

Climate Change: Economic Implications and Opportunities for Agriculture

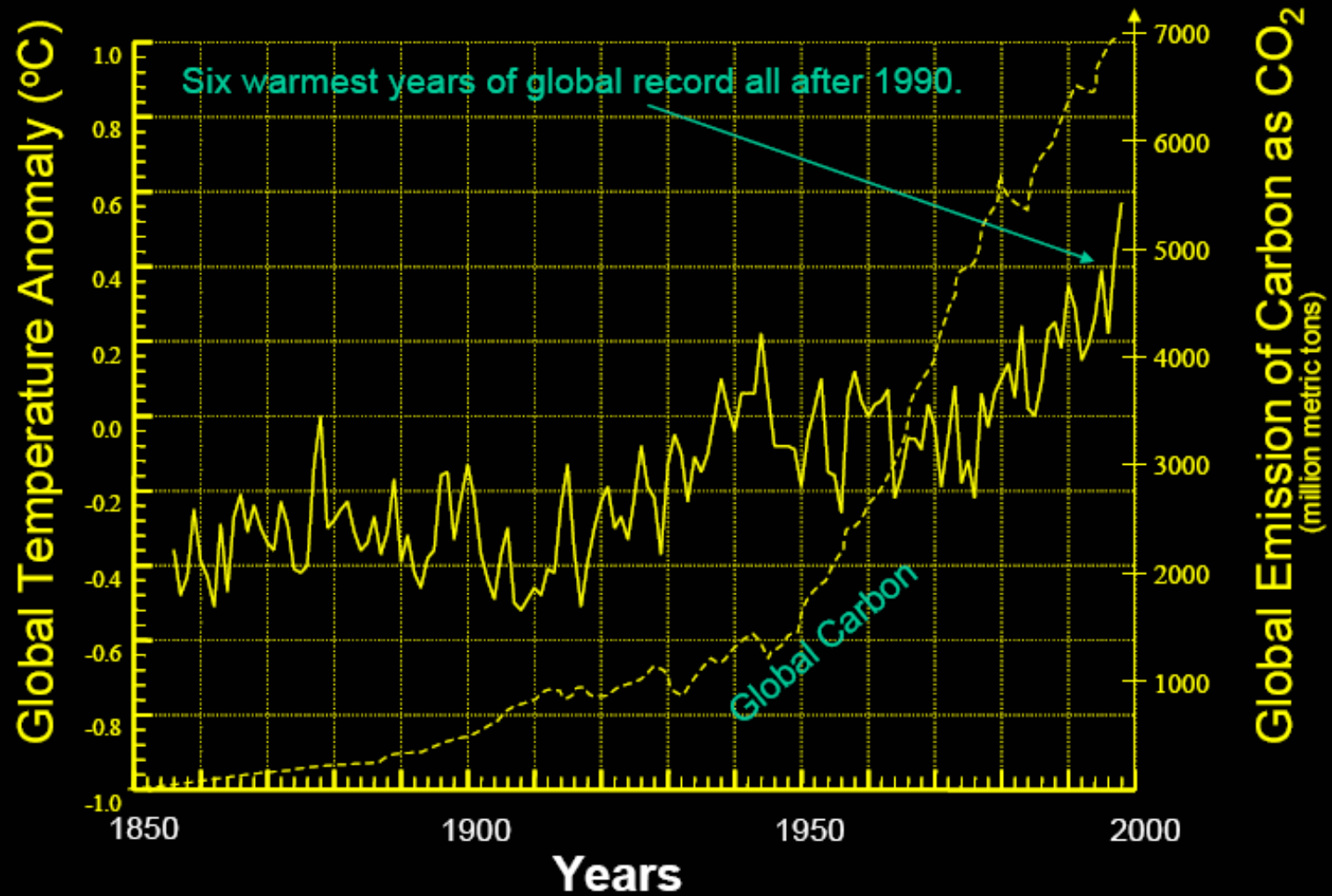
Susan M. Capalbo
Oregon State University

presentation to

***Oregon Global Warming Commission
Natural Resources Committee Meeting
Global Warming and Agriculture
July 17, 2008***

*

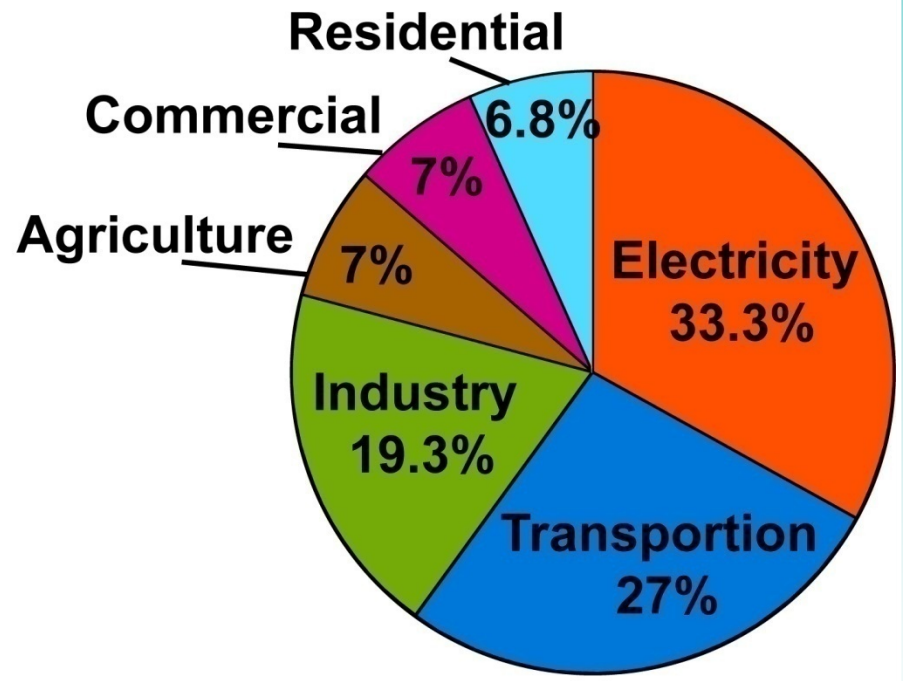
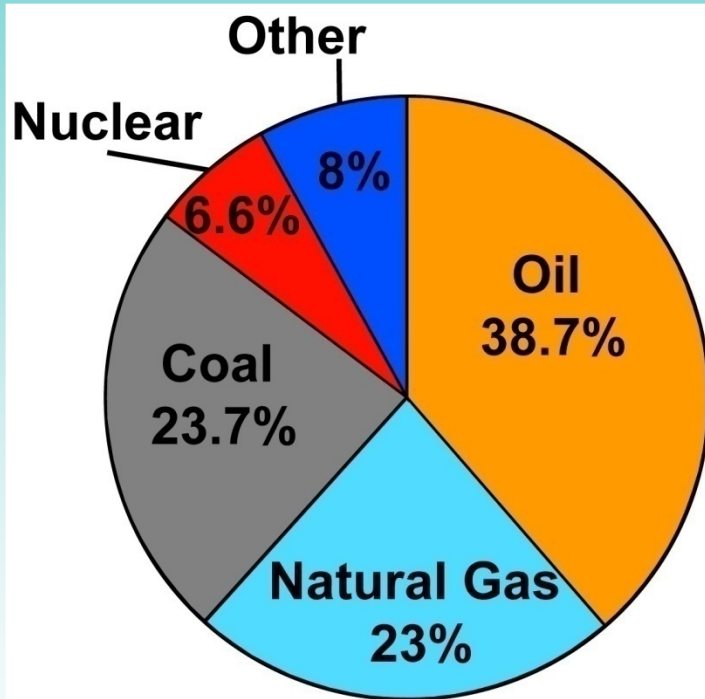
Premise: Rising CO₂ and Temperatures



Current Dominance of Fossil Fuels

Energy Consumption (USA, 2001)

GHG Emission Sources (USA, 2003)



Source: EIA Energy Information Administration , 2001, 2005

Outline

- Mitigation vs adaptation
- Economic considerations for addressing impacts
- Challenges for growers/ranchers and for policy makers: critical research needs



Photo by Bart Eleveld

Reminder: winners and losers



Climate Change may impact:

- Average temp and temp extremes
 - Timing and geographical patterns of precipitation
 - Snowmelt, runoff, evaporation, soil moisture
 - Frequency of drought, insect and disease outbreaks, severe storms, fires
 - Atmospheric composition and air quality
 - Patterns of land use (human settlement and ag)
-
- Studies on the aggregate impacts, now need to drill down to regional, local assessments:

The Effect of CC on Ag, Land Resources, Water Resources, and Diversity (USDA/NCAR 2008)

○ Findings for Ag sector

- Increase CO₂ and temp: earlier maturity of crops and/or crop failures
- Yield of horticultural crops, specialty crops is very likely to be more sensitive to climate change than oilseeds and grains
- Northern migration of weeds, weeds more responsive to elevated levels of CO₂ than crops: glyphosate (herbicide) loses efficacy on weeds at elevated CO₂
- Disease pressure on crops and domestic animals will increase, higher over-winter survival rates for pathogens and parasites
- Lengthening of growing season: benefit for reduced winter forage reserves
- Spatial shifts in plant types and productivity: benefits and costs
- Livestock sector: reduced livestock production in summer, increase in winter
- Soil erosion may increase with increased in intense thunderstorms, wildfires

Findings from:

Economic Impacts of Climate Change in Oregon (2005)

- Oregon agriculture is diverse; impacts across sectors will differ
- Rising temperatures: increase or decrease yields and/or quality
- Rising CO₂ concentrations/longer growing season: increase yields

- Increase in drought frequency & water supply constraints
- New investments in storage capacity – not cost effective at 2005 prices

- Orchard-based crops: mature more quickly at higher temps
- Winegrape sector: continued acceleration in temp can be problematic for existing varieties
 - Increase in temp by 2.7 degrees F displace Pinot Noir grapes from optimum range in Willamette Valley

What about in Oregon? Potential impacts

- Direct: Adams' OSU presentation regarding water
- Direct: Increases in pest and disease pressures -- Stella Coakley, OSU
 - Vulnerability of specialty crops and ornamental horticulture
 - increased use of ag chemicals? viability of “organic” agriculture?
- Direct: Snowmelt for recharge and for irrigation; mining glacial waters for irrigation – Anne Nolin, OSU, Dept of Geosciences
 - $\frac{3}{4}$ of August flow in the Upper Middle Fork of Hood River is coming from melting glaciers (using measurements started in 2007)
 - Projected decline in glacier meltwater contributions to Upper Middle Fork is 50% in approximately 50 years => Middle Fork irrigation district may face decreased late summer flows of 37%
- Indirect: result of economic impacts in other sectors – sorting out causes is difficult
 - Wheat sector, dairy sector, livestock sector , feed prices, energy policies

Adaptation and mitigation

○ ADAPTATION:

- Cumulative past emissions already committed planet to a climate change and associated impacts (rate and nature of impacts)
- Adaptation is the norm in agriculture
- Adaptation strategies will vary location and ag systems

○ MITIGATION:

- Ag has been/is an emitter of GHG to the atmosphere AND is a sequester of CO₂ in the form of soil carbon
 - 25% of CO₂, 50% of methane, 75% of nitrous oxide
 - Question: how much potential exists for increasing the amt sequestered
 - Question: potential for decreasing net GHG emissions
 - Sequestration of CO₂ in the soils, low carbon fuels,
 - Improved efficiency in ag operations

Photo by Bart Eleveld

Economic considerations for addressing Adaptation

- To address the economic impacts within ag settings
 - Understand the impacts of climate change on the physical environment
 - Understand impacts of climate change on species, biological communities
 - Understand the human dimensions of climate change and how growers/ranches will respond to
 - Changes in prices
 - Changes in incentives including new markets
 - Interdependencies

Photo by Bart Eleveld

Mitigation: Terrestrial Sequestration

- Soil is major reservoir for carbon and nitrogen in the terrestrial environment
- Technical vs economic potential for sequestration
 - technical potential cannot be achieved unless farmers are willing to adopt management practices that increase soil C
 - economic potential: At what cost can farmers change practices to increase soil C?
 - how can farmers be provided an incentive to change practices?
- Additional carbon and credible carbon
- Technical component: carbon rates vary due to bio-physical conditions (soils, climate)
- Economic component: Opportunity costs vary spatially due to factors affecting productivity and profitability

Aggregate Assessment (Pew and USDA)

Carbon stocks in agricultural soils are currently increasing by 12 million metric tonnes (MMT) of carbon annually.

If farmers widely adopt the best management techniques now available, an estimated 70 to 220 MMT of carbon could be stored in U.S. agricultural soils annually. (TECHNICAL)

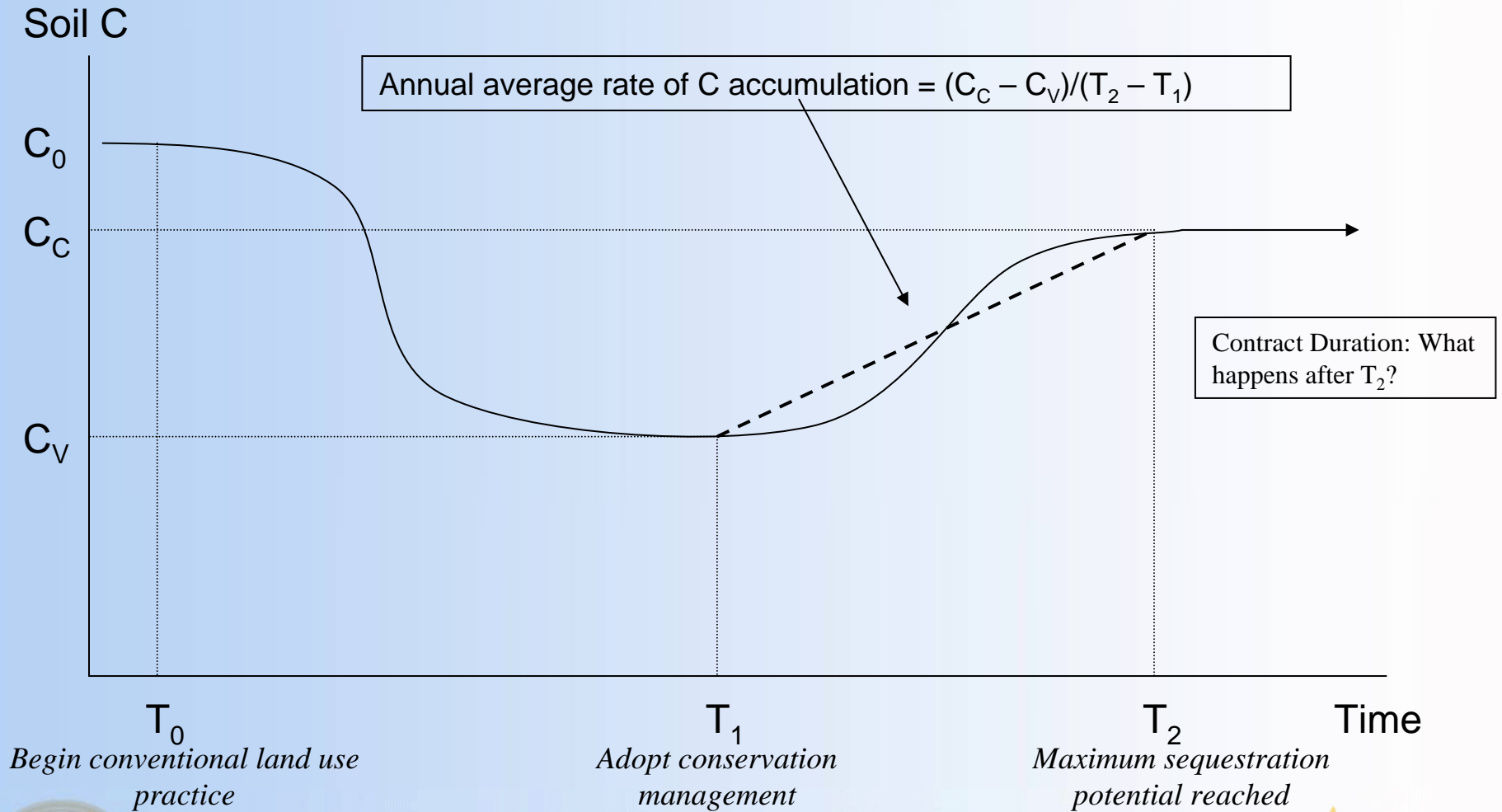
With moderate incentives (up to \$50/tonne of carbon, or \$13 per tonne of CO₂), up to 70 MMT of carbon per year might be stored on agricultural lands and up to 270 MMT of carbon per year might be stored through converting agricultural land to forests (ECONOMIC)

How does all this work at a farm scale: Factors Determining the Cost of C Sequestered in Agricultural Soil

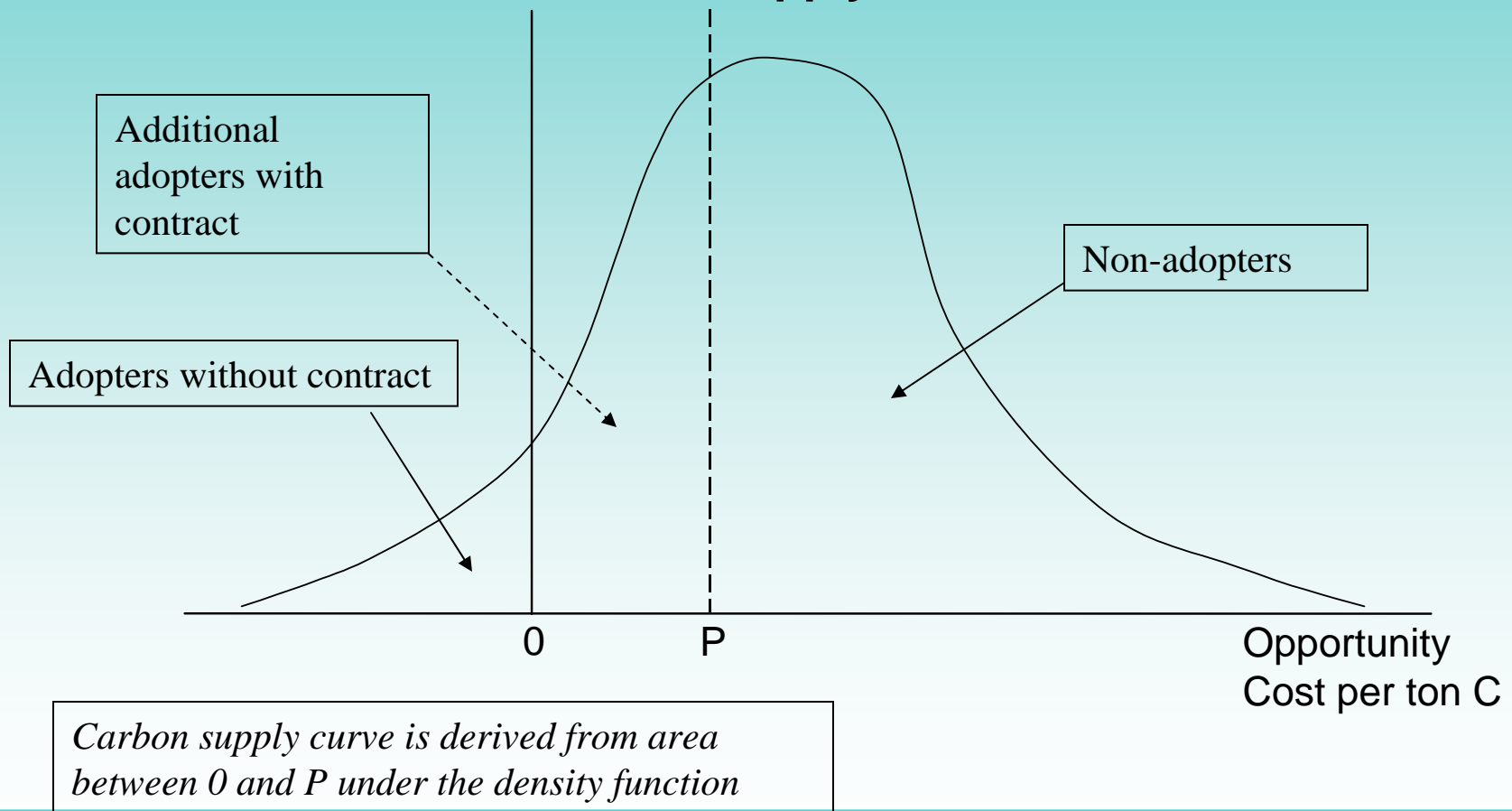
- Rates of change in soil C associated with a change in management
 - Changing from one practice to another increases soil C at an annual average rate of Δc tonnes/ha/yr
 - E.g., in Montana, changing from a crop-fallow rotation to continuous gives an average value of $\Delta c \approx 0.4$ t/ha/yr
- Farm Opportunity Costs: *What does the producer have to do to increase soil C, and how does that affect profitability?*
 - Change tillage practices?
 - Change crop rotation?
 - Change fertilizer rates?

Example: If a producer earns R_F per acre for a crop-fallow rotation, and earns R_C for a continuous crop, the opportunity cost of switching from crop-fallow to continuous is $(R_F - R_C)$.

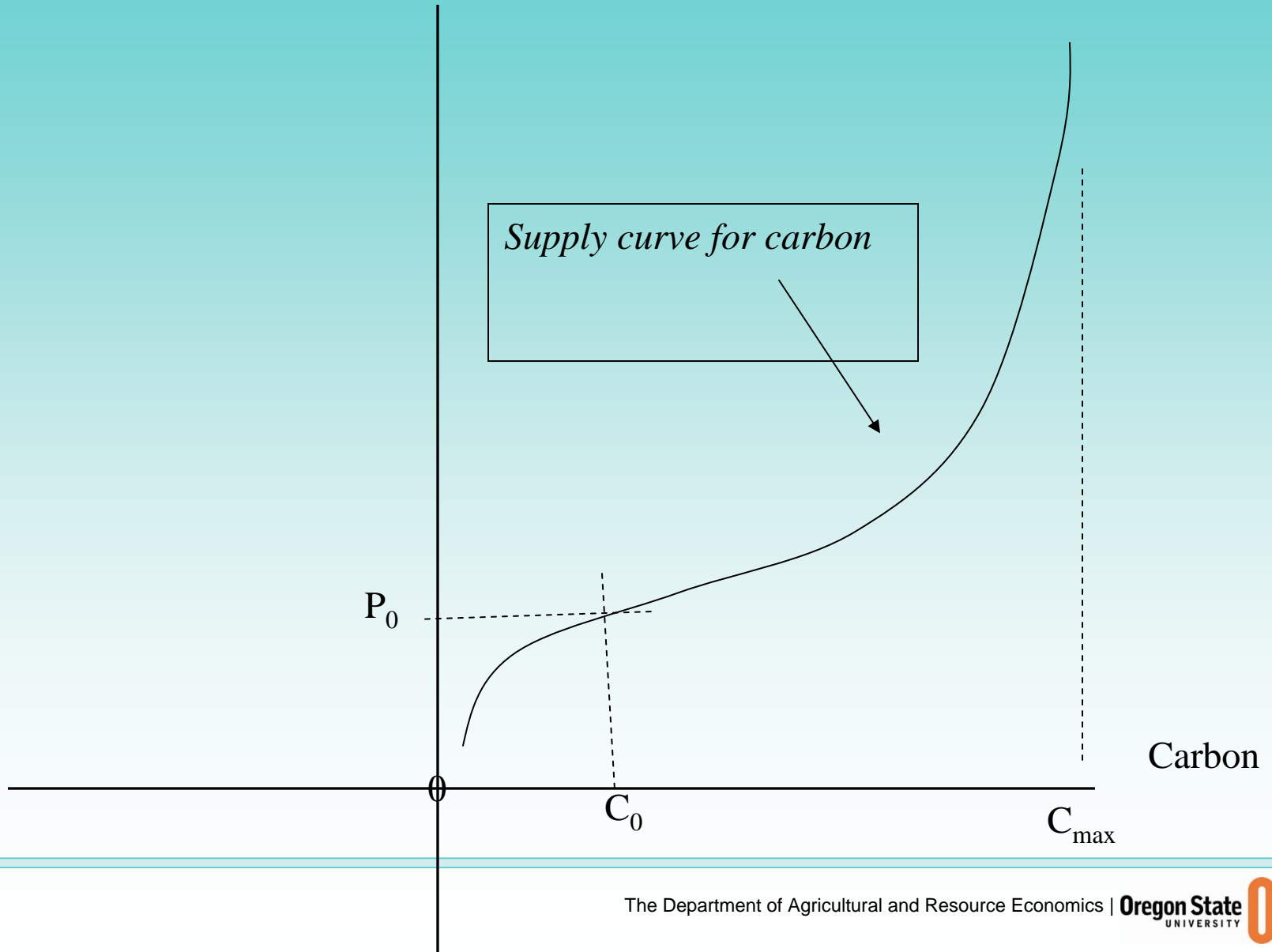
Technical Potential: Changing farm land use and management practices can restore soil C lost from use of “conventional” practices



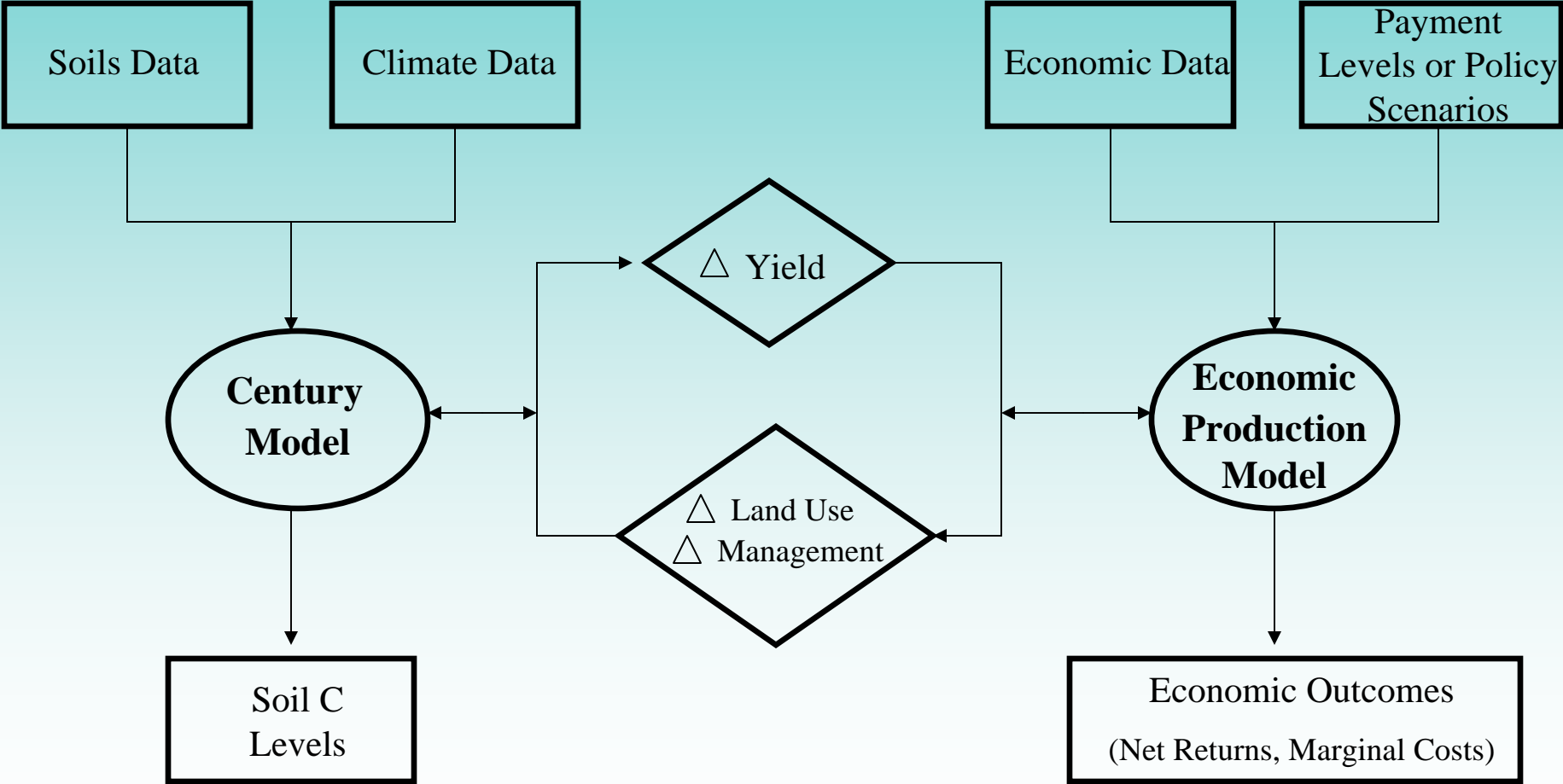
Spatial Distribution of OC, Contract Participation Decisions, and Carbon Supply Curves



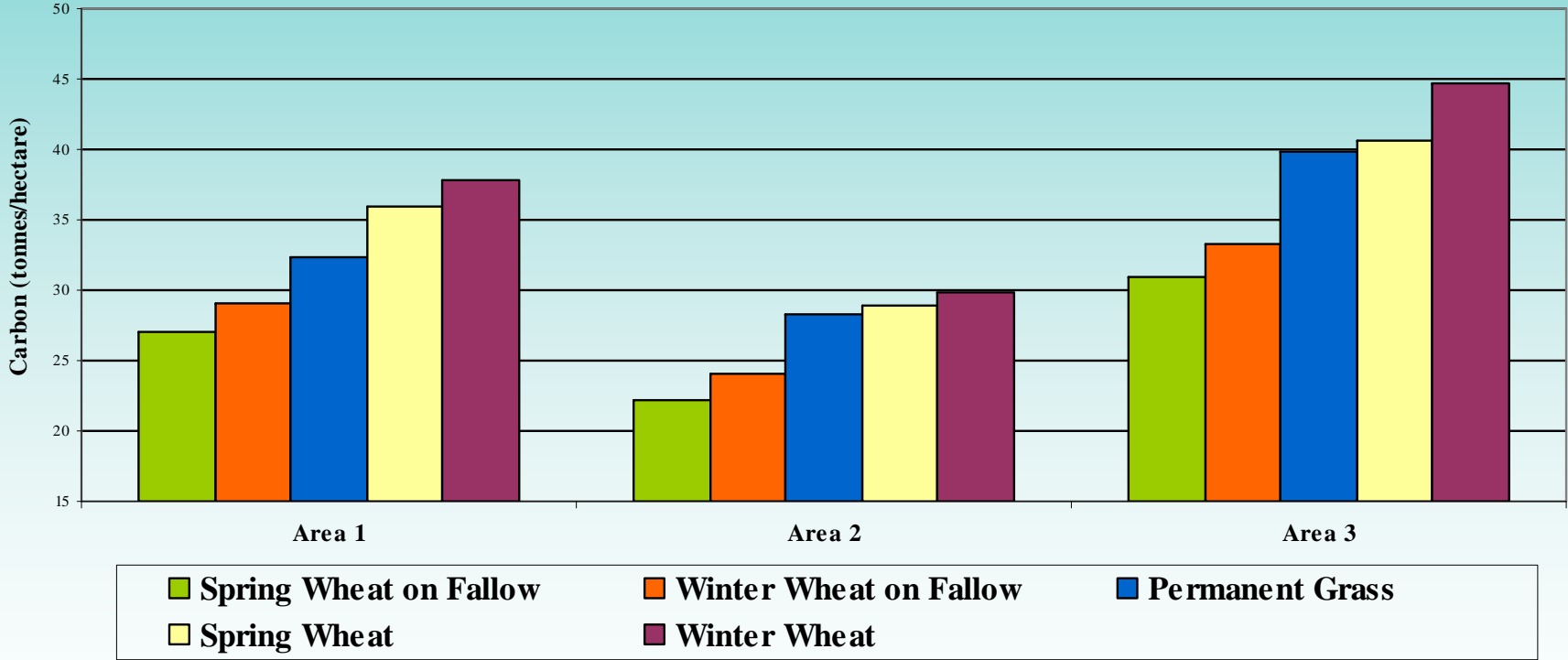
Carbon Supply Curve



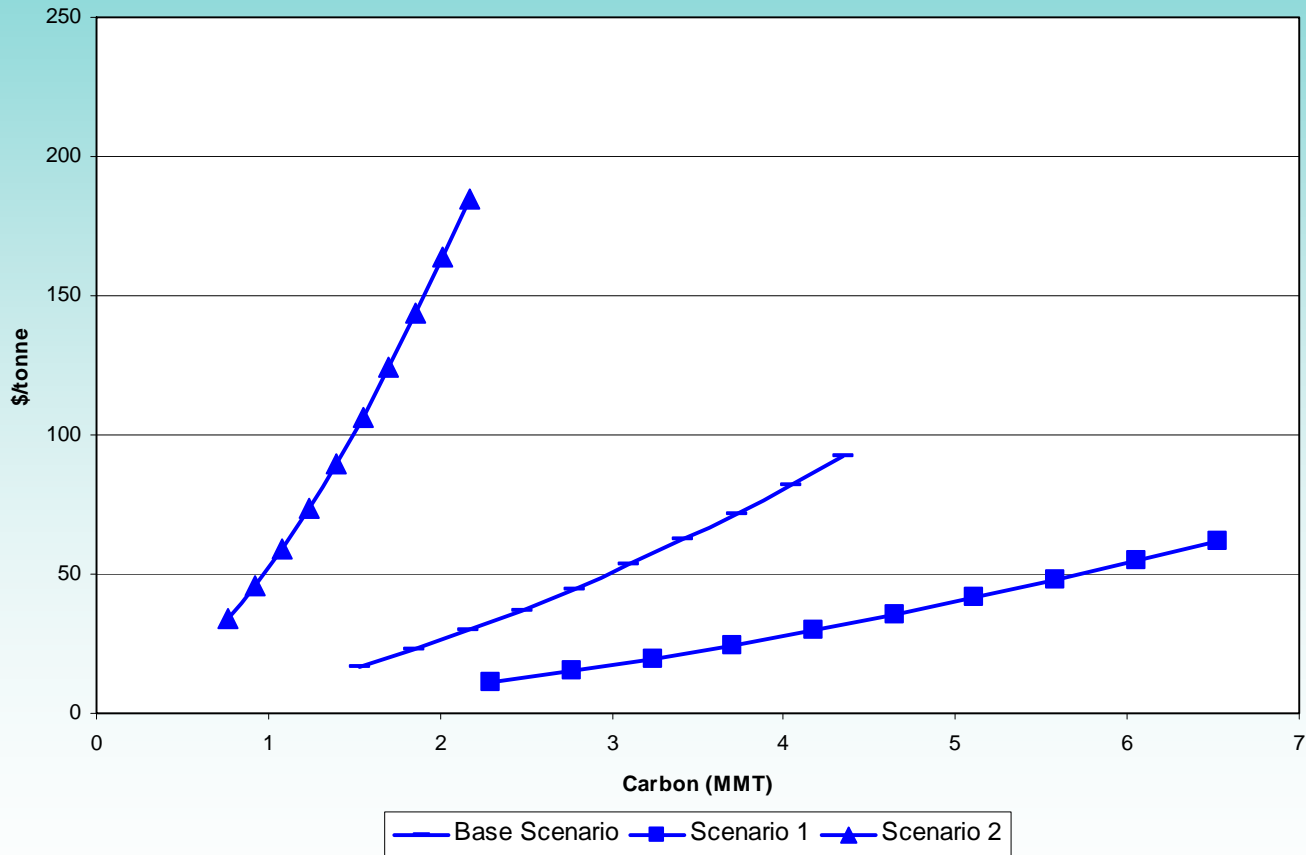
Linkage between Biophysical (Century) Model and Production Economic Model

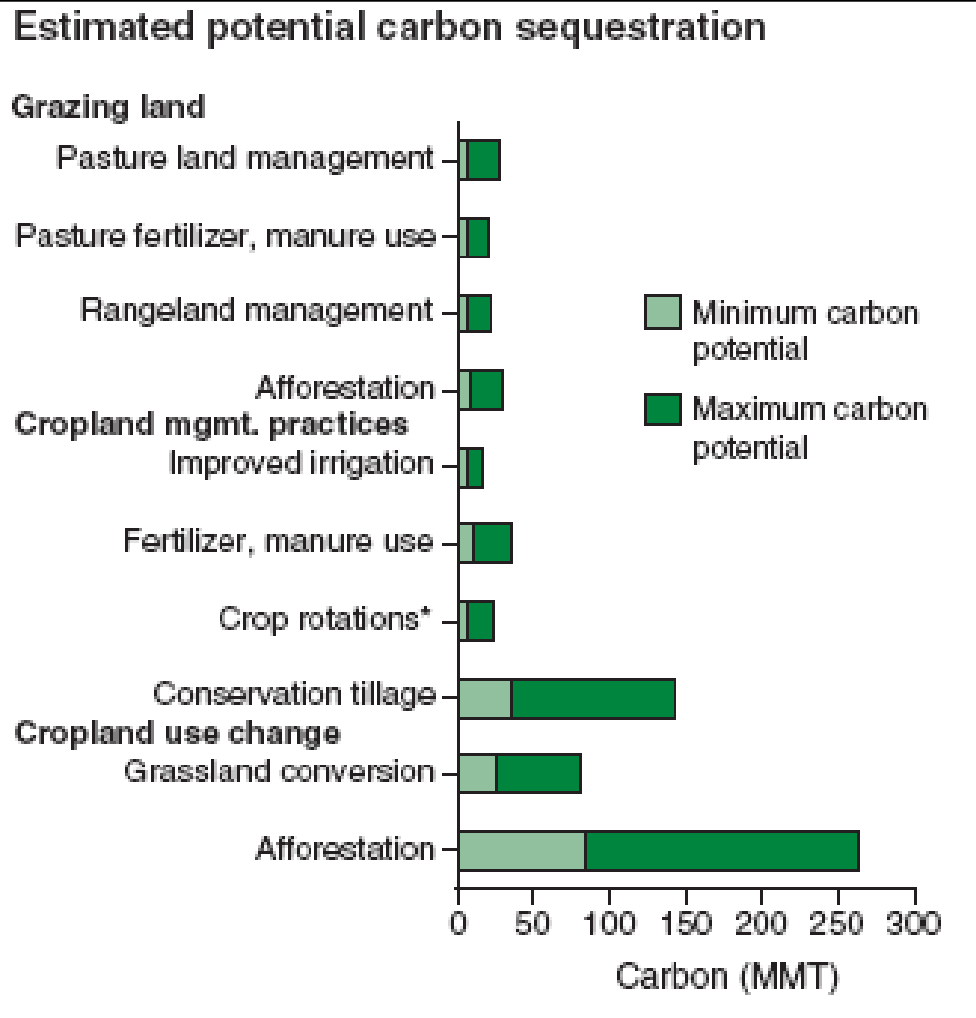


Soil Carbon Levels Predicted by the Century Model for Cropping Systems in Montana



Area 1: Golden triangle Area





Source USDA 2004 Economics of Sequestering Carbon in the U.S. Agricultural Sector
<http://www.ers.usda.gov/publications/tb1909>

Research needs and directions

- Expanded role for research at Land grant institutions: biotech, measurement technologies, environmental-economic-biophysical modeling
- Baseline information on Carbon in soils
- Information on the technical potential for additional sequestration by cropping systems and regions (research by LG institutions)
- Information on the economics of cropping systems (opportunity costs of switching)
- Protocols for Monitoring and verifying carbon – credible carbon