Modeling Wind Erosion

- Wind Erosion Equation:
  \[ E = f( I', K', C', L', V') \]
  - E is average soil loss
  - I’ is soil erodibility index
  - K’ is soil ridge roughness factor
  - C’ is climate factor
  - L’ is width of unsheltered field
  - V’ is equivalent vegetative cover factor
Soil Wind Erodibility Index (I’)

- Expresses the potential annual wind erosion in tons/acre/year, from a site that is wide, level, unsheltered, and isolated; has a bare, smooth, loose, and non-crusted surface; and has climate conditions like those in the vicinity of Garden City, Kansas

- Available on soil survey
Ridge Roughness Factor (K’)

• A function of Ridge height and frequency
• Therefore will change throughout the year based on tillage management
Climate Factor (C’)

• Incorporates wind velocity
• Also incorporates soil moisture content resulting from rainfall and evapotranspiration.
Width of Field Factor (L’)

• Unsheltered distance across the field
• Incorporates the deviation from prevailing wind direction
  – Important when estimating erosion when ridges/crops are placed perpendicular to prevailing wind direction.
Vegetative Factor (V’)

• Incorporates the amount, and geometry of vegetation on the soil surface.
Limitations of the Wind Erosion Equation

• Empirical equation similar to USLE
  – Based on experimental observations
• Assumes that soils (texture and ridges) are homogeneous
• The Original C’ factors were only suitable for use in the high plains region of the U.S
• Did not account for Random roughness
• Did not account for effects of soil freezing, which renders them nonerodible
Limitations of the Wind Erosion Equation

• The factors in the WEQ often interact with each other and therefore it requires complex equations and tables
  – However these do not accurately account for the complex interactions affecting wind erosion

• Therefore the NRCS developed Revised WEQ and an Excel spreadsheet
  – [Website](#) containing RWEQ
Revise Wind Erosion Models

• More accurately portrays the physical processes of wind erosion
• Estimates wind erosion based on wind velocity, rainfall characteristics, soil roughness, erodible fraction of soil, crusts, surface residues and other dynamic factors.
• Under continuous development to incorporate a greater # of conditions
Wind erosion Prediction System

- Process based and provides continuous, daily time-step estimates of erosion
- Can predict erosion from nonuniform fields
- It can estimate suspension separate from saltation and creep
  - RWEQ and WEQ did not distinguish between them.
- Can predict erosion from a single storm on a daily, weekly, monthly or yearly basis.
- Website for WEPS
Management of Wind Erosion

• Goals:
  – Reduce wind speeds at the soil surface
  – Remove abrasive material from the wind stream
  – Reduce soil erodibility

• Maintaining permanent vegetation and/or residue is the most effective way to minimize wind erosion
Wind breaks

• Strips of trees, shrubs or tall grasses.

• Reduce wind speeds
  – Wind velocities will be reduced for a distance 30-35 times the height of the wind break on the downwind side
  – Velocities can be reduced by 70% at a distance of 10X the height of the break.

• Trap eroding material

• Can shorten length of eroding surface
Some Limitations to the use of Wind Breaks

• Lack of suitable species for the environment.
• Loss of cropland acres
• High cost of establishment.
• Host for pests
• Attraction for birds that may consume grain crops
• Competition of barrier with crops for light, water and nutrients.
Crop Residues

• Increase surface roughness
• Standing/anchored residue combined with coarse residues on the soil surface is the most effective practice to control wind erosion
  – Maintains surface soil moisture, which decrease erodibility
• Protects emerging seedling from abrasion
Flat(detached) vs Standing (anchored) Residues

• Standing/intact residue is much more effective than flat detached residue
• Detached residue can simply blow away
• Standing residue reduces wind velocities near the surface and will capture suspended and saltating particles near the surface.