Give me a break!
Using forest windbreaks to reduce crop gene flow.

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Crop gene flow and coexistence
Windbreaks
Switchgrass pollen dispersal
Forest windbreaks to reduce pollen drift
Final thoughts
Gene Flow

Movement of genes from one plant population to another through pollen or seed

Crop-to-crop, Crop-to-wild, Crop-to-weed
Gene Flow through Pollen.

Engineered Corn (yellow)  Conventional/Organic Corn (blue pollen)

Harvested seed can carry genes from neighboring fields
Gene Flow through Seeds.

Unintended presence of genetic lines before planting, at harvest, in storage, or in the food chain. (adventitious presence, low level presence)
GE Crops in the U.S. – Gene Flow and LLP

Corn

Soybeans

Cotton

Sugar Beets

Canola (rapeseed)

Alfalfa
Why control gene flow?

- Ensure coexistence for all farming systems
- Reduce risk or perception of risk
- Protect crop & seed exports
- Protect native plants and habitats
- Contain experimental field trials
- Maintain seed purity
- Prevent economic losses due to unintended presence
Coexistence in Farming Systems.

- Organic
- Conventional
- Genetically Engineered
- Other
Recent Activities

• USDA Stakeholder Workshop on Coexistence (2015)
• USDA Advisory Committee on Biotechnology & 21st Century Agriculture (AC21) (Report 2012)
• USDA web site on coexistence
• Seed industry recommendations
• Organic farming and seed association recommendations
• Academic research
Windbreaks

Field wind velocity — 30 mph

27 mph 21 mph 10 mph 15 mph
200 feet 50 feet 200 feet

NDSU extension bulletin
Ecosystem Services

- Soil erosion
  - Sand
  - Silt
  - Clay

- Water quality

- Pollinators

- Habitat and migration

- Carbon sequestration
Benefits for Agriculture

- Protect Livestock
- Protect Crops
- Reduce pesticide drift
- Protect organic practices

USDA ORGANIC
Windbreaks can reduce pesticide drift.

From USDA (2000)
Features: Height, density, length, orientation to prevailing winds, and continuity.

Figure 1. Windbreak protection zone

Upwind shelter = 1-3 times height
Downwind = 5-20 times height
Switchgrass: A model for studying pollen dispersal.
Panicum virgatum (switchgrass)

Image: Casler et al, 2011
Switchgrass has been engineered for biofuels.
Predicting switchgrass pollen dispersal.

- Pollen source strength: 141 Billion pollen/hectare
- Pollen size: 47 microns
- Pollen lives about 60 minutes
- Three types of switchgrass populations occur in Northeast

Native  Cultivated/Biofuel  Weeds
Predicting switchgrass pollen dispersal using Lagrangian model. Two wind conditions gave estimates of 3.5-6 km dispersal.

Ecker, Meyer, Auer. 2013
Can forest windbreaks reduce pollen dispersal and gene flow?
Forest windbreak experiment at UConn.
The forest windbreak reduced pollen concentrations by 333-20,000 fold.
How does it work?

- Pollen is trapped on leaves and other surfaces
- Lower wind speed allows pollen to settle out
- Pollen deflected and diluted in large volume of air
Research Conclusions

• Forest windbreaks can greatly reduce downwind pollen concentrations
• Windbreaks might reduce gene flow below the thresholds for adventitious presence (example <0.9%)
• Windbreaks offer many benefits for humans and the environment
• Additional research and computer models are needed to improve windbreak design
Challenges

• More tools are needed to control gene flow, segregate crops, and support coexistence of farm systems
• Tools must be practical, open source, low cost, and adaptable to different crop species and sites
• Market forces alone are unlikely to resolve conflicts
• Policies and programs are needed to support stewardship
Publications


Ecker, Zalapa, and Auer. 2015. Switchgrass (Panicum virgatum L.) genotypes differ between coastal sites and inland road corridors in the Northeastern US. PLOS One DOI:10.1371/journal.pone.0130414


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