Indirect Impacts of Agricultural Windbreaks on Atmospheric Carbon Balance

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Agroforestry: As a mitigation and adaptation tool for Ag. under changing climate conditions

- Demands for food are increasing requiring higher yields/ha or an increase in land in agriculture
- Most of the best agricultural land is already being used
- Reducing atmospheric GHG is a key aspect of addressing the magnitude of potential climate change
- Must reduce additional GHG release or find ways to store them

- **Agroforestry does both!**
- Journal of Soil and Water Conservation 67:128A-134A; Schoeneberger et al. Sept/Oct 2012

Windbreak Benefits

- Store carbon
- Reduce wind speed
- Control erosion
  - Reduce blowing dust
  - Reduce heath problems
- Protect homes
  - Reduce energy use
  - Heating and cooling costs
  - Maintenance costs
  - Cleaning costs
- Alter microclimate
- Improve crop yields
- Improve crop quality
  - Better pollination
  - Better spray environment
  - Earlier to market
- Manage snow
  - Store it in small space
  - Spread it across the field
- Provide habitat
- Biodiverstiy
- Provide products
- Aesthetics
- Privacy
- Sound barriers

Windbreaks on Farms

Field & Farmstead

Livestock

Snow Management

Land removed from production (lower input costs – fuel, fertilizer and pesticides)
Reduced heating and cooling needs (energy savings)
Improved weight gains reducing time to market (reduced manure and methane)
Reduce irrigation costs (energy savings)
Reduced snow removal costs (energy savings)

Windbreaks on Farms

Field & Farmstead

Livestock

Snow Management

Land removed from production (lower input costs – fuel, fertilizer and pesticides)
Reduced heating and cooling needs (energy savings)
Improved weight gains reducing time to market (reduced feed costs & less manure)
Reduce irrigation costs (energy savings)
Reduced snow removal costs (energy savings)

Field Windbreaks

- Single or double parallel rows
- Occupy less than 5% of the total field area (3% better)
- The area removed from production reduces the level of inputs needed:
  - **Fuel**
  - **Fertilizers**
  - **Herbicides**
  - Labor
  - Equipment time

Farmstead Windbreaks

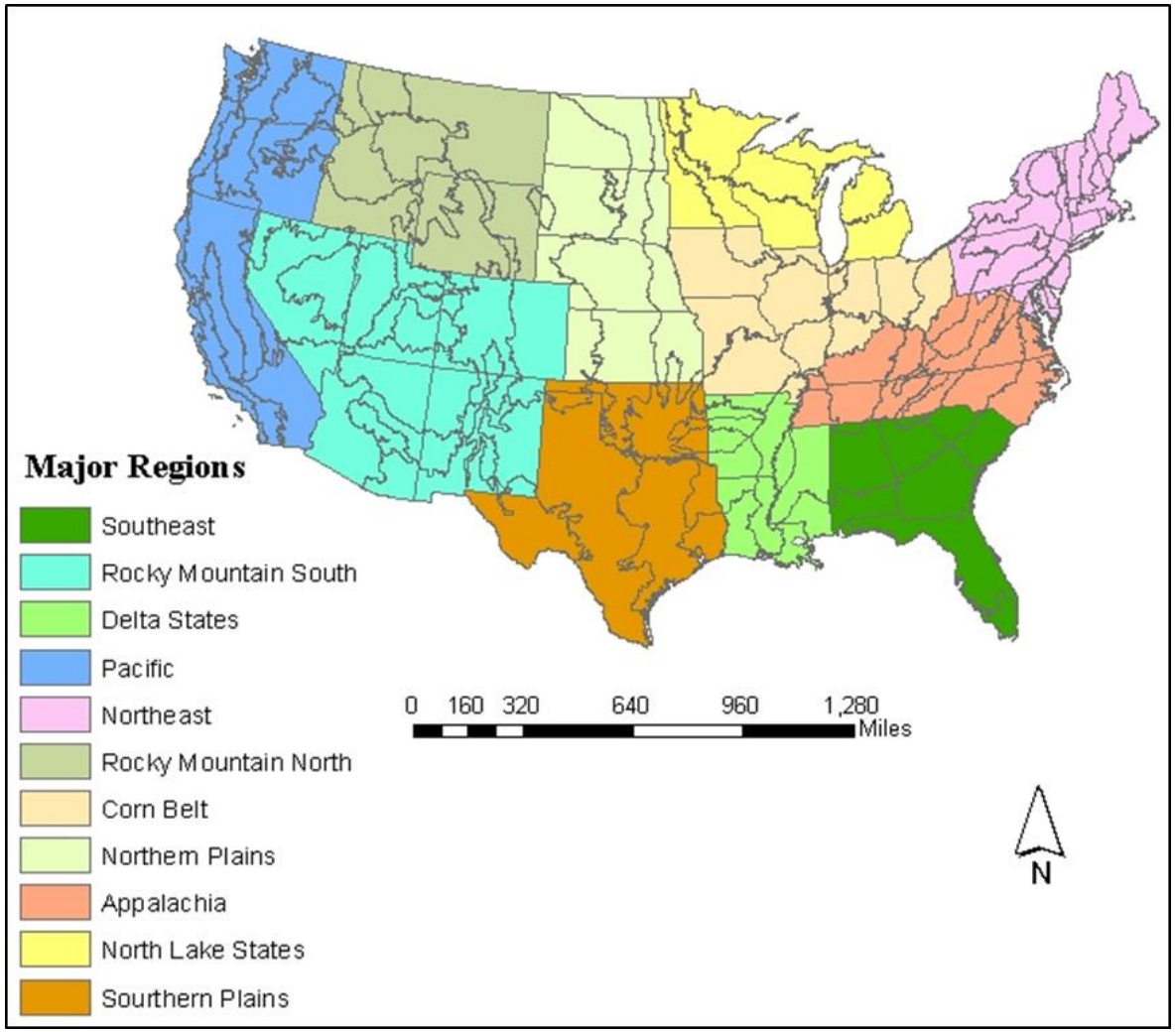
- Three to nine rows depending on climate
- 10 to 40 % reduction in heating costs
- 10% reduction in cooling costs
- Savings directly influenced by house construction/insulation

The carbon equivalent (CE) approach developed by Lal et al. (2004) was used to calculate the contributions of various operations and fuels

Fuel Source (One kg of fuel)	Equivalent carbon emission (kg CE)
Diesel	0.94
Coal	0.59
Gasoline	0.85
Fuel Oil	1.01
Propane	0.63
Natural Gas	0.85

For example: One kg of diesel fuel is equivalent to 0.94 kg CE

Regions of the Continental U.S.A.



Farm characteristics

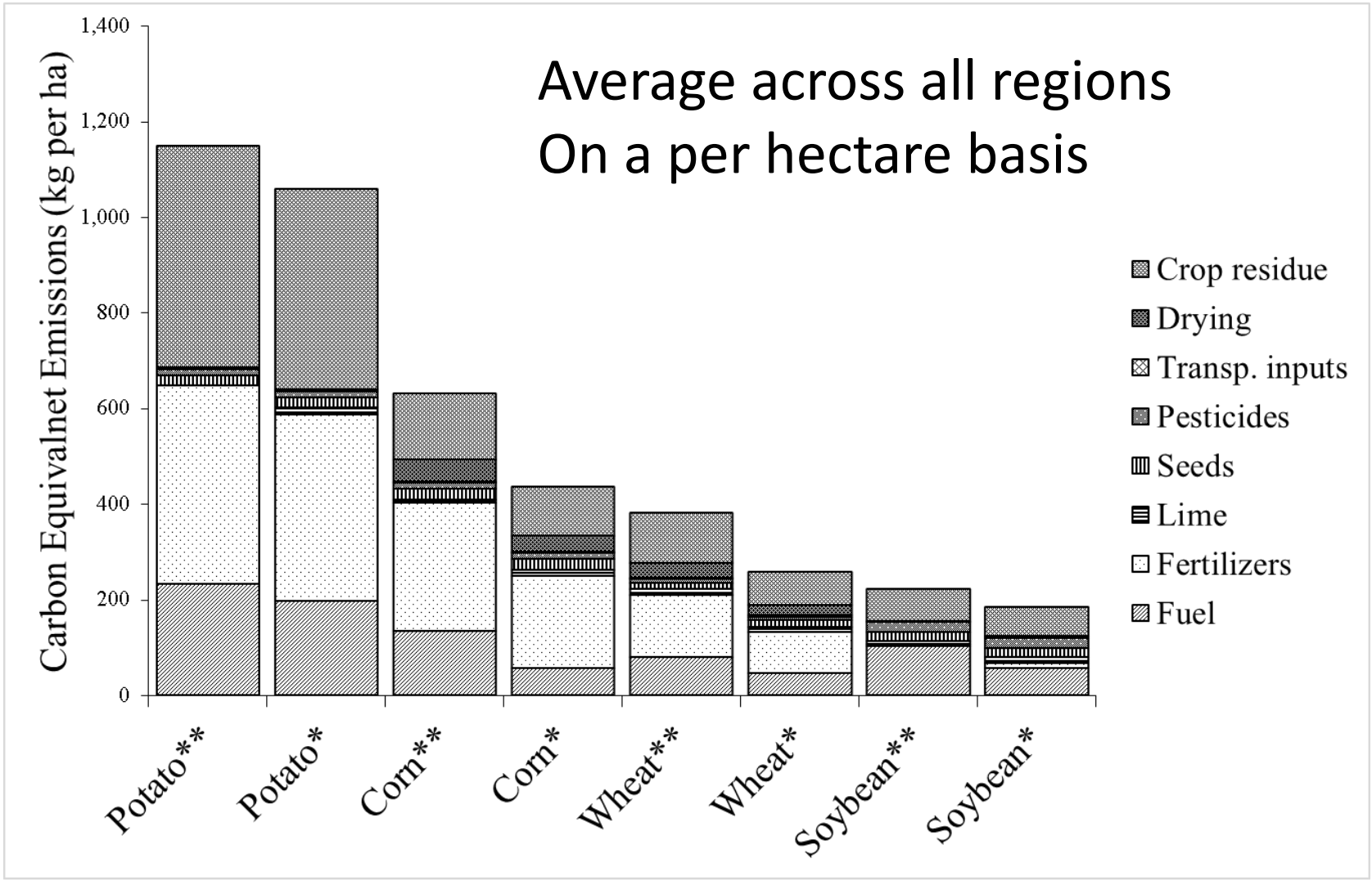
Fields

- Farm size
  - Small – 60 hectares
  - Medium – 300 hectares
  - Large – 600 hectares
- Crops – corn, soybean, winter wheat, potato
- Input costs from various State Crop Budget Ext. Publ. CO, ID, IA, KS, MT, NE, OH, TN, TX, WI

Farm home

- Adequate insulated
- Size of home (farmstead)
  - 230 square meters (2 ha)
  - 270 square meters (3 ha)
- Energy source
  - Propane
  - Electricity
- Energy use from US Energy Information Admin. (EIA)
  - Before & after 2000

Results for field windbreaks

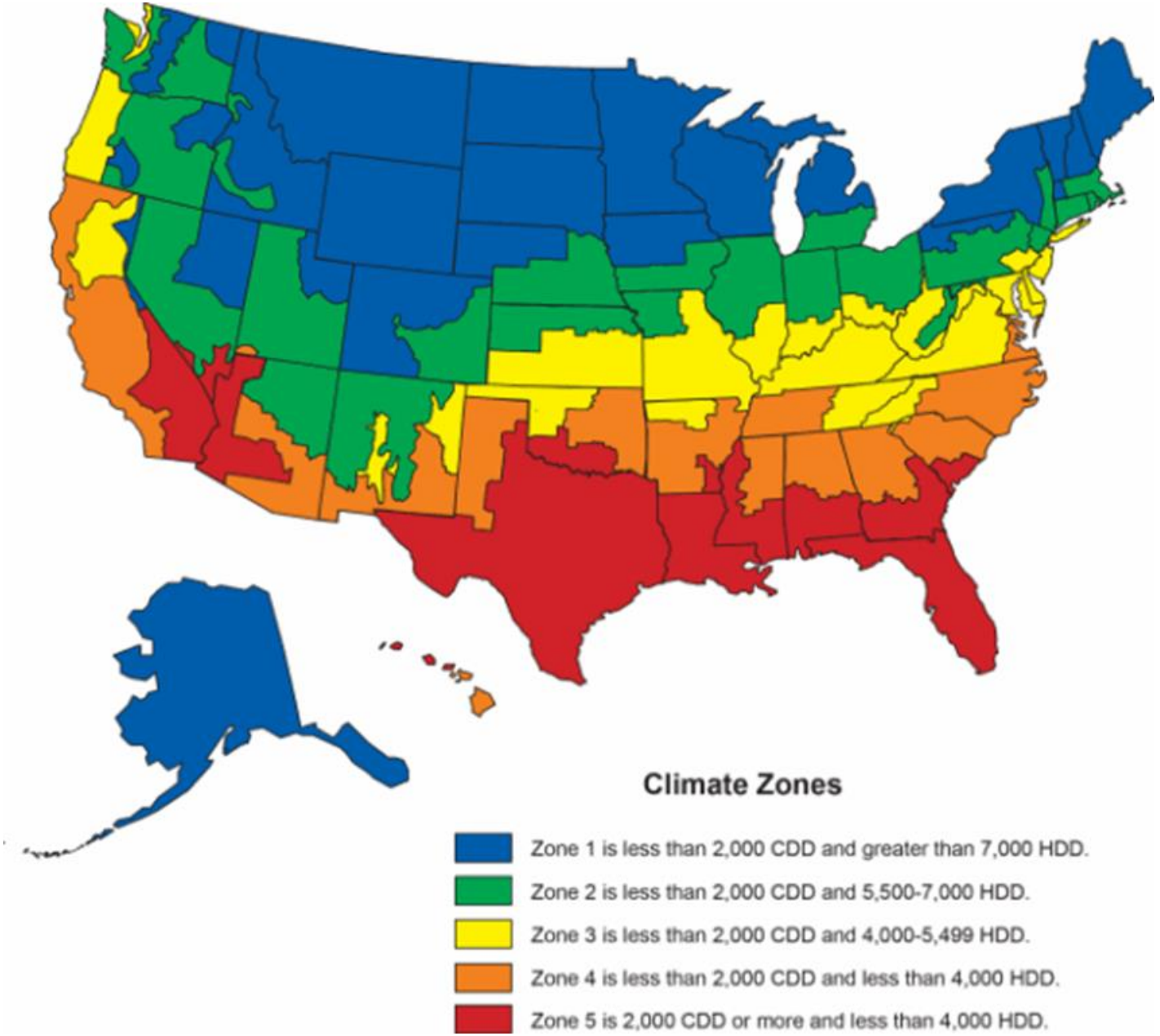


Carbon emissions avoided – corn/soybean/wheat
300 ha NE farm – 15 ha (5%) in Windbreaks

Cropotak	Corn	Soybean	Wheat
Yield (bu/Ac)	90	39	50
	Carbon equivalent emissions (kg CE/ha/yr)		
Fuel (diesel)	49	68	44
Fertilizers	125	0	78
Pesticides	8	21	8
Transportation	1	1	2
Drying	20	0	17
Crop residue	65	70	63
Reduction for 15 ha of windbreaks	**4020**	**2,400**	**3,180**

Farmstead Windbreaks

- Three to nine rows depending on climate
- 20% reduction in heating and cooling costs
- Savings directly influenced by house construction/insulation


Climate Zones
Zone 1 is less than 2,000 CDD and greater than 7,000 HDD.
Zone 2 is less than 2,000 CDD and 5,500-7,000 HDD.
Zone 3 is less than 2,000 CDD and 4,000-5,499 HDD.
Zone 4 is less than 2,000 CDD and less than 4,000 HDD.
Zone 5 is 2,000 CDD or more and less than 4,000 HDD.

Annual Carbon equivalent emissions and reductions from heating and cooling rural farm homes by climate zone

Built before 2000

(230 sq m on 2 ha)

Climate Zone	kg CE/yr.	20% reduction
Zone 1	1800	360
Zone 2	1500	300
Zone 3	1600	320
Zone 4	1700	340
Zone 5	2100	420

Built after 2000

(270 sq m on 3 ha)

Climate Zone	kg CE/yr.	20% reduction
Zone 1	1700	340
Zone 2	1500	300
Zone 3	1500	300
Zone 4	1800	360
Zone 5	1800	360