

# Breakout #3

- Part #1 - Measurements
  - Total root size
  - Dynamics of growth (root/shoot)
  - Root/soil chemistry
  - Length of root /area/volume
  - Surface Area, depth distribution
  - Gas exchange/Turnover of C, N, P
  - Pool size & changes
  - Single plant (for breeding) vs. ecosystem
  - C input to soil via exudates
  - Interrogation of xylem/phloem
  - Isotopic measurements?
  - Transpiration
  - Soil organic matter/abiotic root environment
  - Rhizobiome/soil organisms (fungi/bacteria ratio)
  - Root composition/turnover
  - In-situ root environment (abiotic)
- Challenges
  - Can one create a relationship of root density to total surface area?
  - Current resolutions of measurement tech are limiters,
    - Leads to trade-offs
- Who are these for?
  - Three levels of users, different needs and price-points
    - Researchers
      - High-precision and accuracy
      - <1K units
    - Breeders
      - More units, cheaper
    - Growers
      - Many thousands/millions? Of units, cheapest
  - Three bins of measurement
    - Structure of roots/microbiome
    - Composition underground (chemical) soil/root
    - fluxes

# Breakout #3 (cont)

- Part #2 – Teams
  - Integrated
    - Engineers + biologists + soil scientist + biogeochemist + modeler(s)
  - Minimal
    - Sensor developer/engineer + biologist
- What about a measurement competition
  - Bring in engineers not thinking about soil yet
- Where does an LCA/Economist fit in?
  - Program level