NABS 2005 – Teaching session: my favorite ecology lab exercise

# How Ecosystems Breathe: Measuring Respiration of Soil

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# Typical Ecology Labs

- Computer simulations
- Field observations
- Semester-long field projects
- Non-experimental but data-rich labs
- Focus on ecophysiology, population interactions
- Ecosystem processes largely ignored
- Most observational, not experimental

# What Is Soil R?

- Production of $CO_2$ or consumption of $O_2$ by organisms living on or in soils
- Players: bacteria, protozoans, soil fauna (nematodes, worms, snails, arthropods), fungi

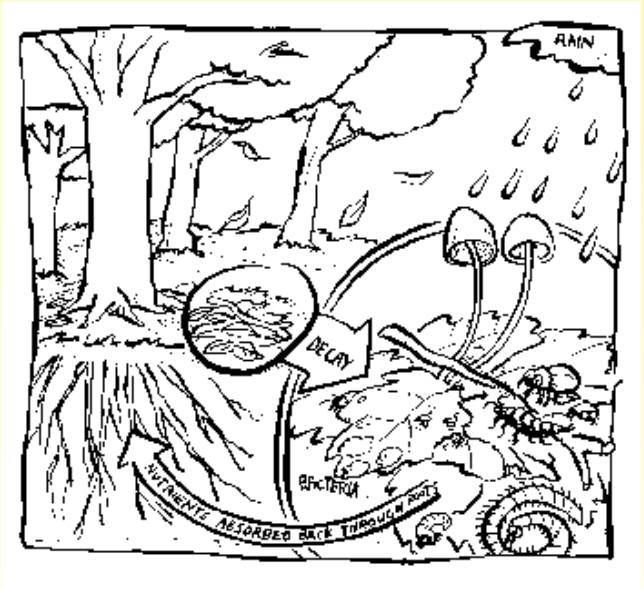






# Why Measure Soil R?

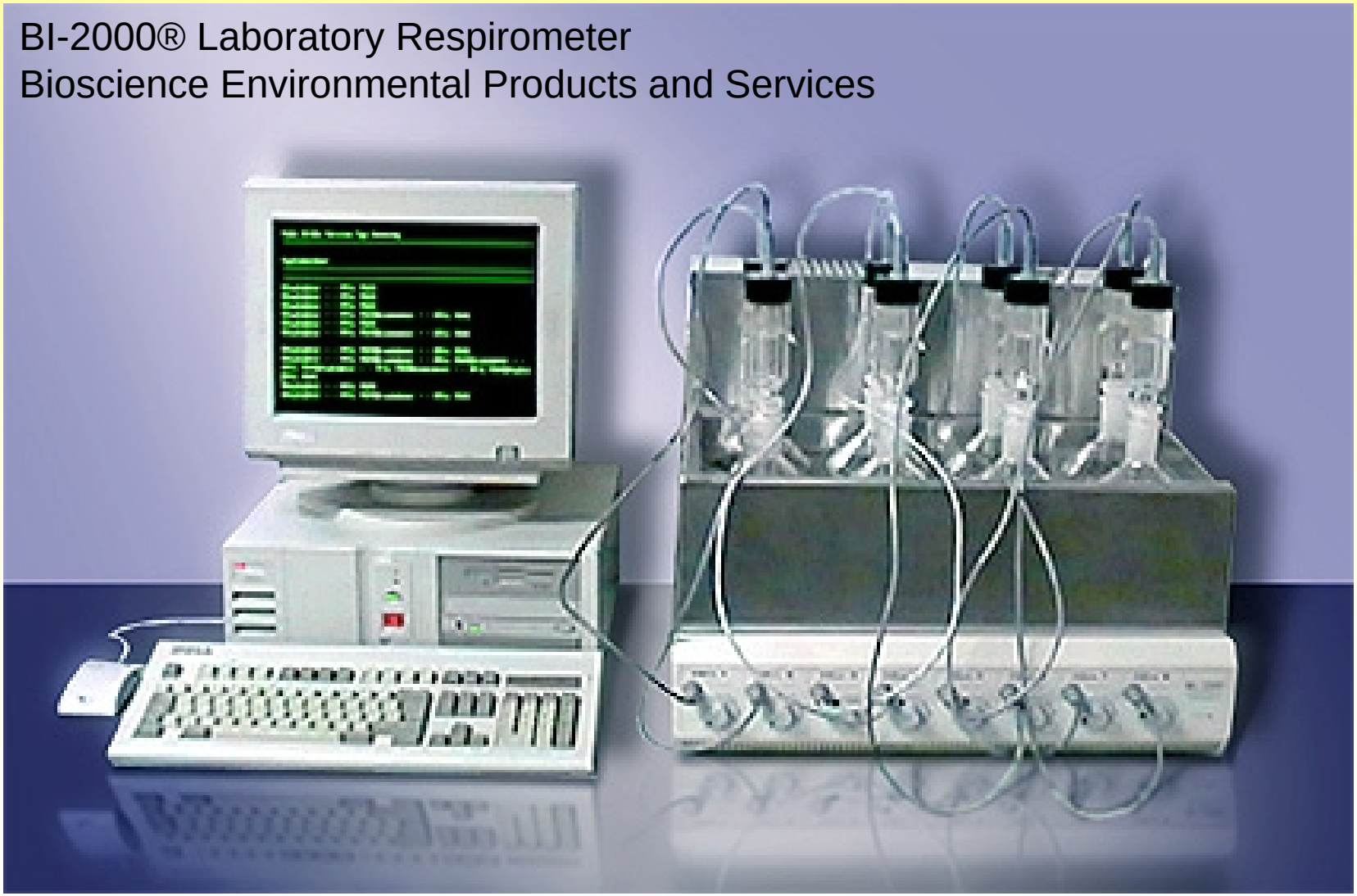
- Reinforce concepts about metabolism of individual organisms
- Promote appreciation for microbes and invertebrates



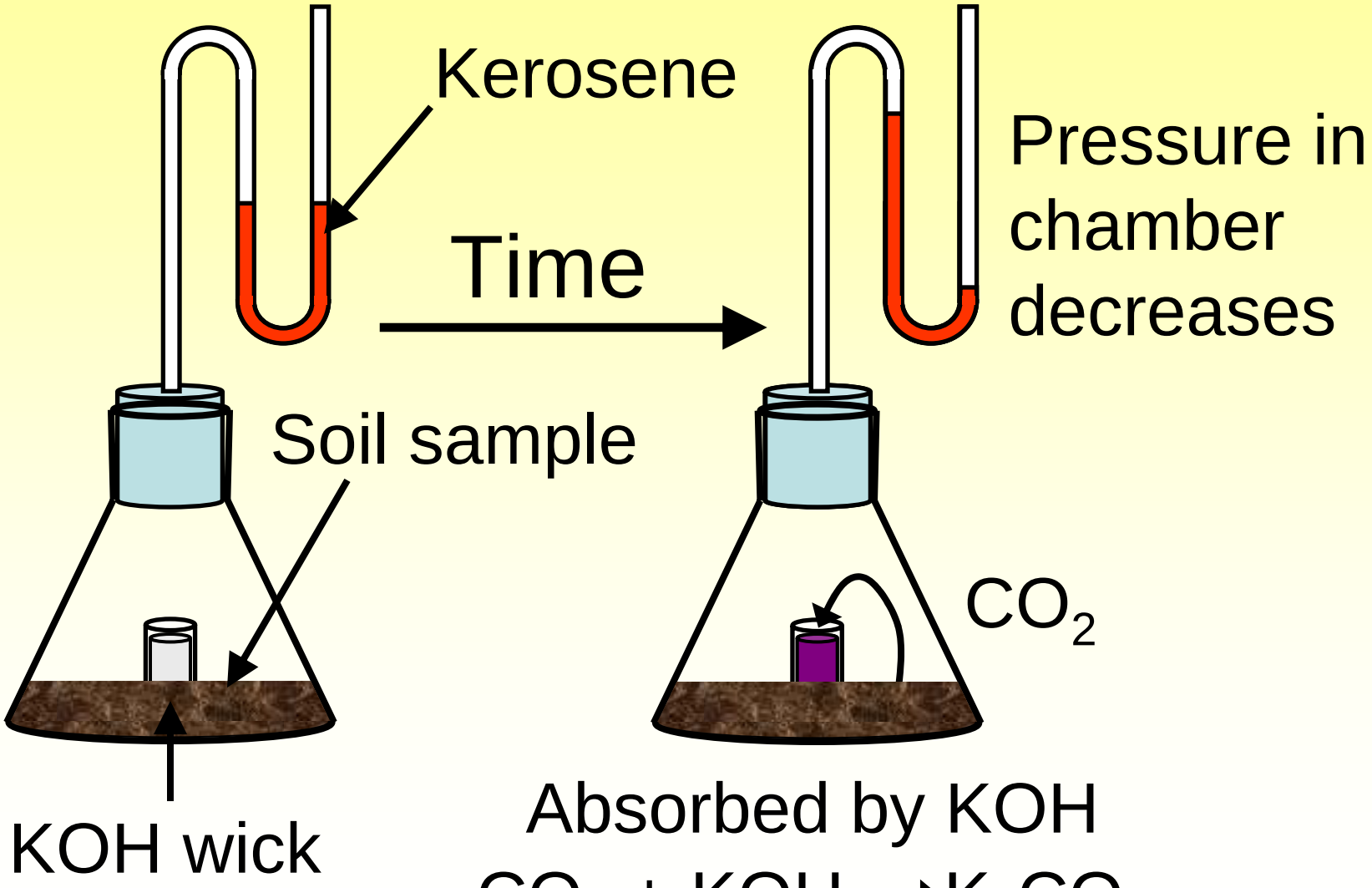

- Can perform experiments virtually anywhere
- Show big picture of ecosystem processes (C flux, energy flow, mineralization rates)

# Lab Respirometer

BI-2000® Laboratory Respirometer
Bioscience Environmental Products and Services



# Manometric Techniques



# Field Respirometer

CFX-2 Soil $CO_2$ Flux System
PP Systems

LI-8100 Automated Soil
$CO_2$ Flux System
LI-COR Biosciences

# Chamber $CO_2$ Titration

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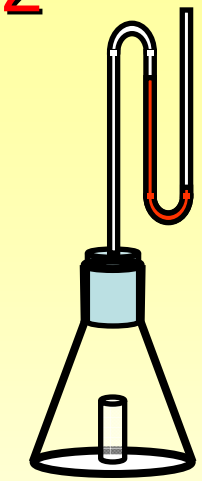

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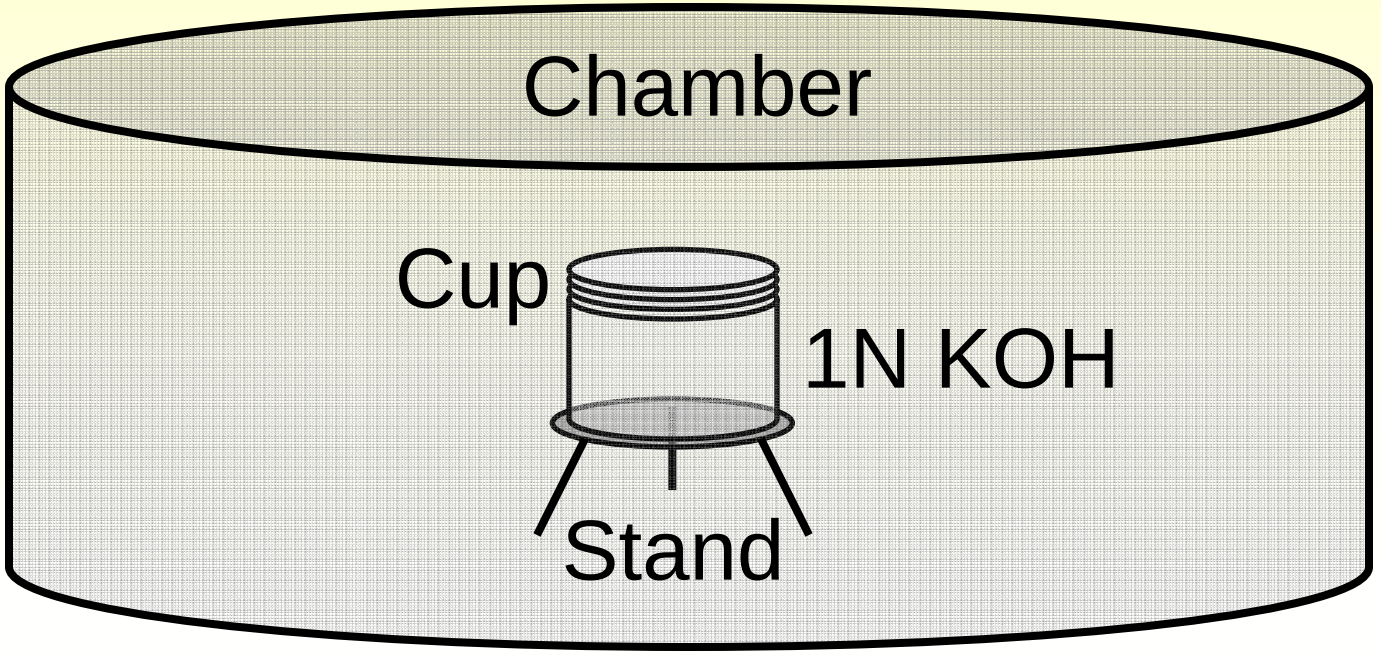


# Example Experiment

Chillisquaque Creek Natural Area, central PA

- Vegetation and slope affect soil conditions

# Natural Area Sites

Old field

Mature bottomland forest

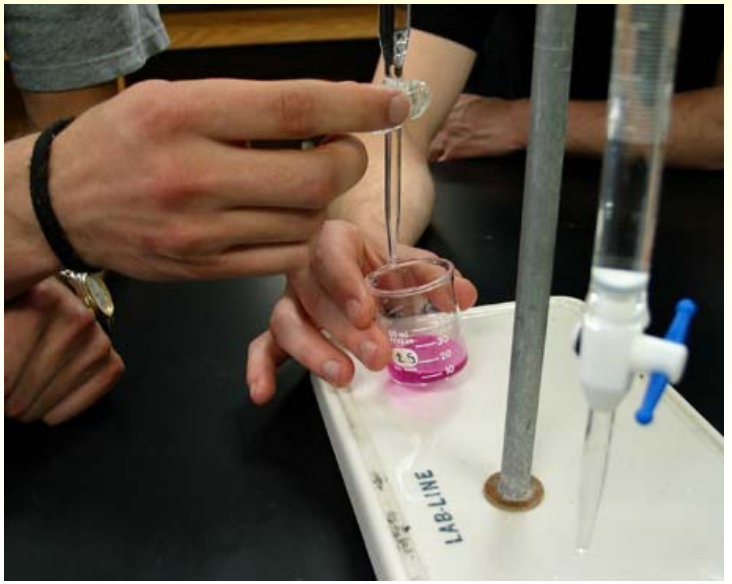
Young red maple forest

# Field Methods (Week 1)

- 20 mL 1N KOH
- Treatments & controls
- Seal chamber
- 24-hour incubation

# Lab Methods (Week 2)

- 10 mL sample to centrifuge tube
- 5 mL 3N $BaCl_2$, $BaCO_3$ precipitate
- Centrifuge (~1000 RPM, 3 min.)
- 5 mL supernatant, 3 drops phenolphthalein
- Titrate w/ 1N HCl to clear



# Calculations

mL HCl Control – Treatment

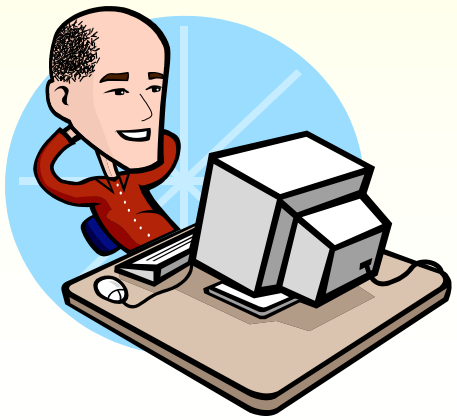
mg $CO_2$ = (C – T) N E

Normality of acid

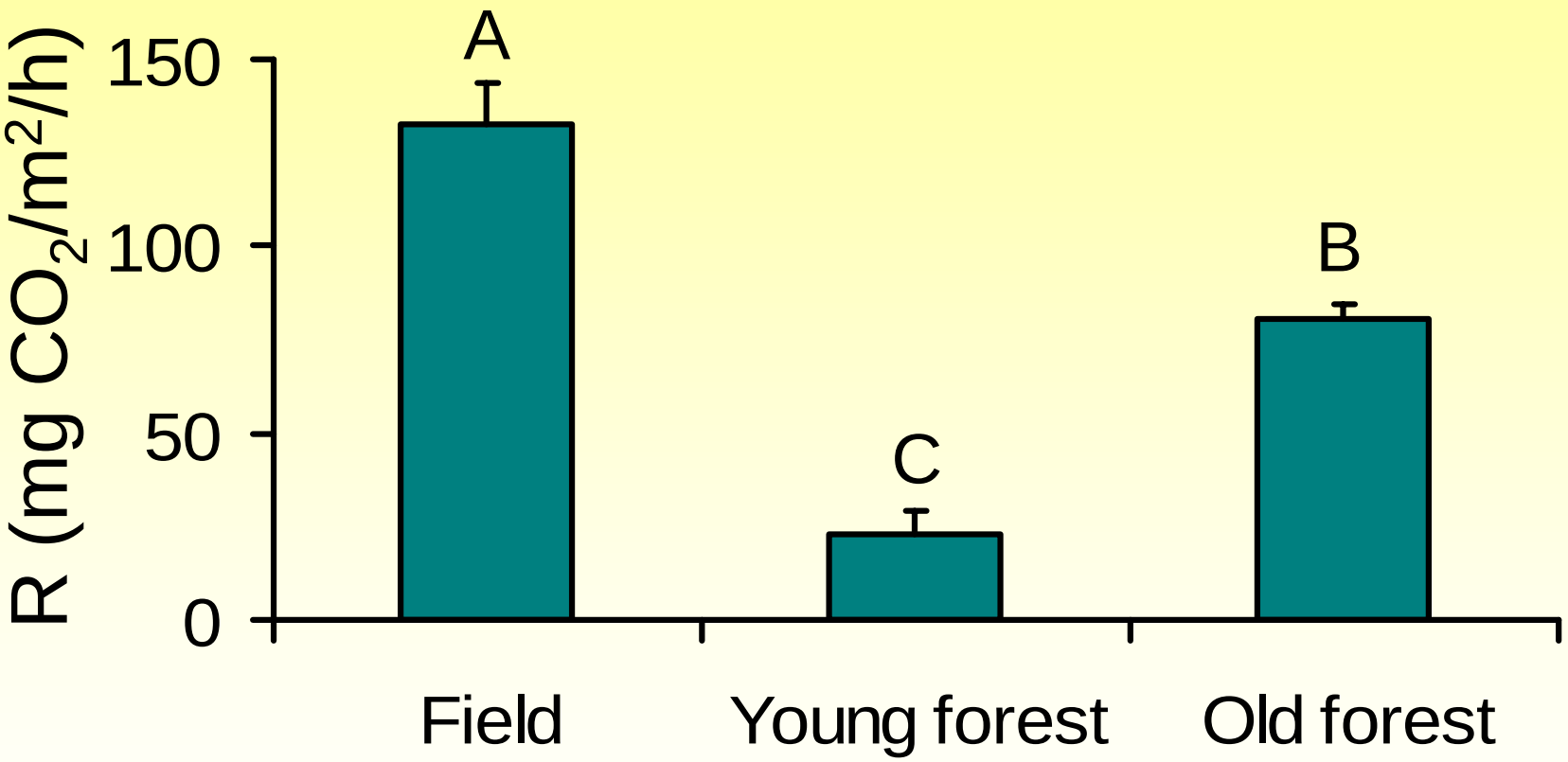
Equivalent weight (22)

Rate = mg CO2 / soil area / incubation time

Compare sites... STATS!!!



# Results: 11 April 2005




Results similar day-to-day

Good for lab reports (unlike many eco labs)

# Possible Experiments

- Compare R with other ecosystems
- Nutrient enrichment
- Organic matter quality manipulation
- Pesticide/herbicide application
- On-campus habitats (mulched flower bed vs. grass vs. exposed dirt on foot path)
- Opaque vs. transparent containers
- Many possible ancillary measurements

# Cost Comparison

- Lab respirometers $20,000-100,000
- Gilson respirometer $2000-10,000
- Field respirometer $2000-15,000
- Chamber titration (50 samples)
  - $225 for buckets, cups, and stands (one-time cost)
  - $37.50 for reagents (yearly)
  - Assuming labs have pipets, centrifuge tubes, centrifuge, 25-mL beakers, burets, and stands

# References

**Anderson, J. P. E. 1982.** Soil respiration. Pages 831-871 in Methods of soil analysis, Part 2, chemical and microbiological properties. Agronomy Monographs #9. ASA-SSSA, Madison, Wisconsin.

**Rochette, P., E. G. Gregorich, and R. L. Desjardins. 1992.** Comparison of static and dynamic closed chambers for measurement of soil respiration under field conditions. Canadian Journal of Soil Science 72:605-609.

**Witkamp, M. 1966.** Rates of carbon dioxide evolution from the forest floor. Ecology 47:492-494.

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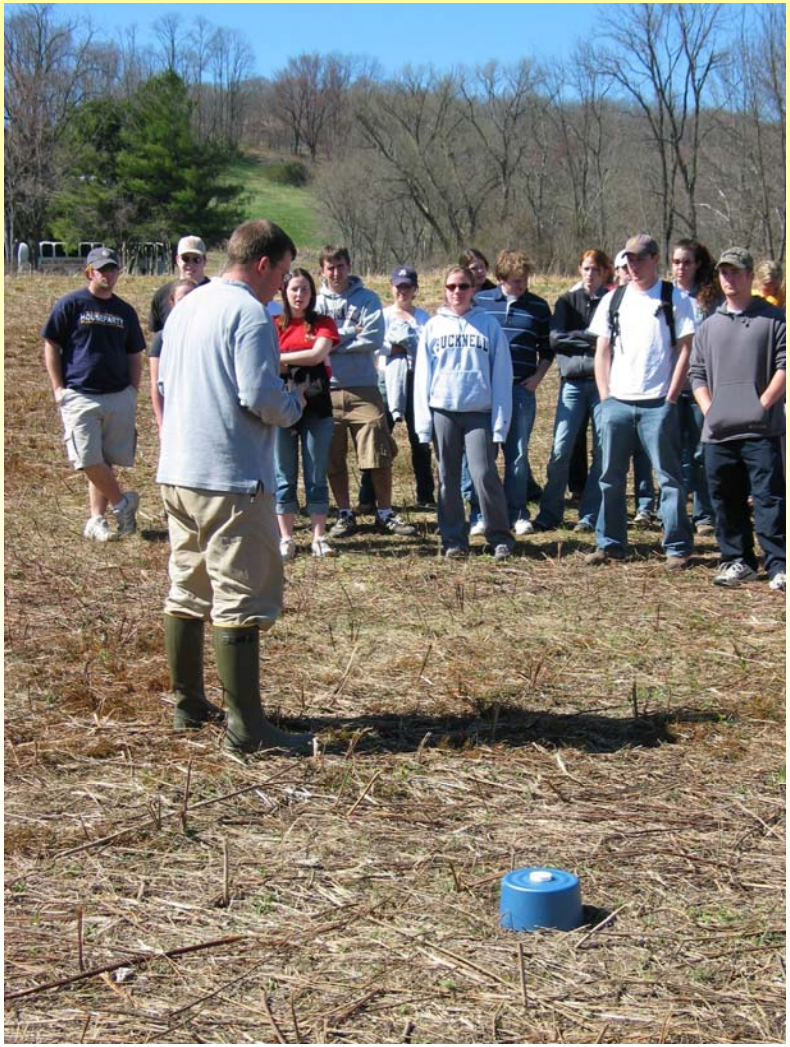

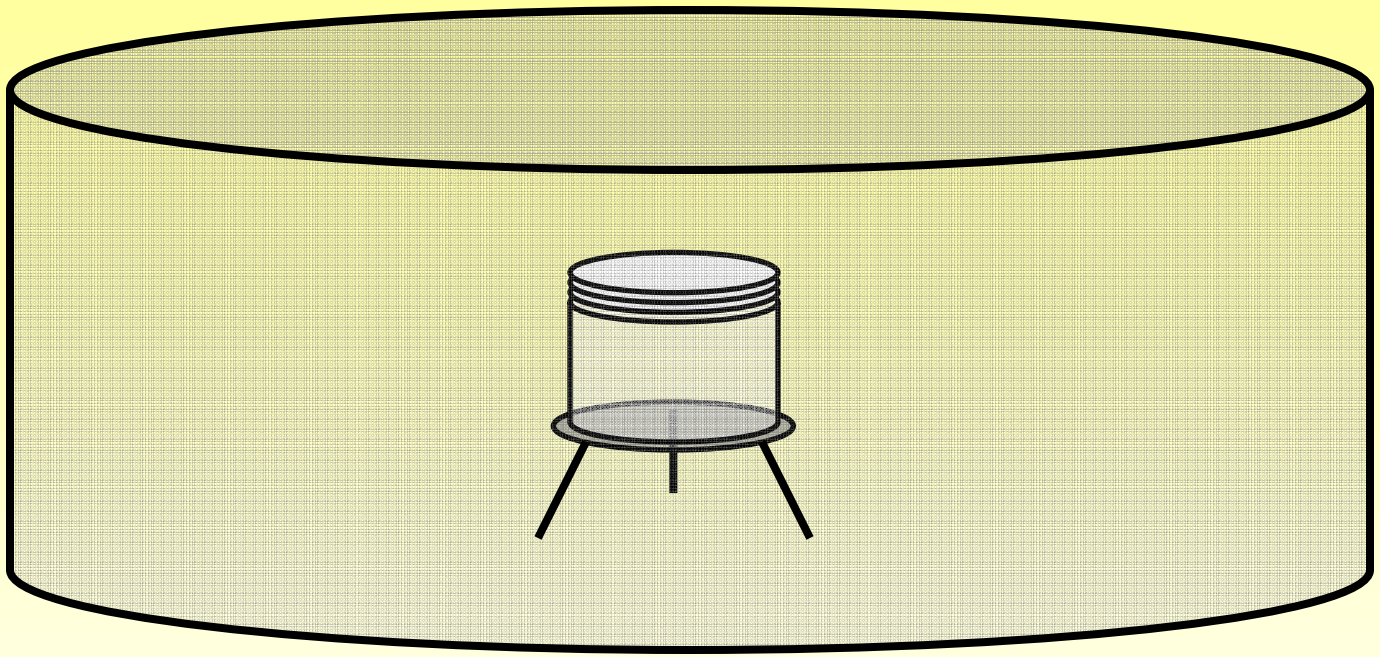

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