Assessing P Losses:
P Source Risk and P Transport Risk



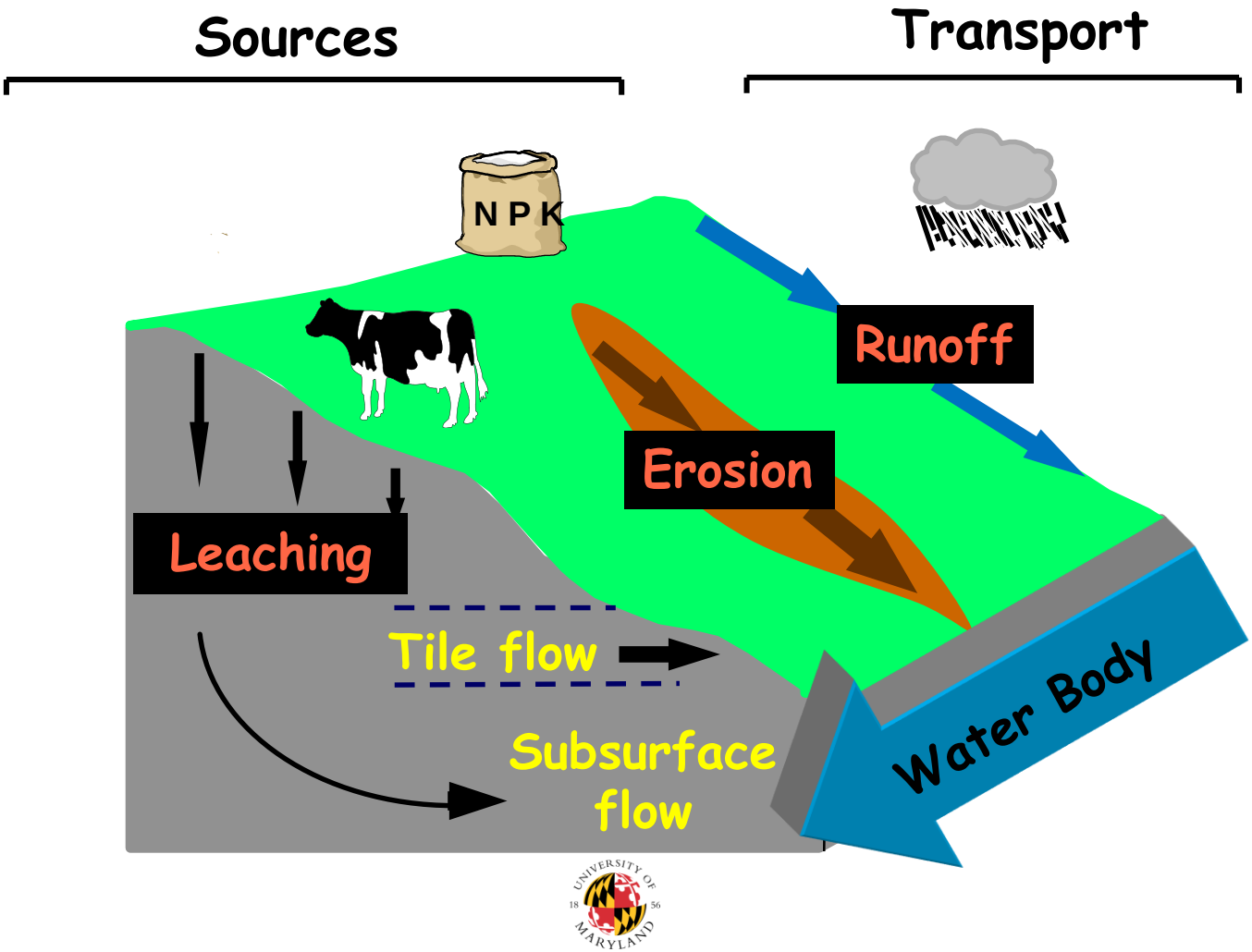
Evolution of P-loss Risk Assessment Tools

- **P Site Index (PSI)**



  - P Site Index ➔ P loss risk assessment tool (2002)
  - Numerical PSI score ➔ Interpretive category
  - Largely based on best professional judgment
  - Interpretive categories ➔ Adjust farm management

Assessing P Losses:
P Source Risk For Each P Transport Pathway



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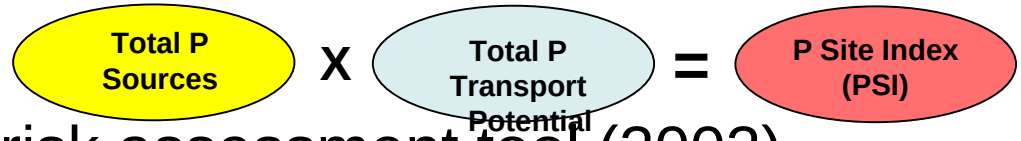

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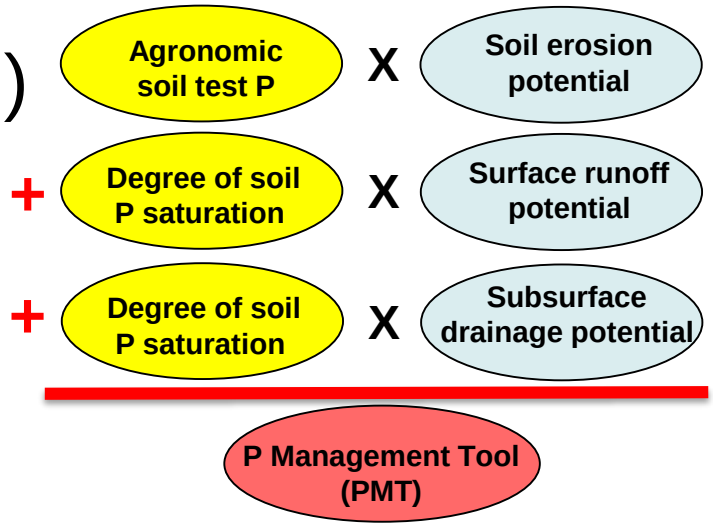
- **Transition: PSI ➔ PMT** (2012)
  - P Management Tool (PMT)
  - Multiplicative ➔ component
  - Represents processes of P loss
  - More complex



Factors Evaluated in PSI and PMT Assessments

	PSI	PMT
Soil erosion loss estimation	✓	✓
Surface runoff potential of site	✓	✓
Subsurface drainage potential of site	✓	✓
P leaching potential of site	✓	✗
Distance from edge of field to surface water	✓	✓
Buffer type and width	✓	✓
Receiving water body priority status	✓	✗
Agronomic soil test P level	✓	✓
Soil P saturation ratio	✗	✓
P fertilizer application rate	✓	✓
P fertilizer application method, placement, tillage & timing	✓	✓
Manure P application rate and P solubility	✓	✓
Manure P application method, placement, tillage & timing	✓	✓

Phosphorus Management Tool (PMT)
Final Score Interpretation

P Loss Rating	Interpretation
0 – 50	LOW potential for P movement from this site given current management practices and site characteristics. Total phosphorus applications should be limited to no more than one three-year crop removal rate applied over a three year period.
51 – 100	MEDIUM potential for P movement from this site given current management practices and site characteristics. Phosphorus applications should be limited to the amount expected to be removed from the field by crop harvest.
> 100	HIGH potential for P movement from this site given current management practices and site characteristics. No phosphorus should be applied to this site

Evolution of P-loss Risk Assessment Tools

- **Transition: PMT ➔ PMT-2** (2015)
  - Replace “best professional judgment” calibration with external calibration data
    - Ideal scenario: calibrate PMT to **measured** P loss data
    - 2nd best scenario: calibrate PMT to **modeled** P loss data

Annual P Loss Estimator (APLE)

- Vadas et al., 2013 (http://www.ars.usda.gov/Services/docs.htm?docid=21763)
- Annual time step
- Edge-of-field estimation
- Simulates sediment and dissolved P surface losses from soil, manure and fertilizer sources
- Minimal subsurface loss or leaching to groundwater simulated

Evolution of P-loss Risk Assessment Tools

- Calibrate PMT-2 using APLE P loss model
  - APLE-modeled P loss from empirical data set (n=10,000)
  - Modified PMT to include coefficients suggested by APLE P loss estimations for each P-loss pathway
  - APLE-modified PMT ➔ PMT-2

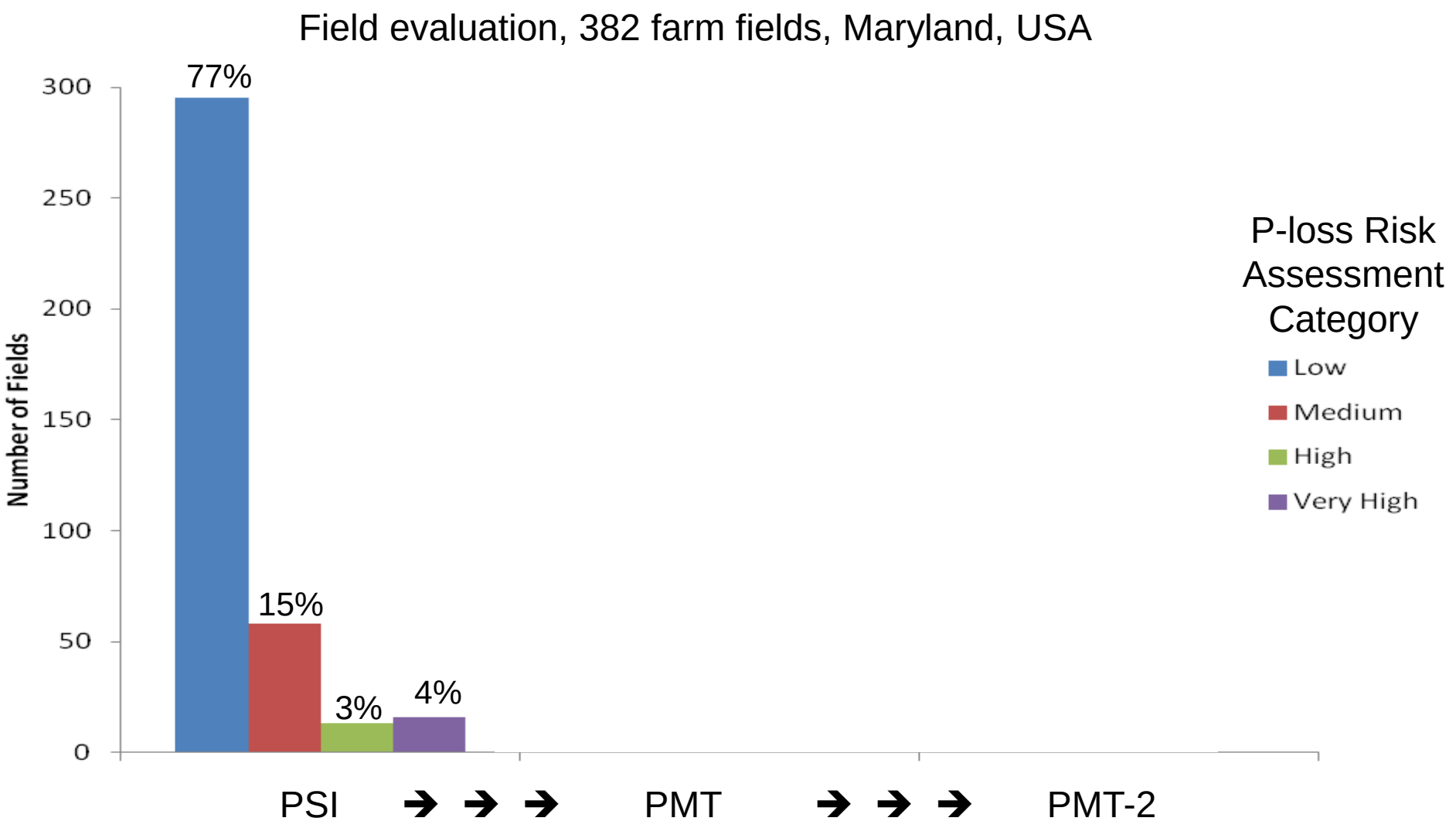
Evolution of P-loss Risk Assessment Tools

- **P Site Index (PSI),** 2002
  - Average transport risk **X** average P source risk
  - Largely based on best professional judgment

- **P Management Tool (PMT),** 2012
  - Represents complex processes of P loss pathways
  - Introduced P-loss risk analysis by pathway components
  - Largely based on best professional judgment

- **P Management Tool – 2 (PMT-2),** 2015
  - PMT calibrated with APLE model derived coefficients
  - Independent calibration with model data

Evolution of P-loss Risk Assessment Tools



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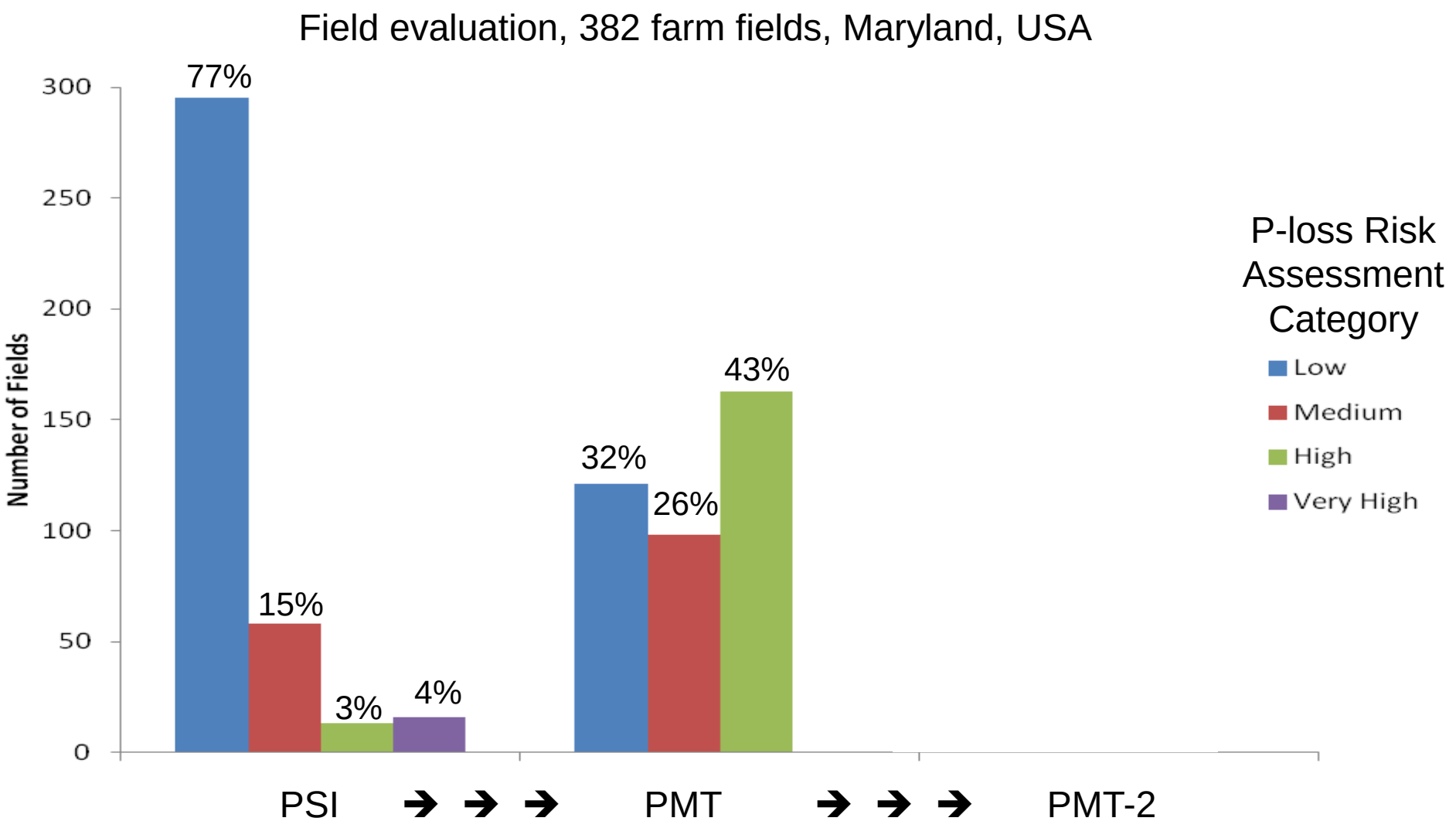

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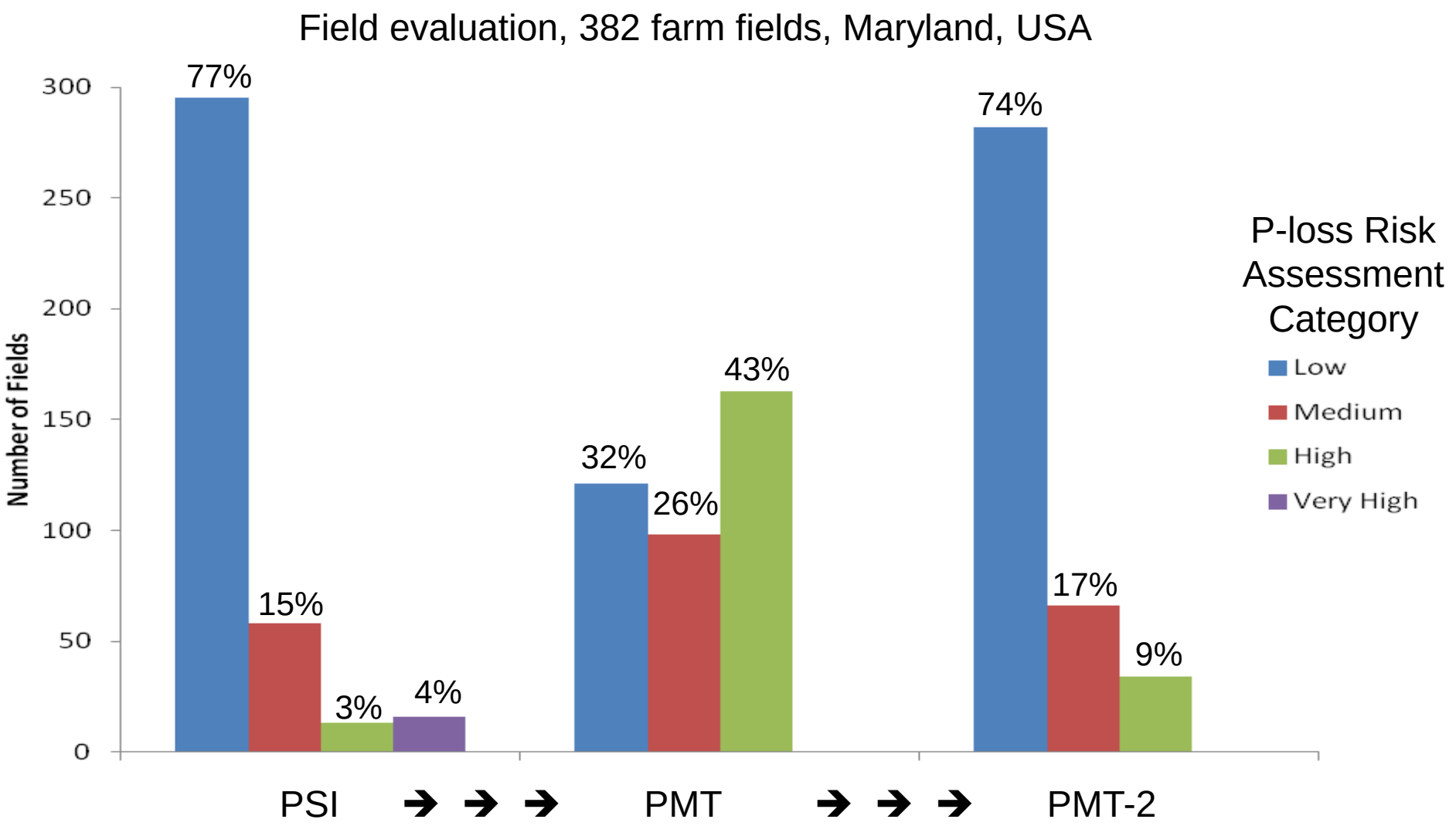

Evolution of P-loss Risk Assessment Tools

- Science and understanding evolve with long-term continuous research efforts.
- Intuitive, best professional judgment-based P-loss risk assessment can be valuable for guiding management.
- Complex risk assessments that mimic physical processes are reliable representations of real-world conditions but are difficult calibrate without independent data.
- Independent model output can be effectively utilized to calibrate process-based P-loss risk assessment tools.

Thank you!

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