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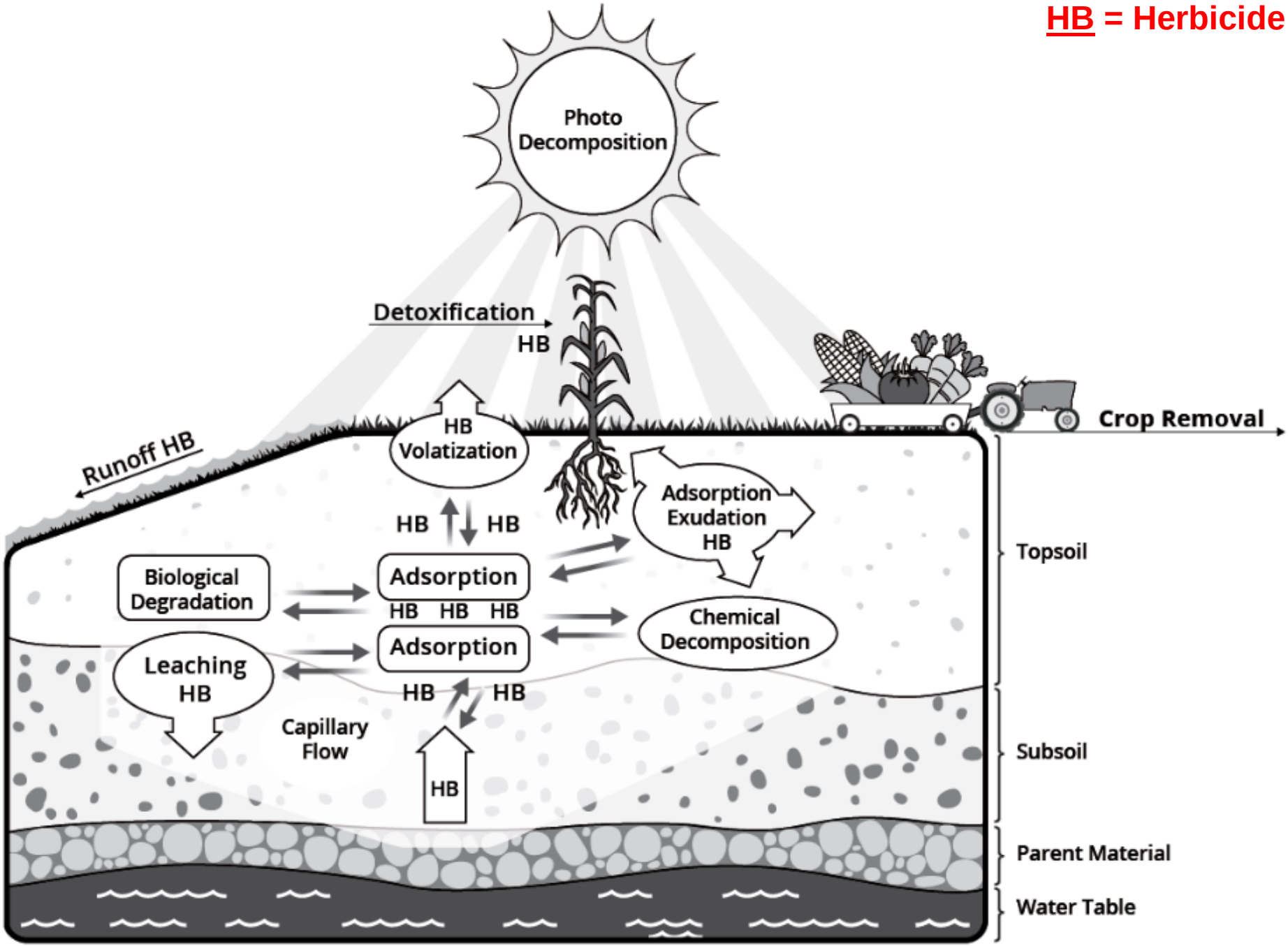
Fate of Herbicides in Soil

Ian Burke and Alan Raeder

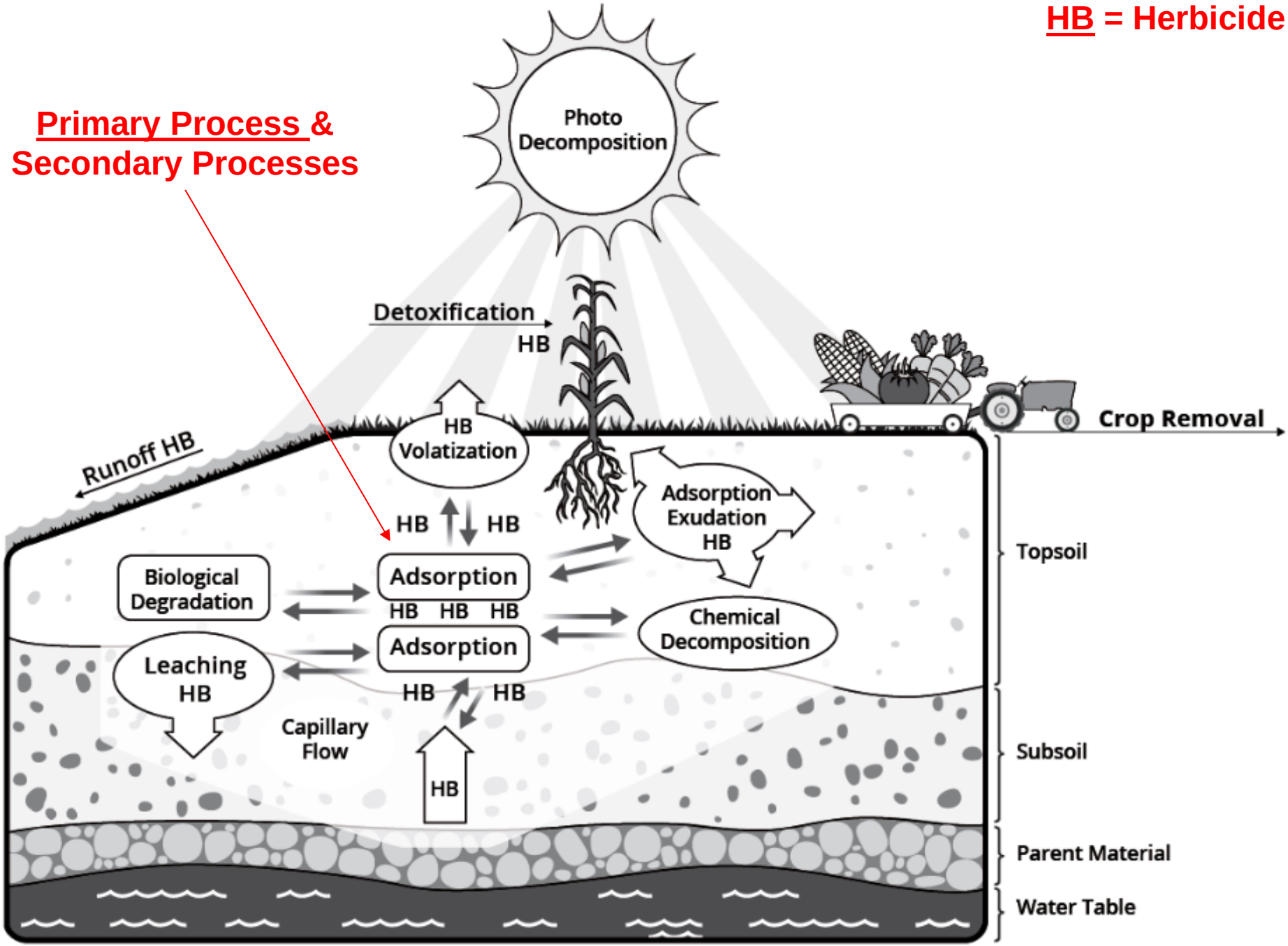
HB = Herbicide



(Ross & Lembi, 1999)

HB = Herbicide

Primary Process & Secondary Processes



(Ross & Lembi, 1999)

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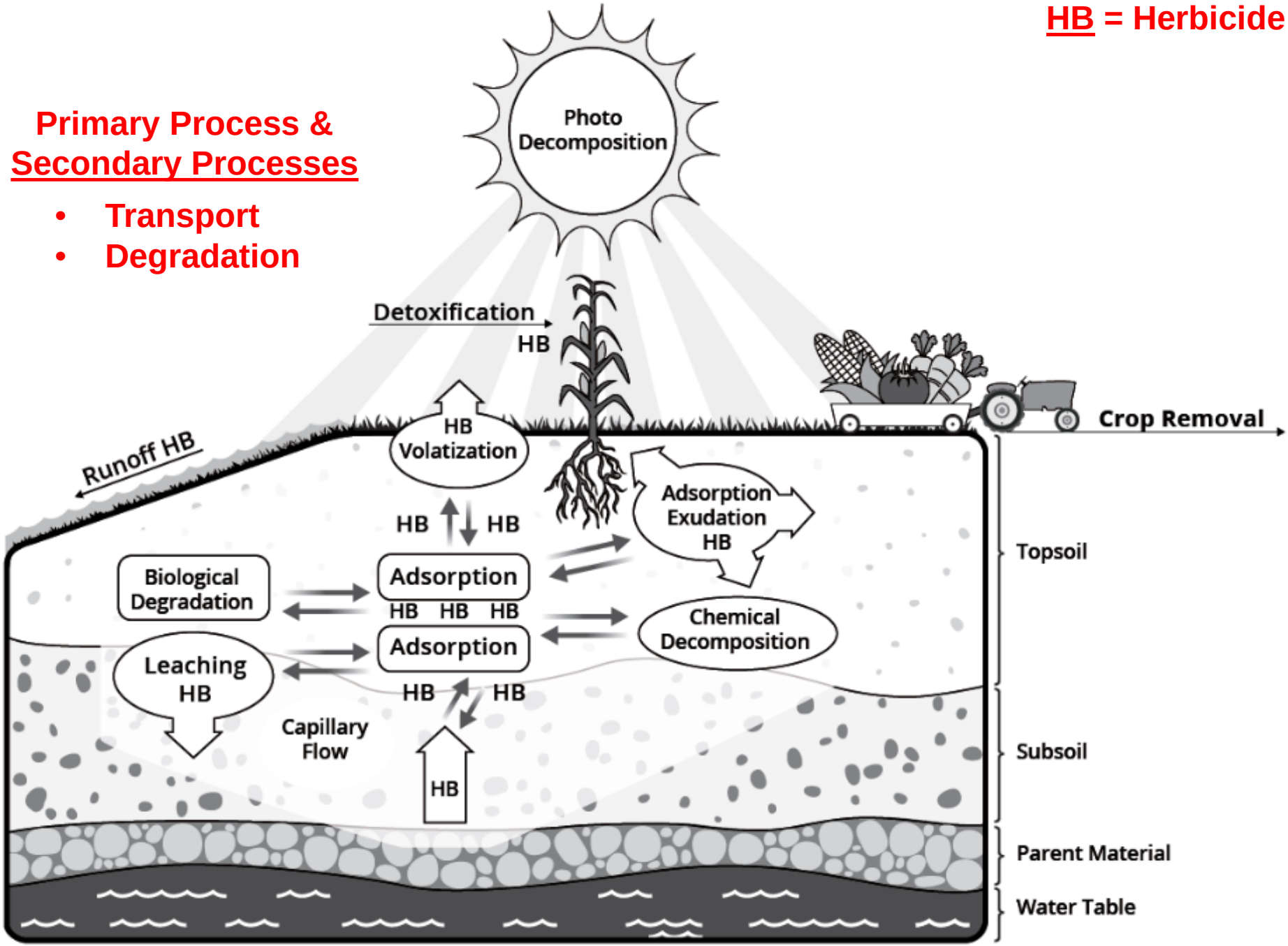
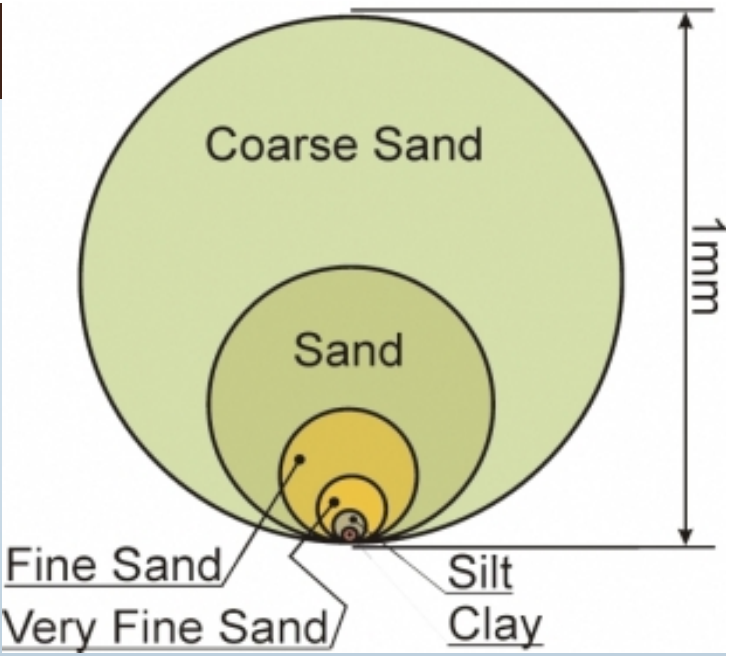
Primary Process & Secondary Processes

- Transport
- Degradation

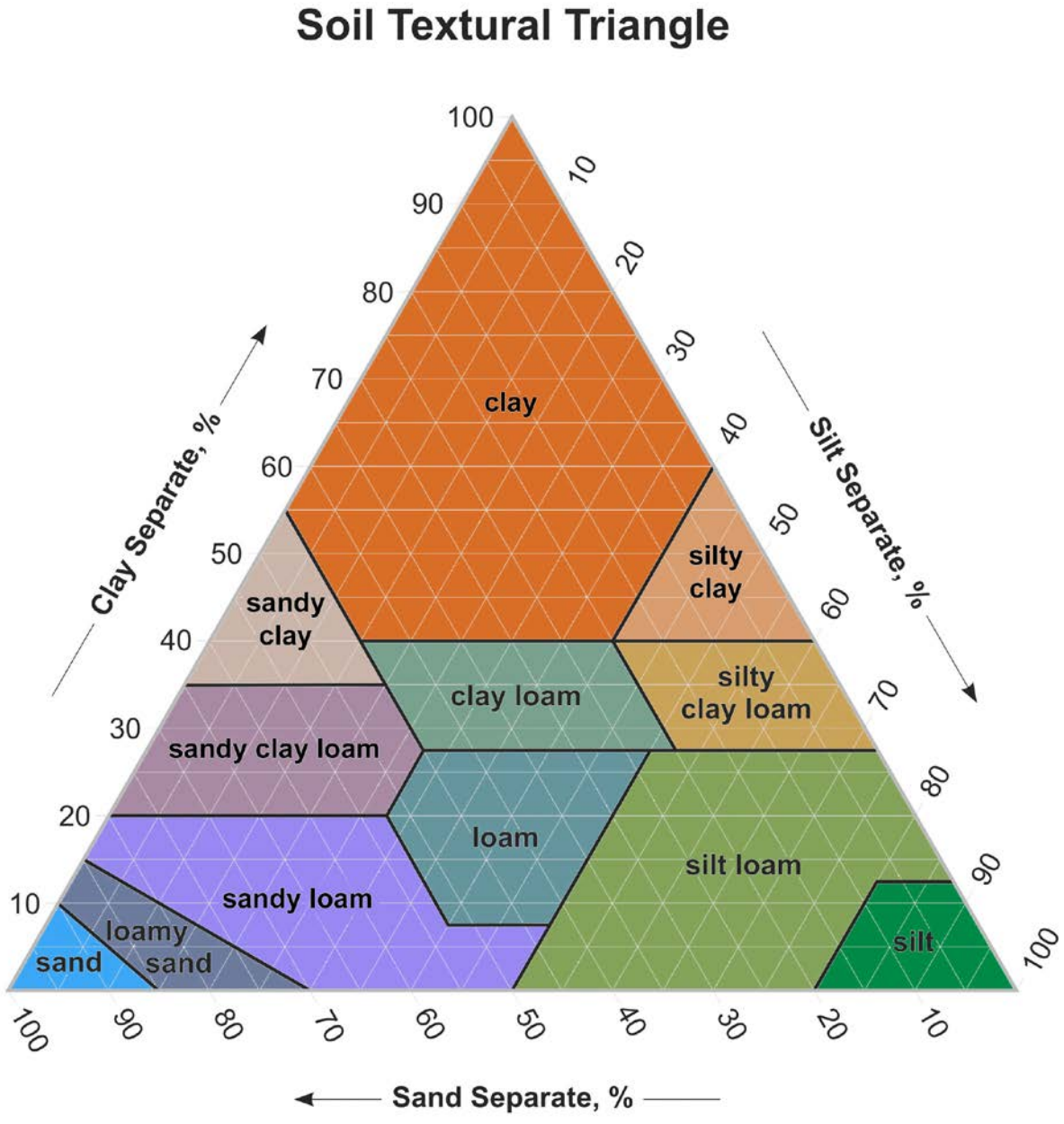


(Ross & Lembi, 1999)

Soil Texture Classification



- Clay content
- Organic matter
- Soil pH



Clay

- Any minerals with a particle size <2 µm are considered to be part of the clay fraction.
- Clay possesses very high surface area.
  - **Kaolinite particles are positively charged on their edges when in a low pH environment**
  - **Negatively charged in a high pH environment**

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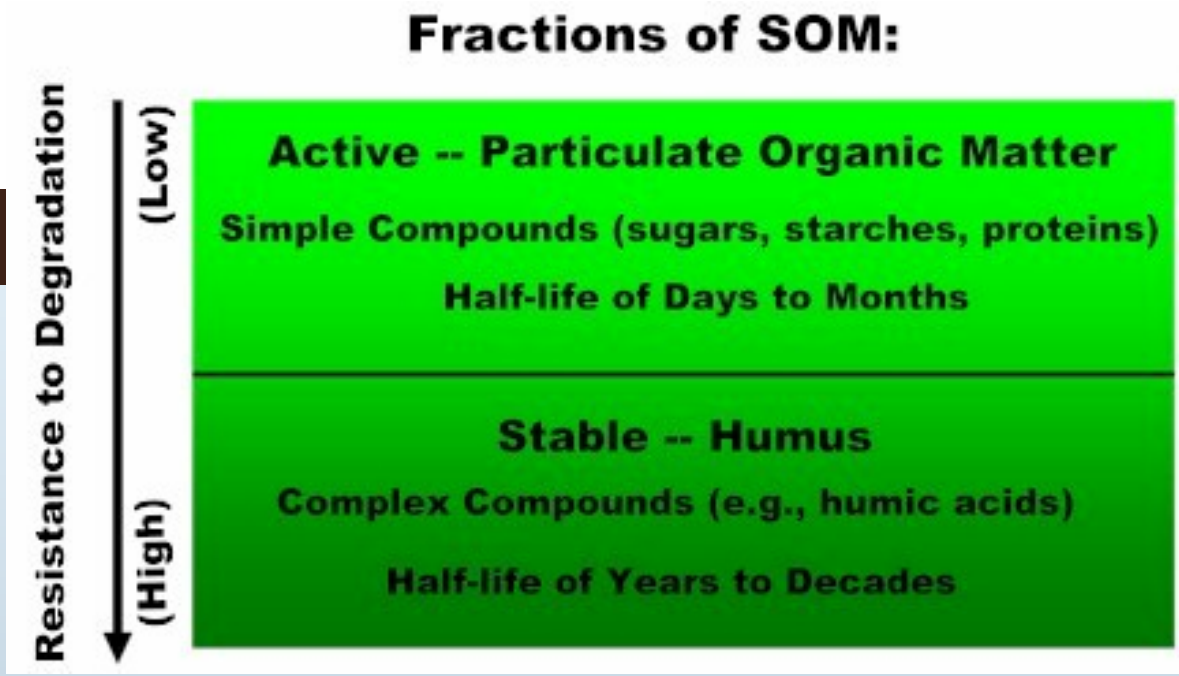
Organic Matter

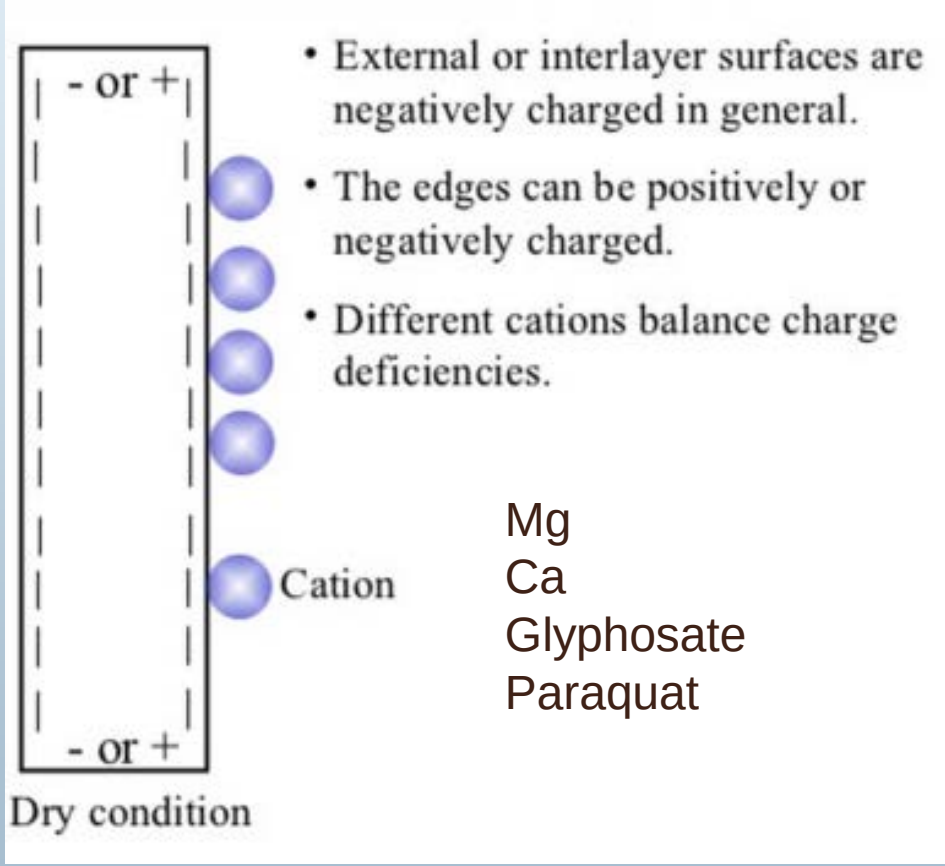


- Soil organic matter is the fraction of soil that consists of various plant and animal tissues in various stages of decomposition.
- **Humus** (considered the stable form of organic matter).
  - The final product of decomposition.
  - Contributes to cation exchange capacity.
  - **Negatively charged.**

Clay and Organic Matter

Both Clay and Organic matter contribute substantially to the chemical reactivity of soils.

Increasing clay and organic matter combine to increase CEC.

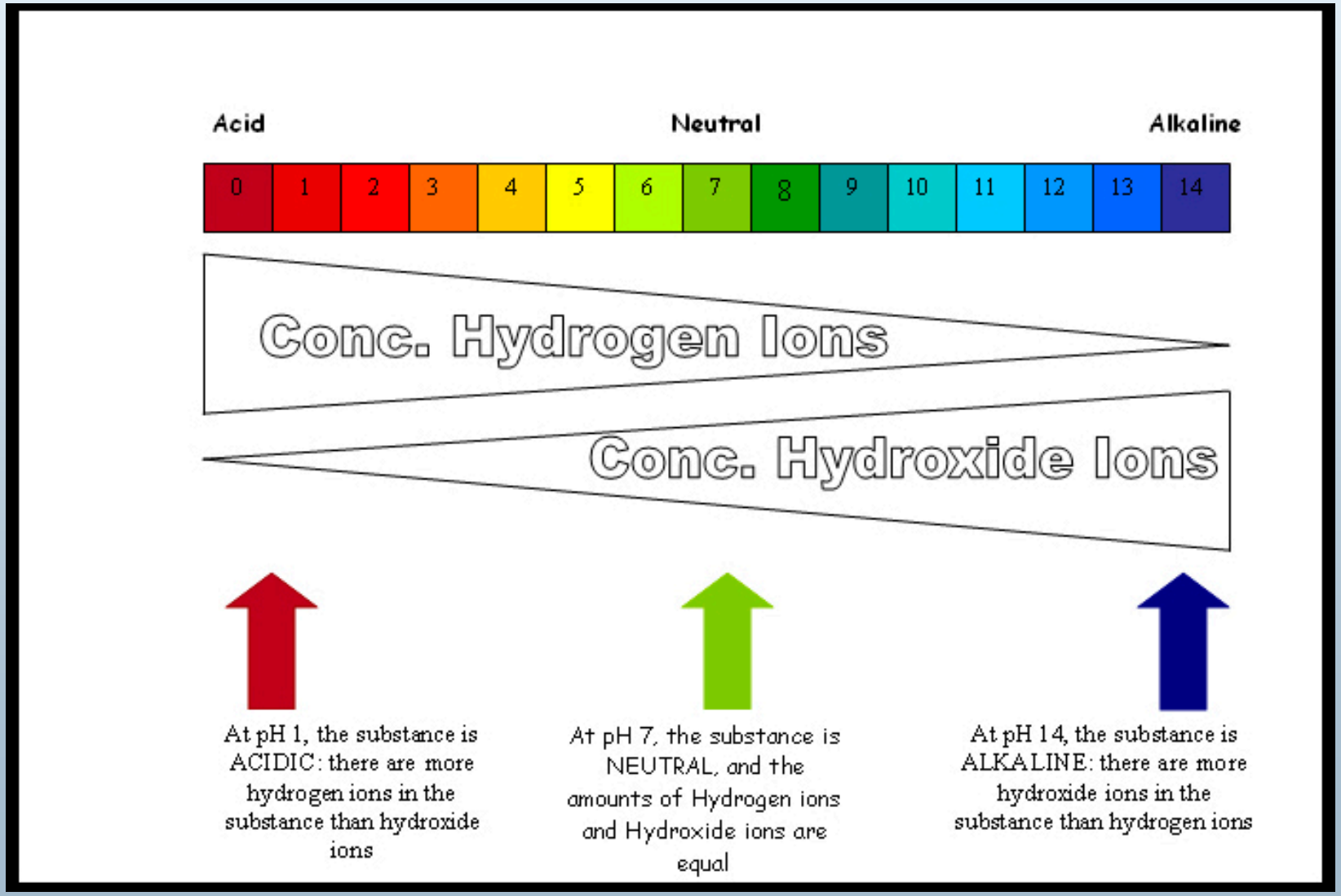


Soil pH

- In soil, pH is known as the Master Variable.
- pH influences almost every process in the soil system…
  - Biology of crops and other soil life.
  - Availability of nutrients.
  - And, *interactions with herbicides*.
- Soil pH is measured by the concentration of hydrogen ions in a system and uses a negative logarithmic scale.

Consequences of soil pH

As the pH of soil changes, so can the charges of soil particles and **HERBICIDES.**



Primary Process & Secondary Processes

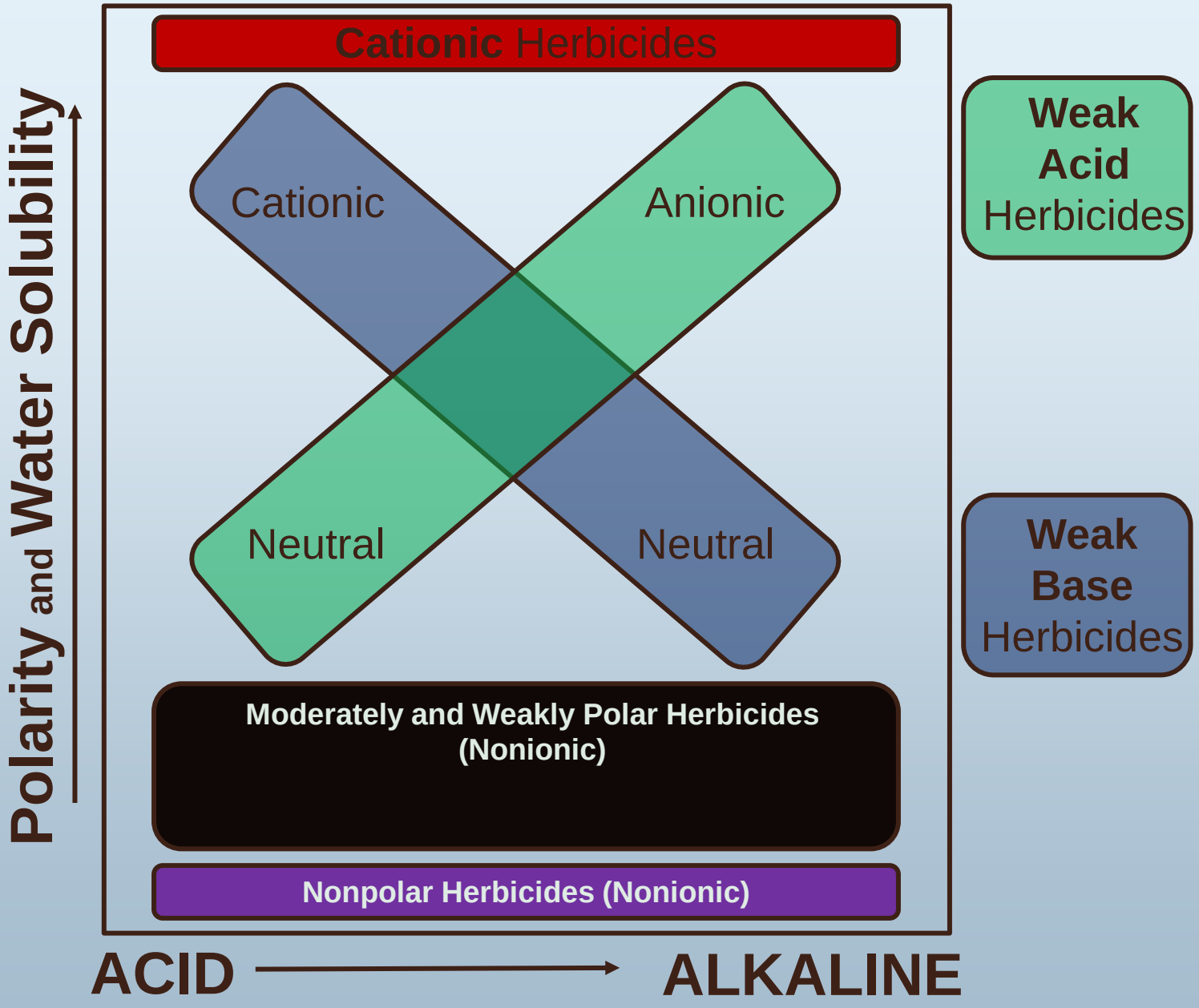
- Herbicides range from NONIONIC to IONIC (charged).
  - **NONIONIC (Nonpolar – Moderately Polar)** – most likely to interact with organic matter.
  - **IONIC (Polar Herbicides)** – will range from neutral to positively- or negatively charged and are either repelled by or attracted to a given soil component (organic matter, clay mineral, etc.).

Positively charged = Cationic

Negatively charged = Anionic

- When considering how herbicides interact with soil it is important to also classify herbicides by there **polarity and charge properties.**
- There are **5 categories** in which herbicides can be classified.

1. Weak acid
2. Weak base
3. Cationic
4. Moderately and Weakly Polar (Nonionic)
5. Nonpolar (Nonionic)



Classification of herbicides based on their polarity and charge (from McBride 1994 – Environmental Chemistry of Soils).

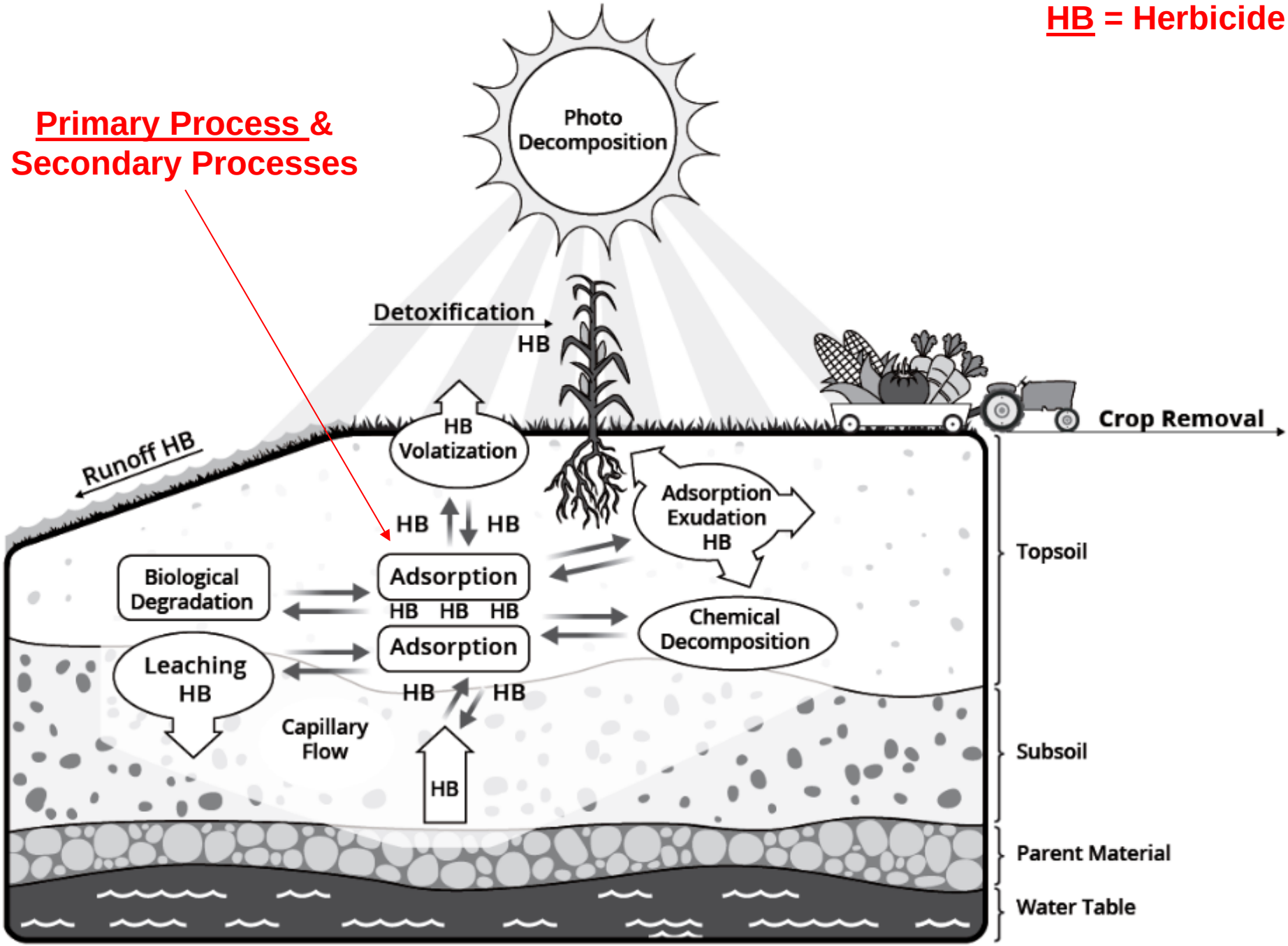
CLIMATE

- **Warm** Soil Temp.
- ↓ Soil Moisture

- **Cold** Soil Temp.
- ↑ Soil Moisture

HB = Herbicide

Primary Process & Secondary Processes



(Ross & Lembi, 1999)

Pyroxsulam Fate in the Inland PNW

- Pyroxsulam – the active ingredient in PowerFlex HL
  - Group B/2 herbicide.
  - Selective post-emergent grass and broadleaf weed control in winter wheat.
    - Applied primarily for grass weed control in the inland PNW.
  - When applied in the spring to winter or spring wheat, pyroxsulam residues can cause injury to lentil grown the following year.
  - Phenomena is not observed anywhere else in the world.

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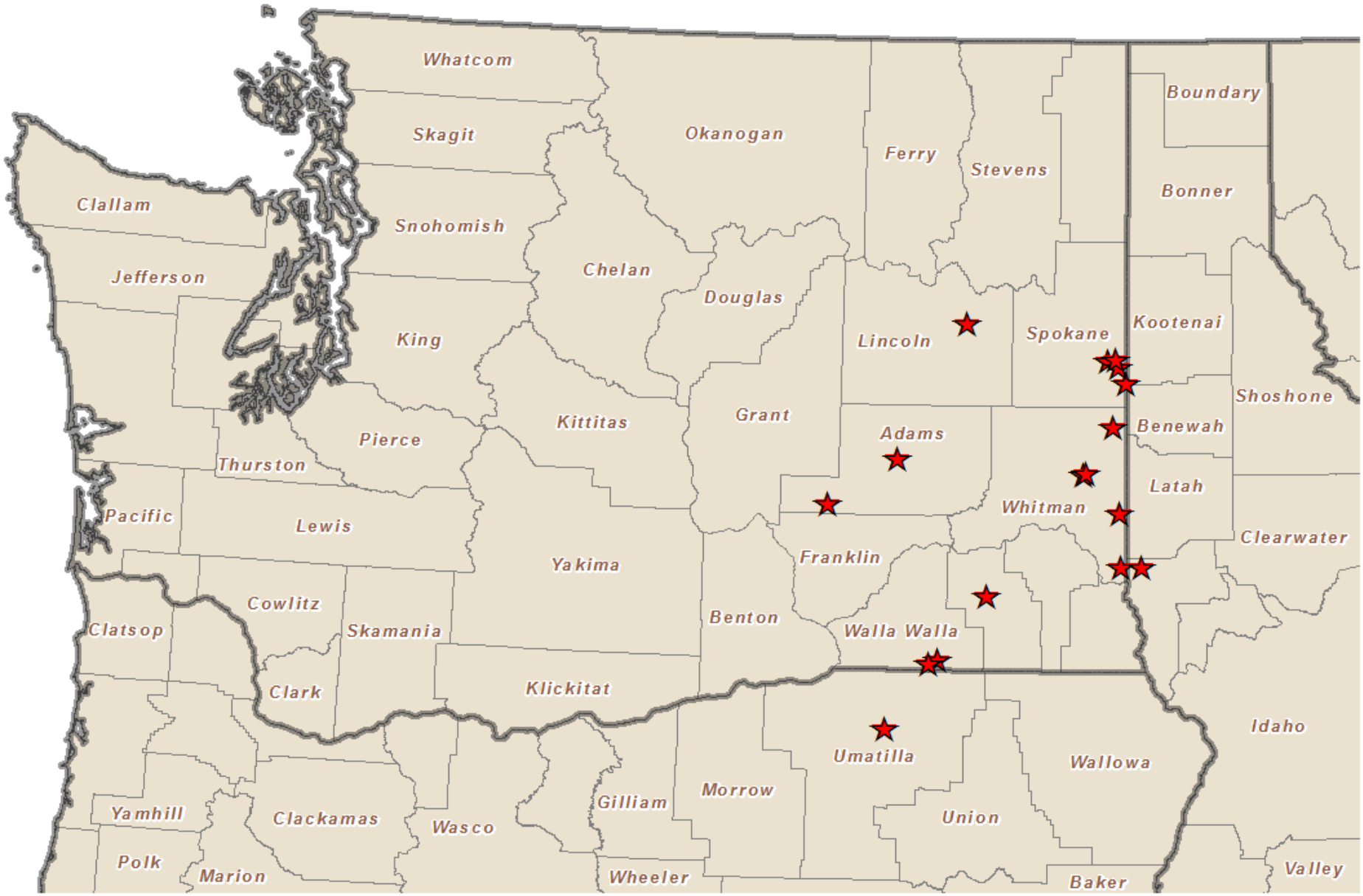
SOIL



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SOIL

Location	pH	% OM	CEC	% Clay
Valleyford, WA	4.3	3.05	18.0	10.50
Rockford, WA	4.4	4.18	19.5	8.75
Rockford, WA	4.8	3.01	20.1	12.50
Davenport, WA	5.0	2.46	17.0 ←	8.00
Genessee, ID	5.1	3.63	24	17.5
Uniontown, WA	5.1	4.5	22.2	20 ←
Fairfield, WA	5.4	2.84	20.9	15.00
Colfax, WA	5.5	4.96 ←	21.6	10
Dayton, WA	5.6	3.35	29.6	13.00
Pendleton, OR	5.7	2.34	28.6	14.00
Lind, WA	5.7	1.55 ←	18.1	11.80
Pullman, WA	5.8	4.48	30.4	12.00
Oakesdale, WA	5.8	3.63	29.2	14.00
Walla Walla, WA	5.8	2.49	23.5	11.80
Colfax, WA	6.1	4.33	21.3	7.75
Walla Walla, WA	7.5	3.52	33.2 ←	13.00
Othello, WA	8.4	1.67	19.2	2.00 ←

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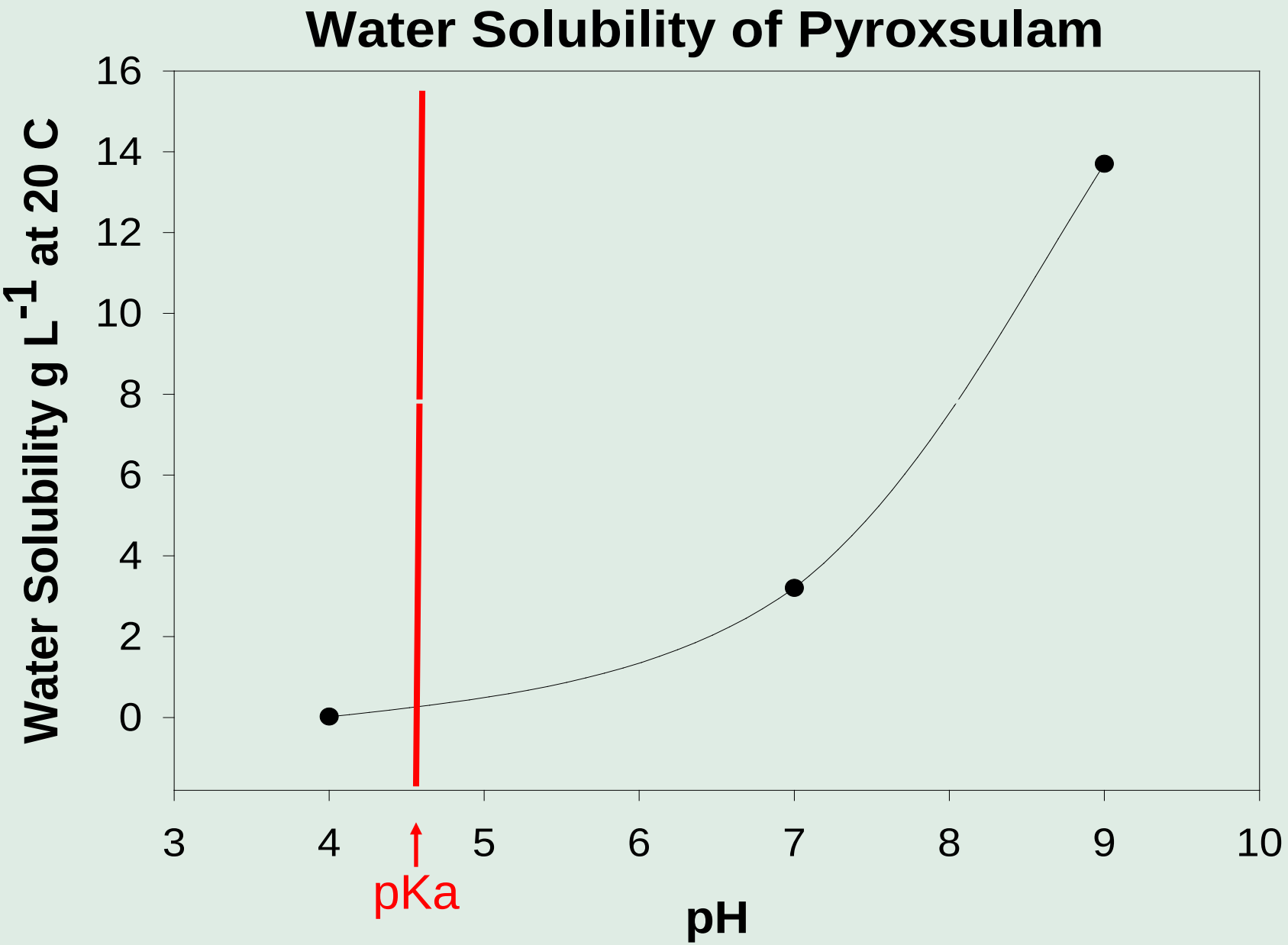
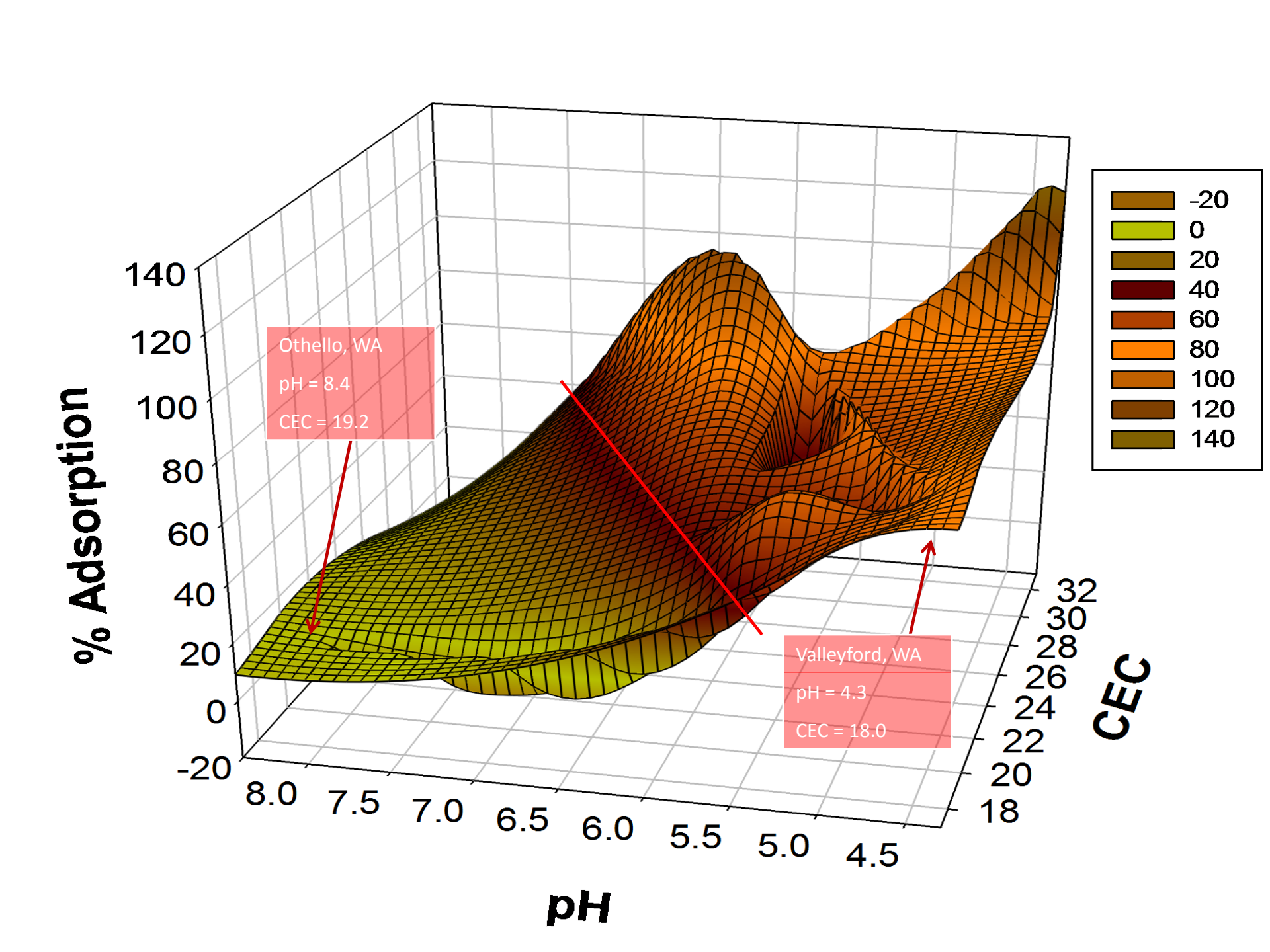
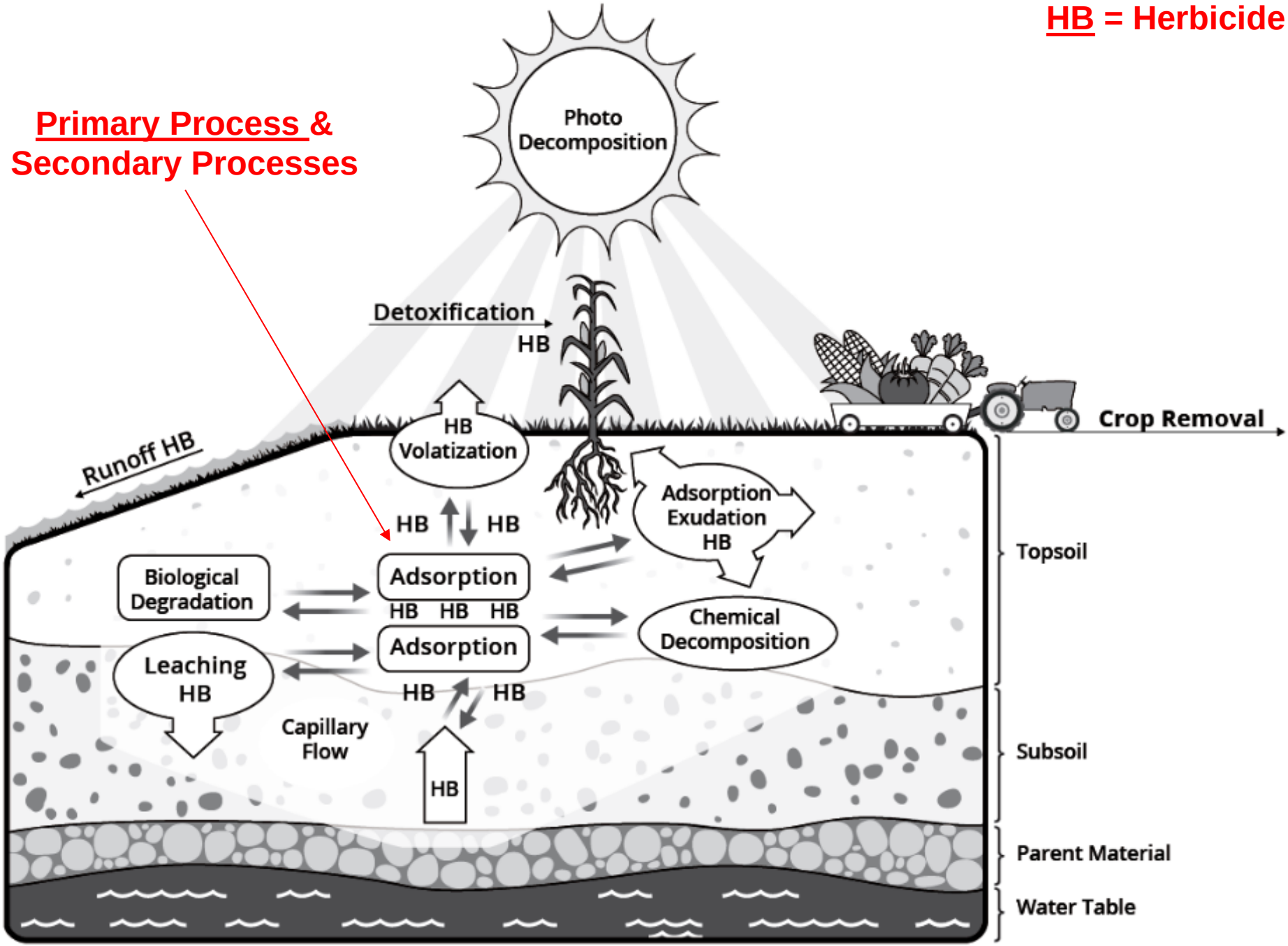
HERBICIDE




% Adsorption
140
120
100
80
60
40
20
0
-20
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
pH
CEC
32
30
28
26
24
22
20
18
-20
0
20
40
60
80
100
120
140
Othello, WA
pH = 8.4
CEC = 19.2
Valleyford, WA
pH = 4.3
CEC = 18.0

HB = Herbicide

Primary Process & Secondary Processes



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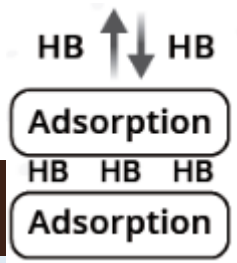
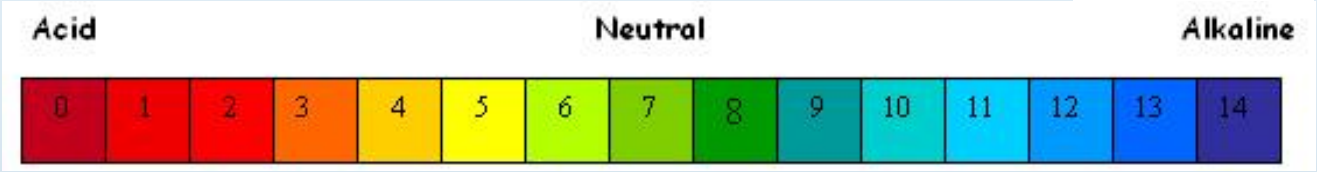


Generalization of Herbicide Persistence by Chemistry



Herbicide Family (pKa)			
Sulfometuron (5.7) Metsulfuron (3.8)	Acid hydrolysis	Slower acid hydrolysis	Adsorption
Imazapyr (3.6)	Adsorption	Microbial Deg	Microbial Deg
Atrazine (1.7) (OM)	Deg/Trans	Deg/Trans	Deg/Trans
Hexazinone (1.8) (OM)	Deg/Trans	Deg/Trans	Deg/Trans
Triclopyr (2.68) (OM)	Deg/Trans	Deg/Trans	Deg/Trans

Every herbicide molecule is unique!