Windbreaks

Some Basic

Whats, Whys and Hows

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USDA National Agroforestry Center

What to Expect

- Working definition
- Brief history of where windbreaks work
- How windbreaks work
- How we make windbreaks work
- Work you can do to improve understanding of windbreaks
- Possible future windbreak work

Windbreak Definition

- A barrier placed on the land surface that obstructs the wind flow and alters flow patterns both up-wind (windward) and down-wind (leeward) of the barrier.
- Plantings of single or multiple rows of vegetation (trees, shrubs, grass) that are established for one or more environmental and economic purposes.

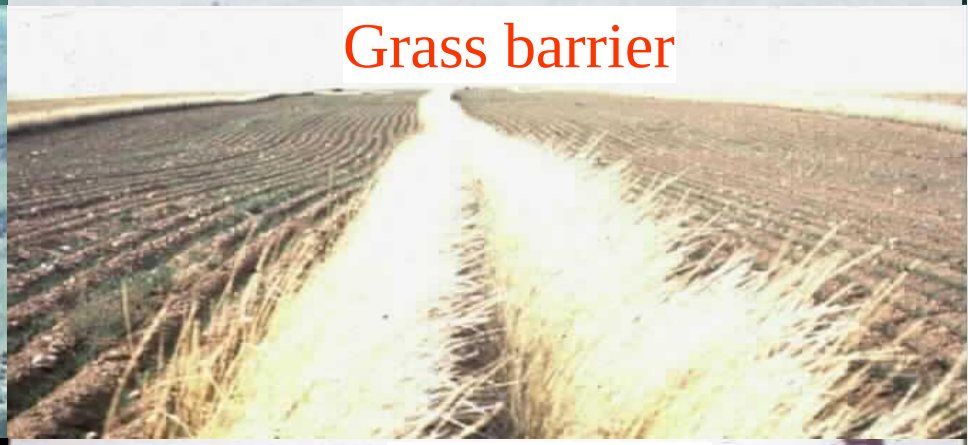
Not a Windbreak

Tree row

Fabric & Gates

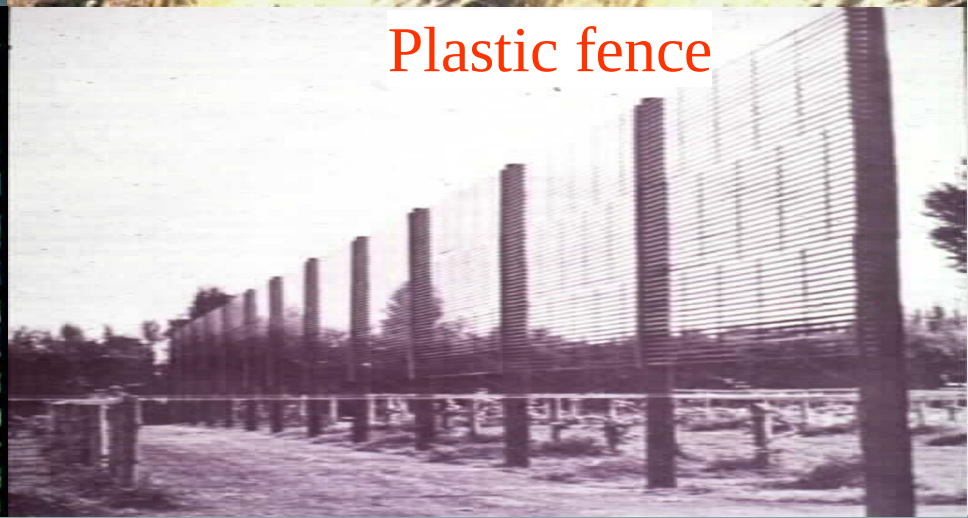
Shrub barrier

Grass barrier



Slat fence

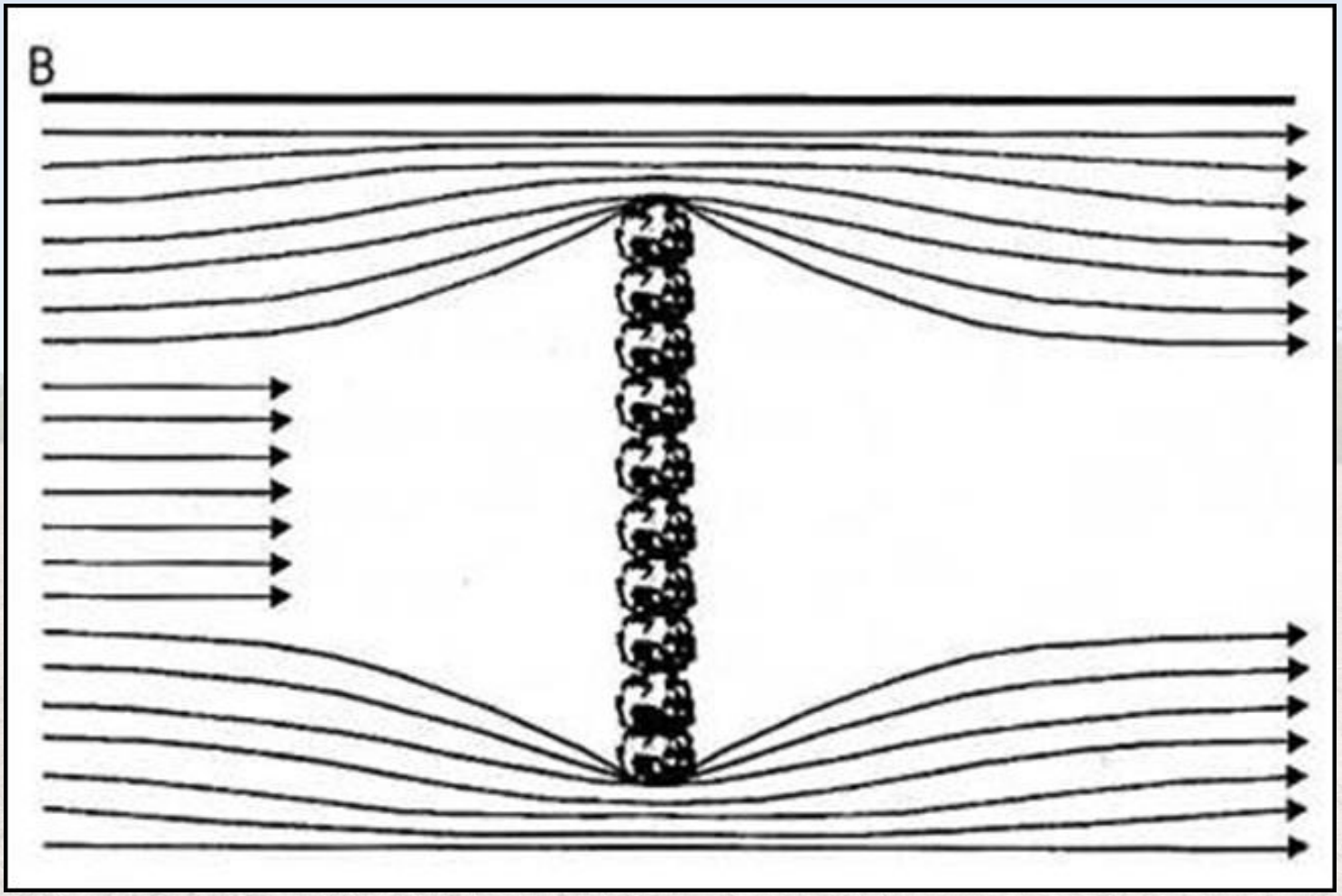
Plastic fence



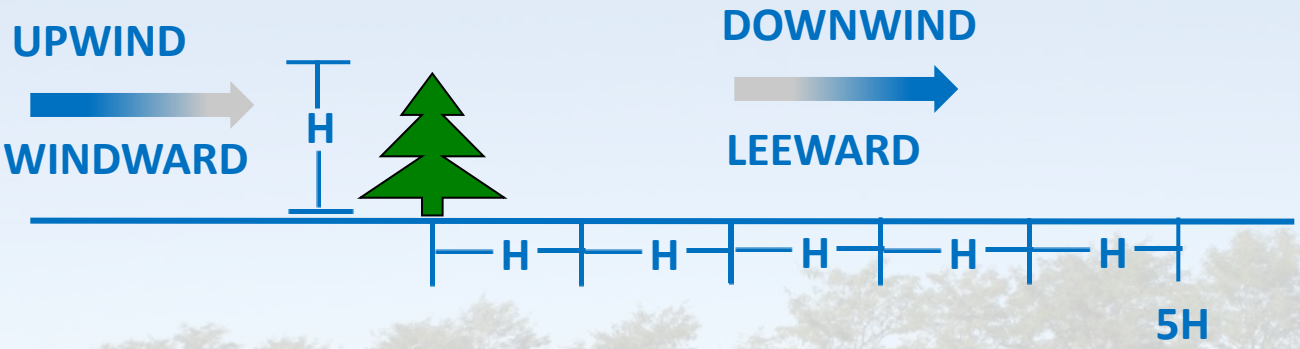
Brief History

- Scottish Parliament urged the planting of tree belts to protect agricultural production in the mid-1400's
- Westward expansion in the U.S. saw homesteaders planting windbreaks
- Dust Bowl conditions led to the Prairie States Forestry project
- 1930's Conquest, Saskatchewan project included planting 960 miles of shelterbelts using about 7 million seedlings

What does it mean to break wind?



Wind Speed is Reduced



	Open wind speed 20mph / multi-row 60-80% density				
H - distance from windbreak	5H	10H	15H	20H	30H
MPH	5	7	13	17	19
% open wind speed	25%	35%	65%	85%	95%

So what if the wind is slower?

How does the change in wind speed affect microclimate?

- The change in wind flow affects the exchange rates between the surface of an object and the air above that object.
- The net vertical motion of air parcels is brought about by turbulent transfer.
- As these parcels move up they carry with them the various “properties”.

How does the change in wind speed affect microclimate?

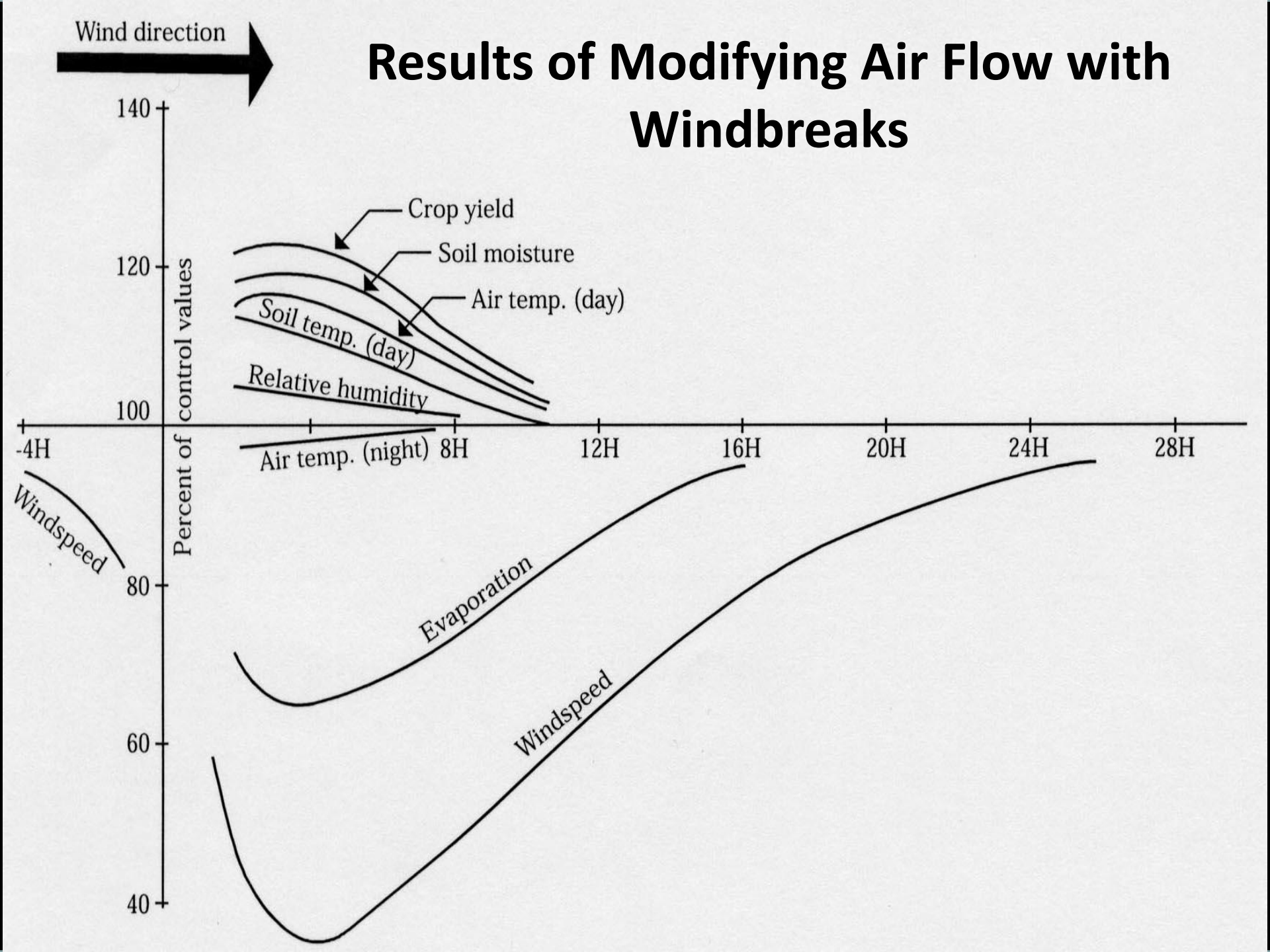
- Almost any measurable property of interest in the atmosphere is moved from levels of high concentration to levels of low concentration.
- Properties such as:
  - Water vapor - Pollen
  - Heat - Ozone
  - Dust - Carbon dioxide

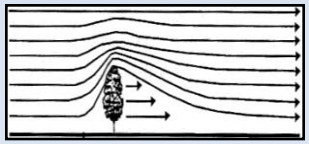
How does the change in wind speed affect microclimate?

Also:

- Lower wind velocity causes particulate matter to be deposited
- Windbreak vegetation physically traps particulate matter
- Windbreak vegetation may adsorb some of the chemicals attached to particulate matter

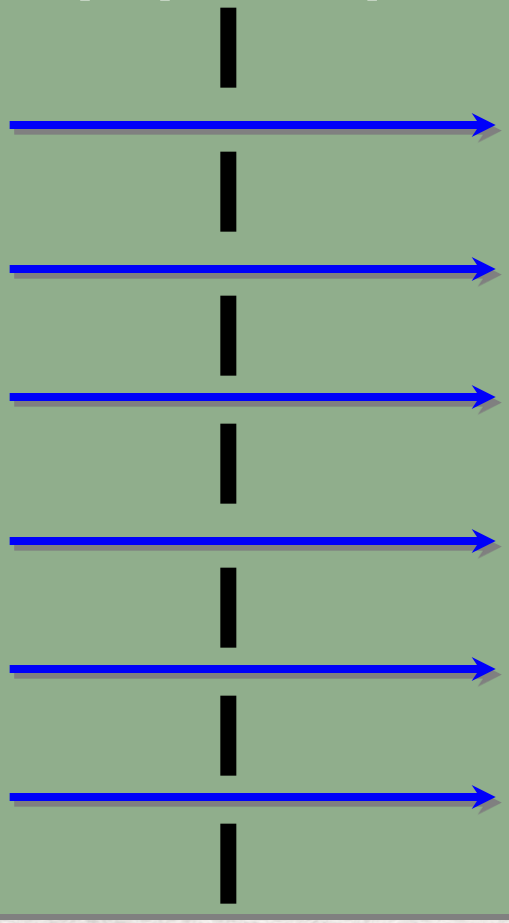
Results of Modifying Air Flow with Windbreaks





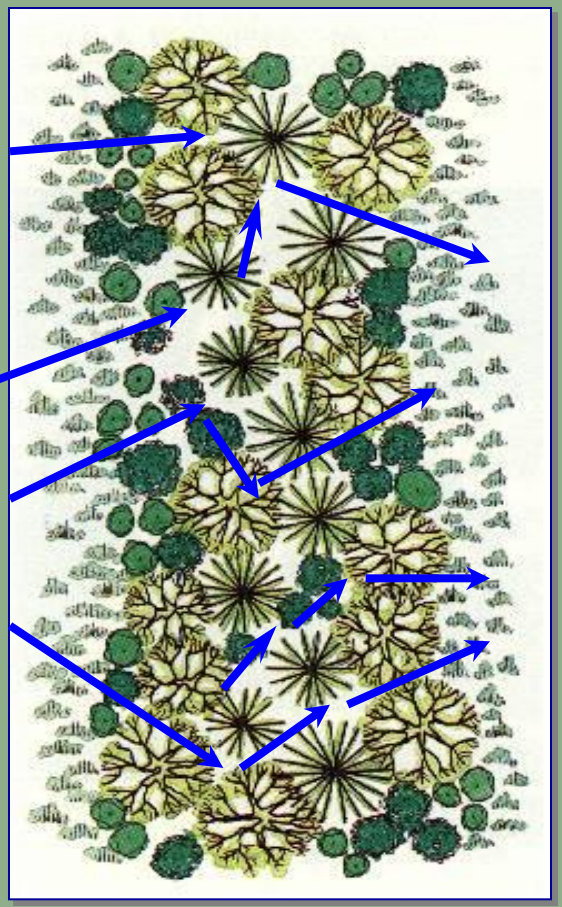
Air Flow Differences

2-D fence (top view)

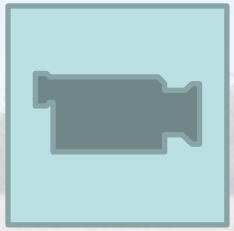


vs

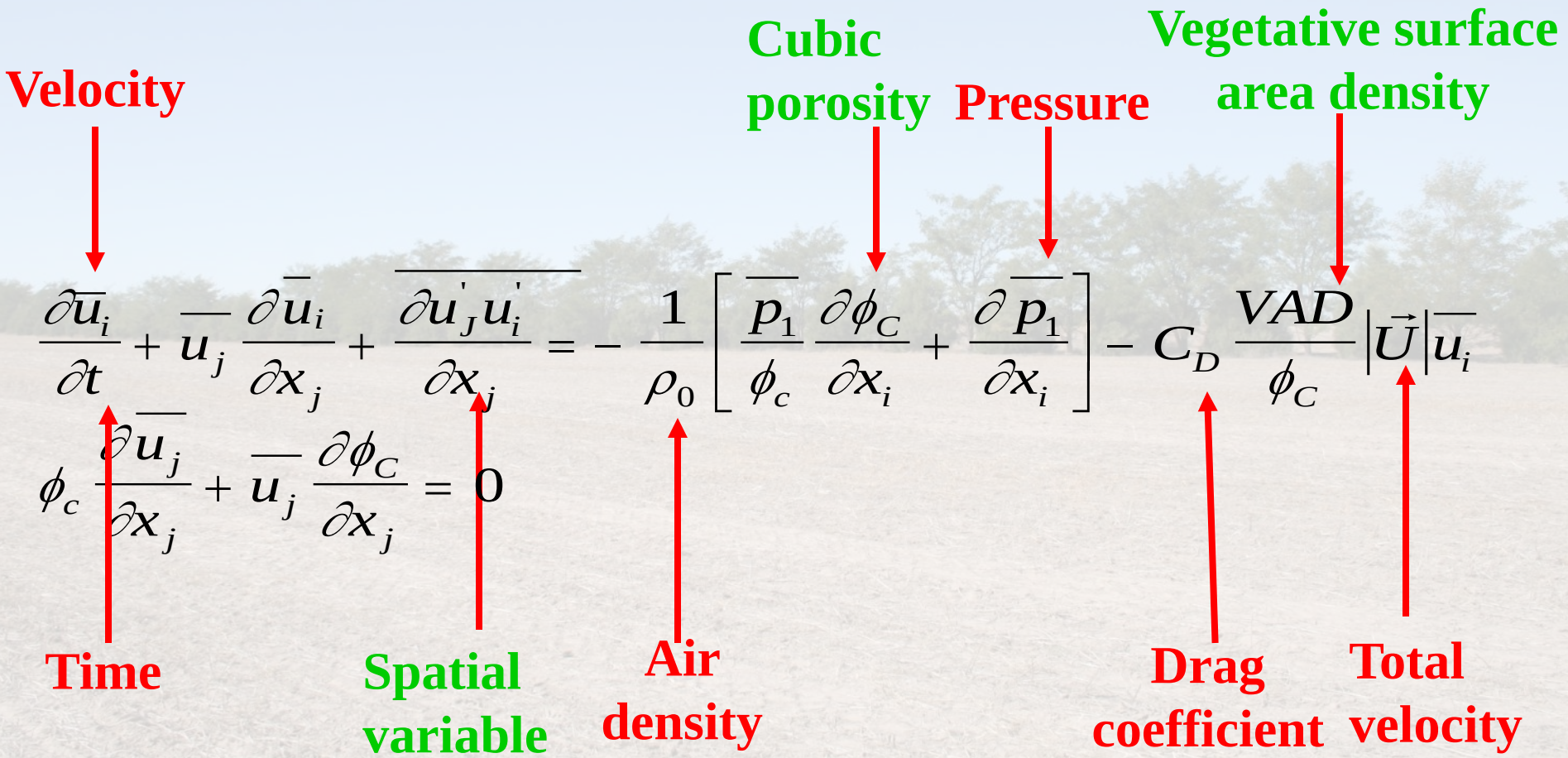
3-D barrier (top view)



Video Intermission



Proposed Turbulence Model Around a Tree Shelterbelt:



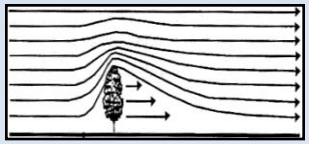
Field Windbreaks

Livestock Windbreaks

Farmstead Windbreaks

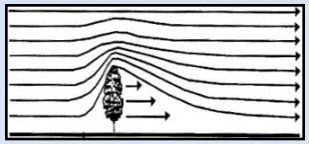
Snow management

Types of windbreaks: specialty



Vegetable Response to Wind Protection

Crop	Response
Broccoli	Increased leaf area
Pepper	Reduced bacterial spot; Improved yield in dry years; Larger plants; Earlier flowers; Greater yields
Potato	Earlier sprouting and ripening; Increased yield and quality
Snap bean	Reduced disease; Earlier ripening; Larger leaf area; Increased yield of marketable beans
Tomato	Reduced sandblast injury; less flower abortion; greater fruit set; Increased yield of high quality fruit
Cabbage	Greater yield and improved tenderness
Melon	Longer vines; Earlier flowering and fruit maturity; Increased yield
Carrot	Improved germination; Reduced sandblasting
Cucumber	Reduced vine damage; Increased yield
Lettuce	Reduced sandblast injury; Increased yield



Fruit Response to Wind Protection

Crop	Response
Raspberry	Reduced desiccation of canes; Improved yields and fruit quality
Strawberry	Increased yields and fruit quality
Plum	Increased yield and more marketable fruit
Anjou pear	Improved quality of fruit
Grape	Reduced desiccation of young vines; Improved growth rates and yields; Reduced leaf damage and rubbing of grape bunches; Improved quality
Citrus	Increased total sugar, Vitamin C and yield; Decreased premature fruit fall; Decreased fruit damage and improved fruit quality
Valencia orange	Improved yield of marketable fruit
Naval orange	Decreased premature fruit fall
Kiwi fruit	Improved yield of marketable fruit

Field Windbreak - Benefits

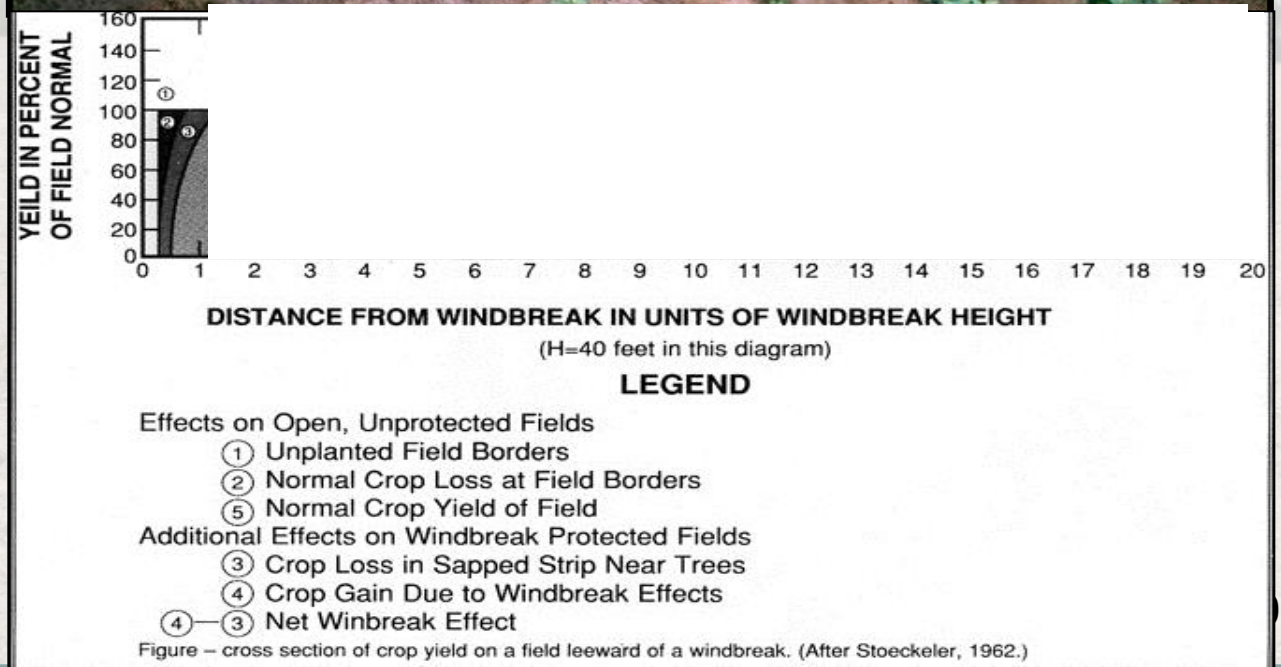


Figure – cross section of crop yield on a field leeward of a windbreak. (After Stoeckeler, 1962.)

<u>Weighted Average Crop Yield Increase</u>:

Corn - 12%

Soybeans -13%

Winter Wheat - 23%

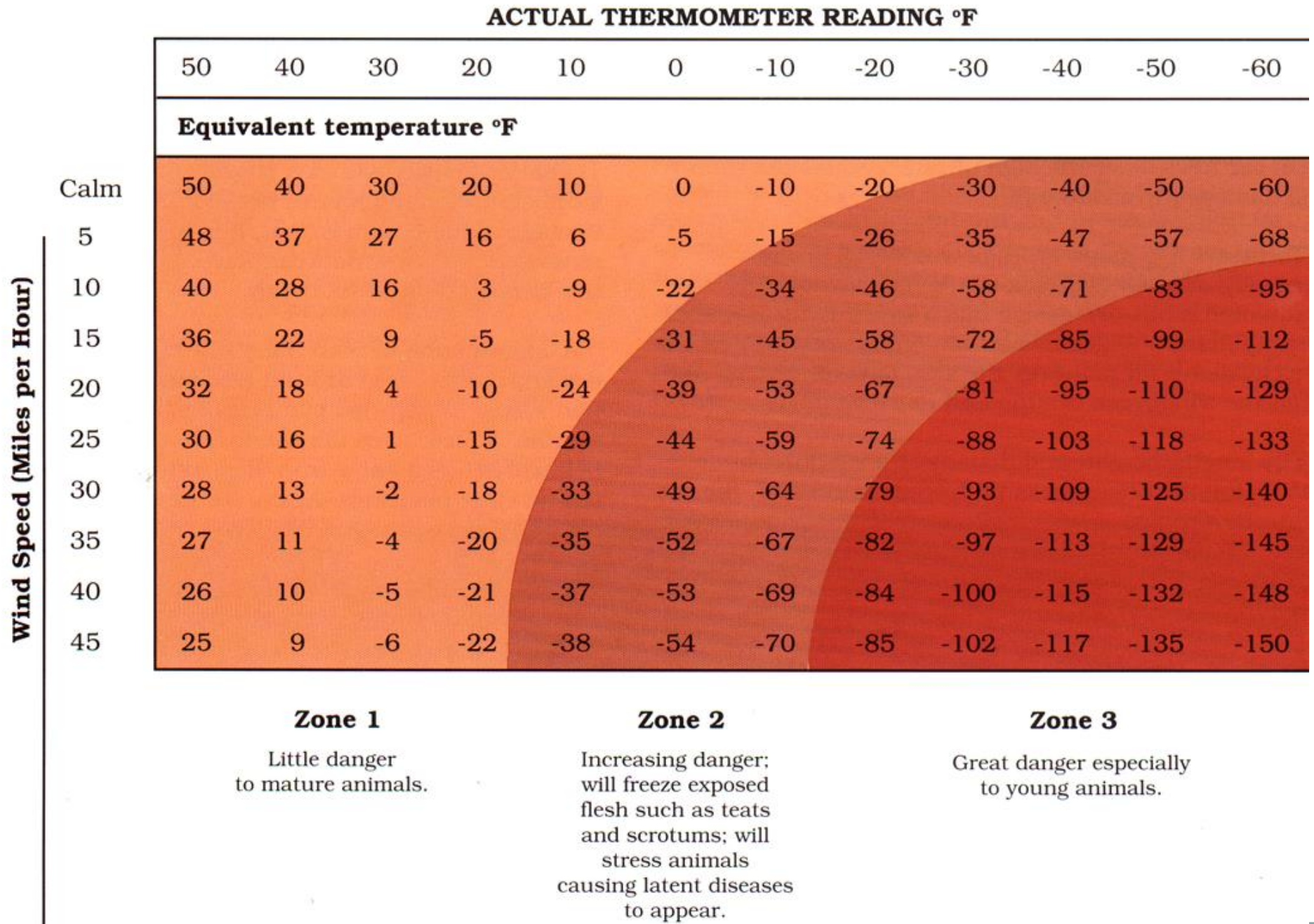
Spring Wheat - 8%

Hay - 20%

(Kort, 1988)

Livestock Response to Cold & Windchill

Maintenance Energy Requirements for Cattle Below Critical Temperature							
		Beef Animal Weight (lbs)					
		440	660	880	1100	1200	1320
Description	**Critical Temp**	**Percent Increase per Degree of Cold (F)**					
Summer Coat or Wet	59	2.3	2.1	2.0	2.0	1.9	1.9
Fall Coat	45	1.5	1.4	1.4	1.3	1.3	1.3
Winter Coat	32	1.2	1.1	1.1	1.0	1.0	1.0
Heavy Winter Coat	18	0.7	0.7	0.7	0.7	0.6	0.6

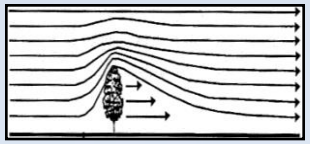

ACTUAL THERMOMETER READING °F
50 40 30 20 10 0 -10 -20 -30 -40 -50 -60
Equivalent temperature °F
Wind Speed (Miles per Hour)
Calm 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60
5 48 37 27 16 6 -5 -15 -26 -35 -47 -57 -68
10 40 28 16 3 -9 -22 -34 -46 -58 -71 -83 -95
15 36 22 9 -5 -18 -31 -45 -58 -72 -85 -99 -112
20 32 18 4 -10 -24 -39 -53 -67 -81 -95 -110 -129
25 30 16 1 -15 -29 -44 -59 -74 -88 -103 -118 -133
30 28 13 -2 -18 -33 -49 -64 -79 -93 -109 -125 -140
35 27 11 -4 -20 -35 -52 -67 -82 -97 -113 -129 -145
40 26 10 -5 -21 -37 -53 -69 -84 -100 -115 -132 -148
45 25 9 -6 -22 -38 -54 -70 -85 -102 -117 -135 -150
Zone 1
Little danger to mature animals.
Zone 2
Increasing danger; will freeze exposed flesh such as teats and scrotums; will stress animals causing latent diseases to appear.
Zone 3
Great danger especially to young animals.

What are the qualities of a windbreak's design we control?

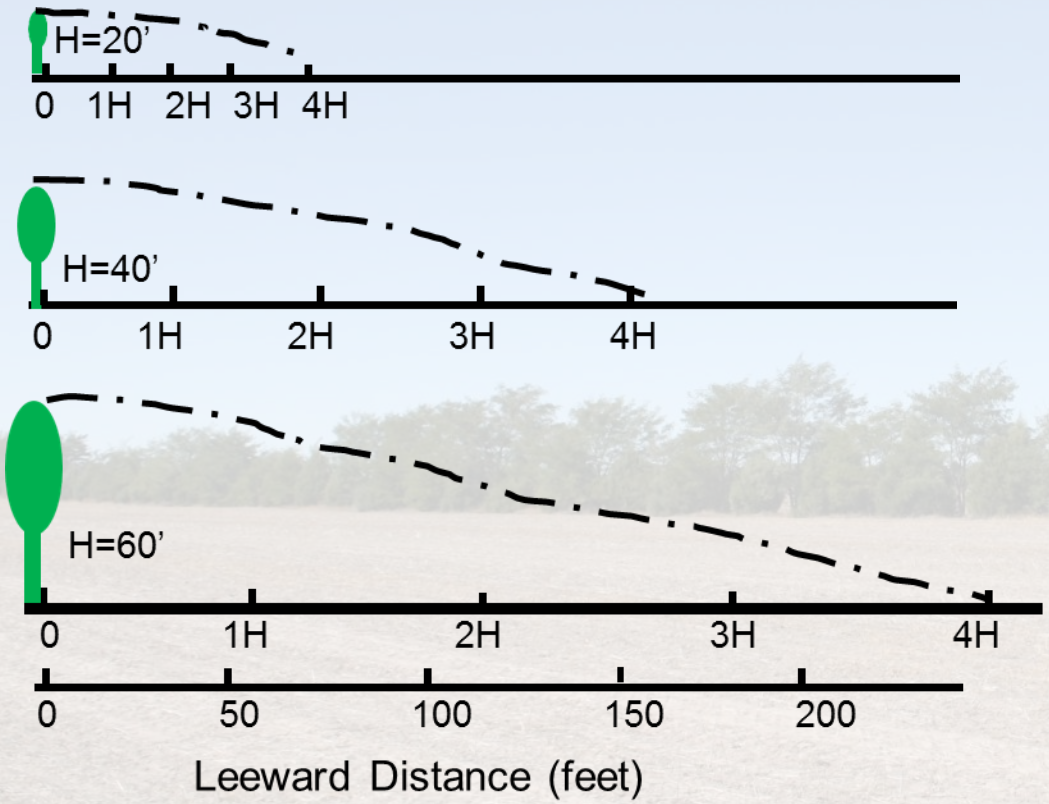
Windbreak function depends upon six key windbreak elements:

- **Height**
- **Density**
- **Orientation**
- **Length**
- **Width**
- **Continuity**

Criteria for elements vary by purpose

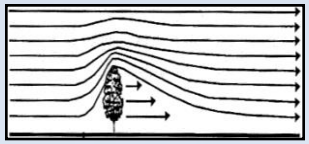


Windbreak Height

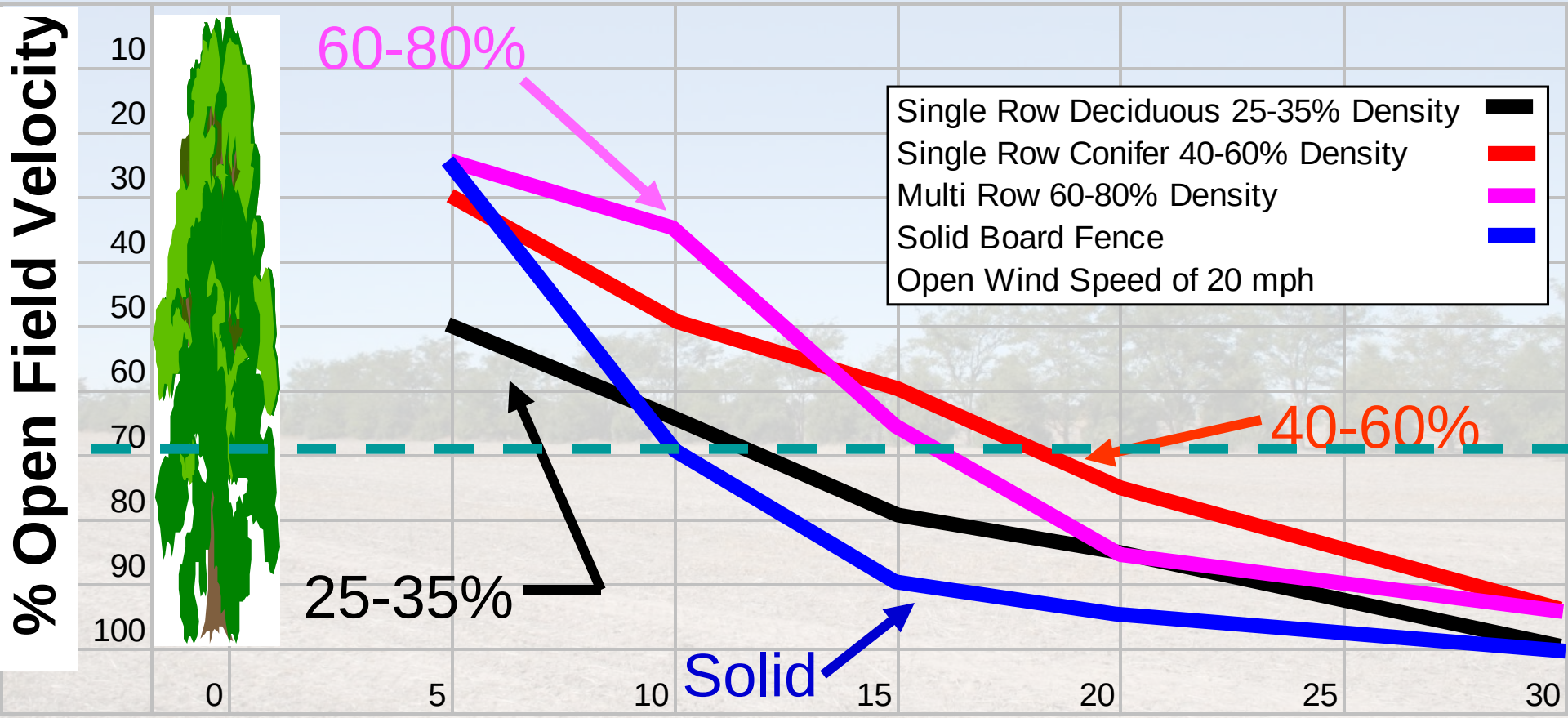


The leeward distance of wind protection is directly proportional to the height of the windbreak.

Note: 4H is about the mid-point of maximum wind reduction

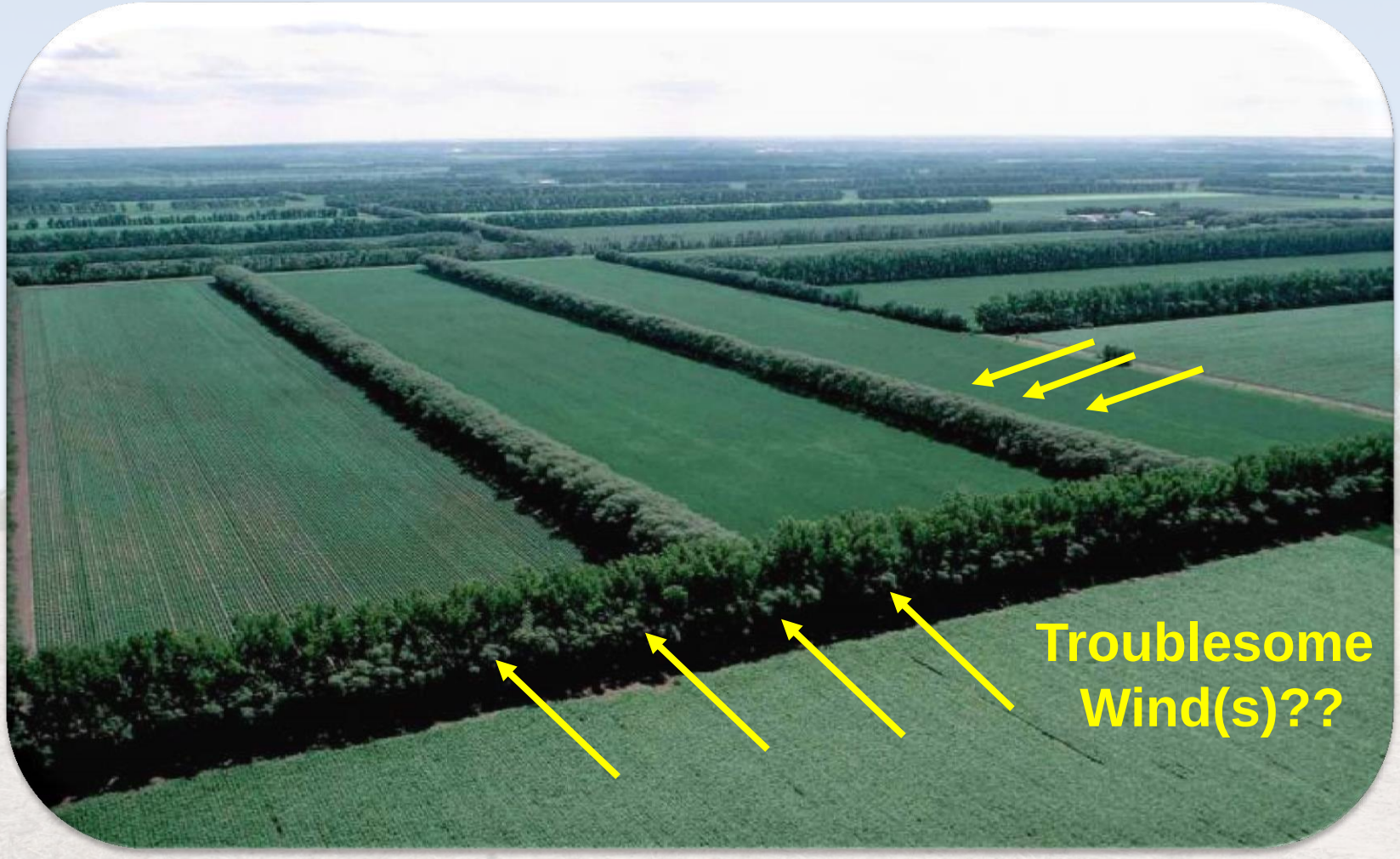


Impact of Density on Windbreak Effectiveness



Downwind multiples of Windbreak Height

Windbreak Orientation

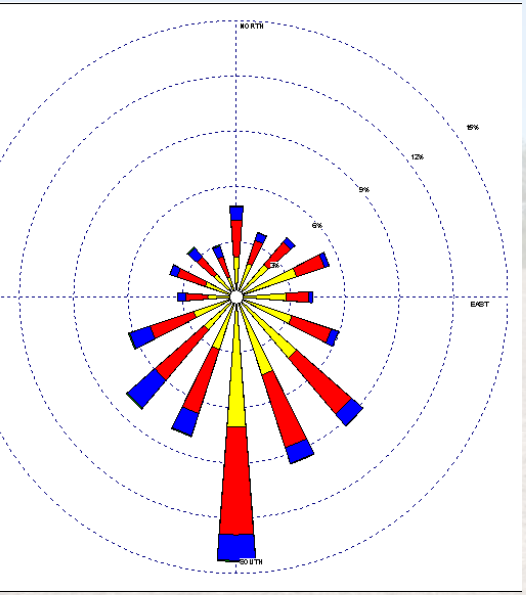


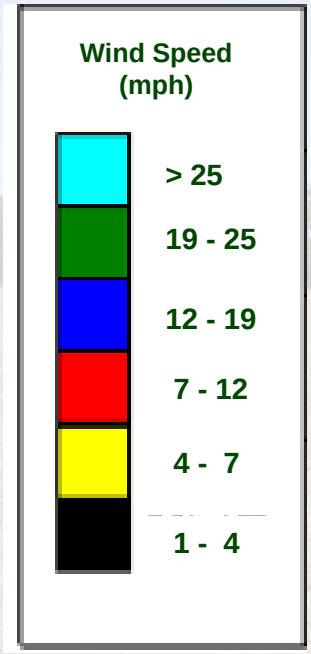
- **Orient windbreaks perpendicular to troublesome winds**
- **Plan multiple windbreaks for whole field protection**

Wind Rose

http://www.wcc.nrcs.usda.gov/climate/windrose.html

olumbia, MO- July

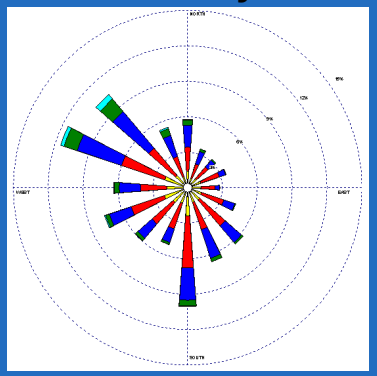




- Wind direction indicated by spoke orientation (16 cardinal directions)
- Velocity is indicated by color
- Percent of time the wind blows from that direction is indicated by the concentric rings
- Percent of time that the wind blows with a particular velocity from that direction is indicated by the width of the colored band

Columbia, MO monthly wind roses

January



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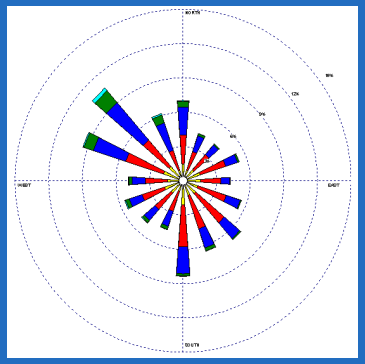
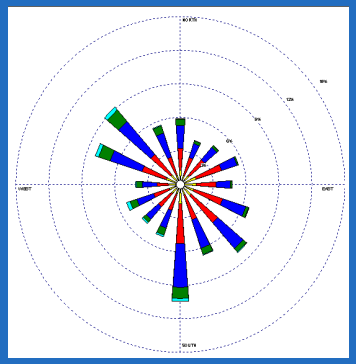


March



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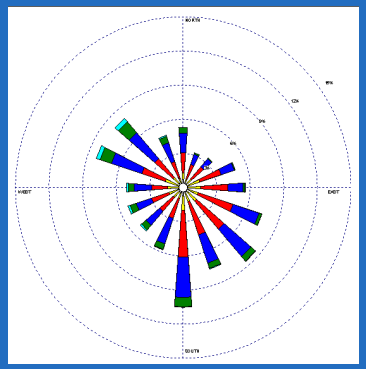

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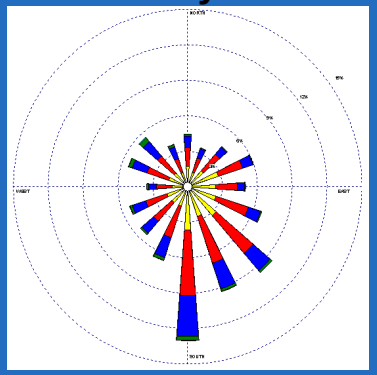

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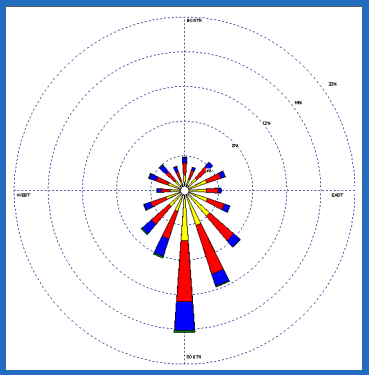

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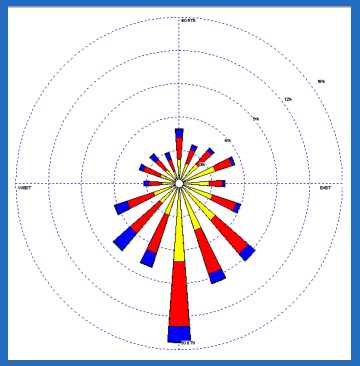
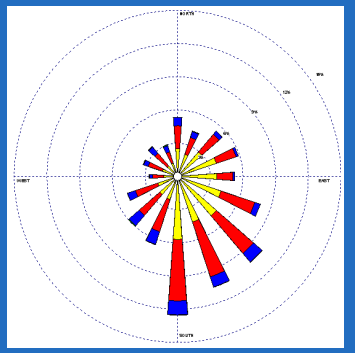
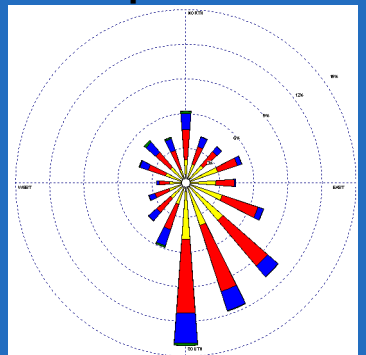


August



September



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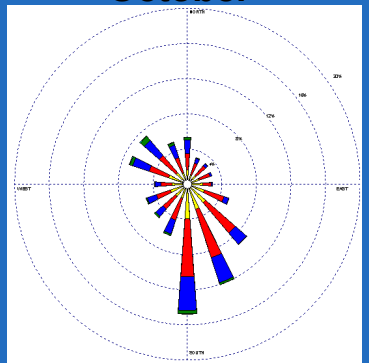

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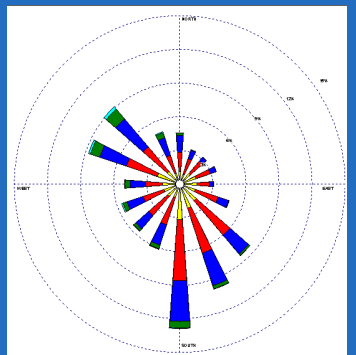
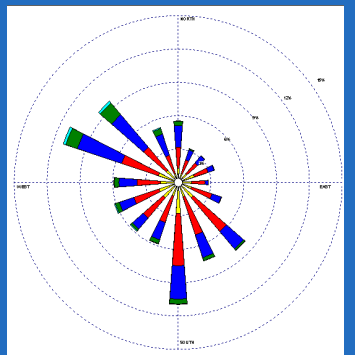
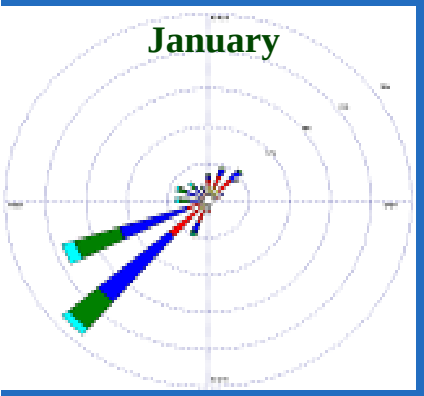
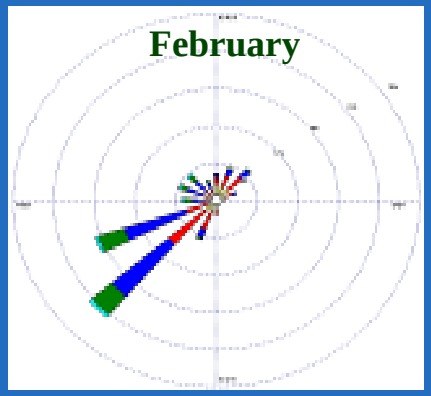


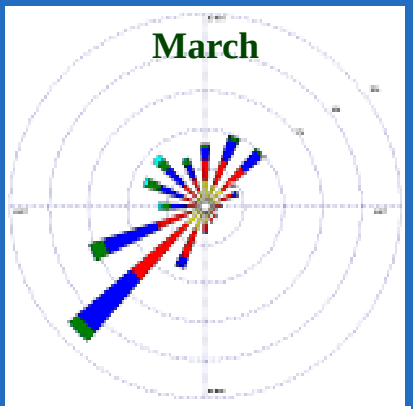
December

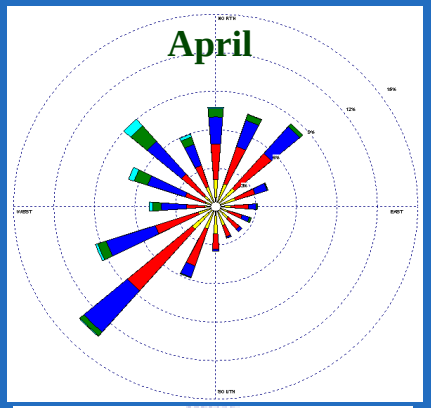


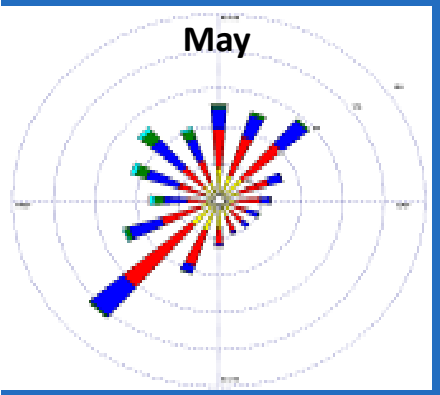
Wind Roses – Billings, MT

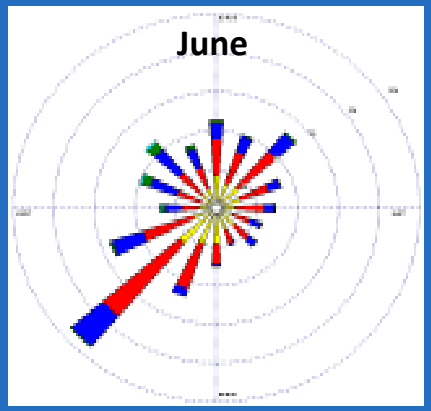


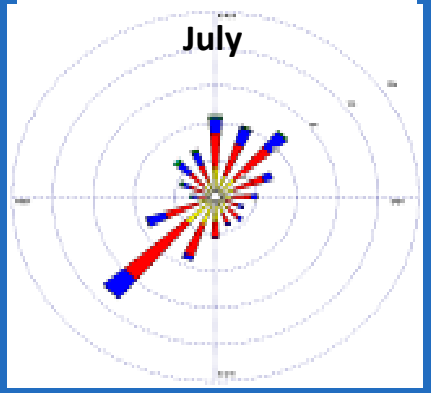


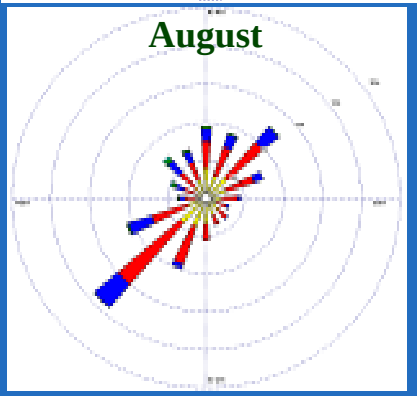


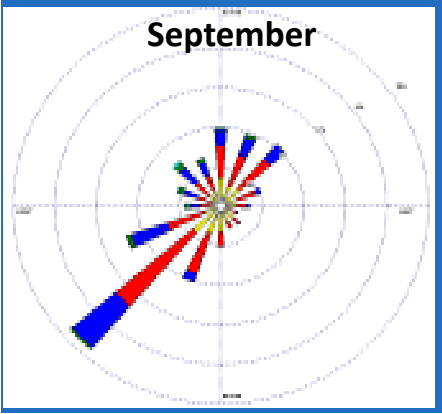


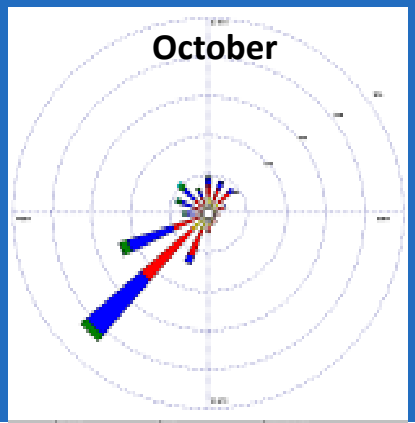


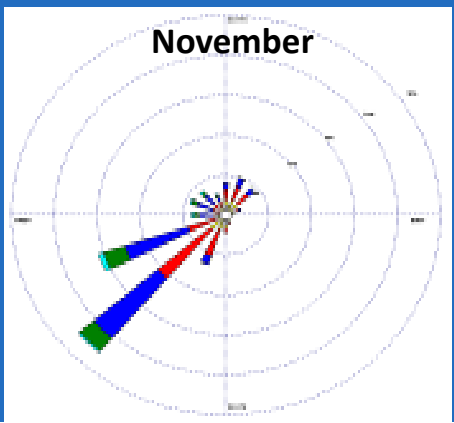


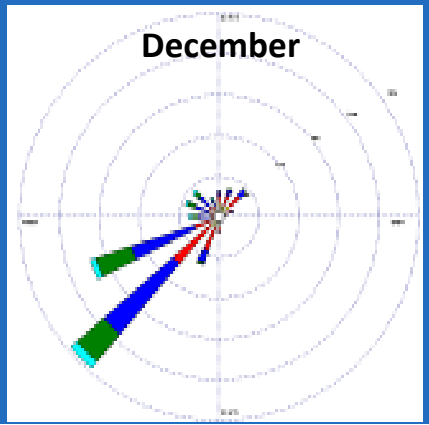










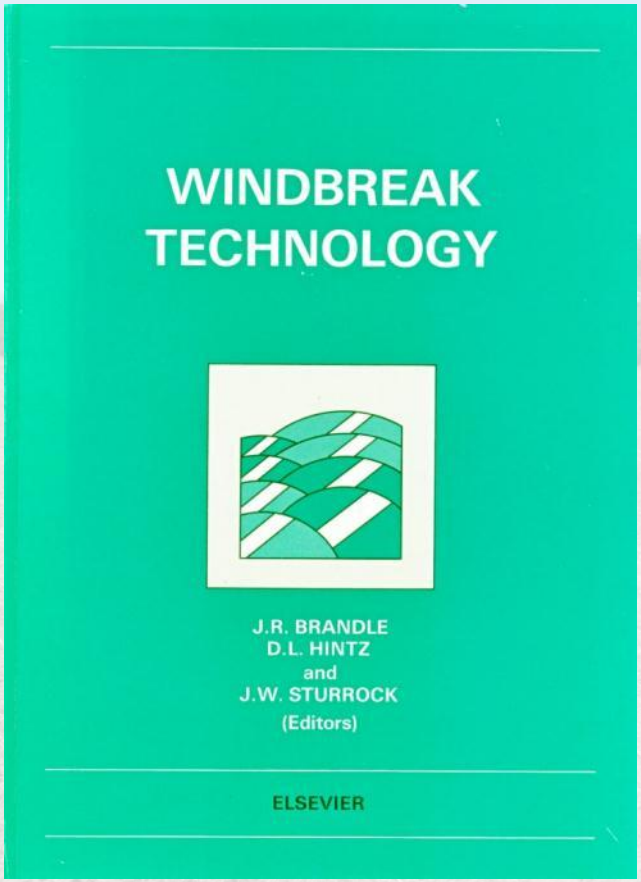


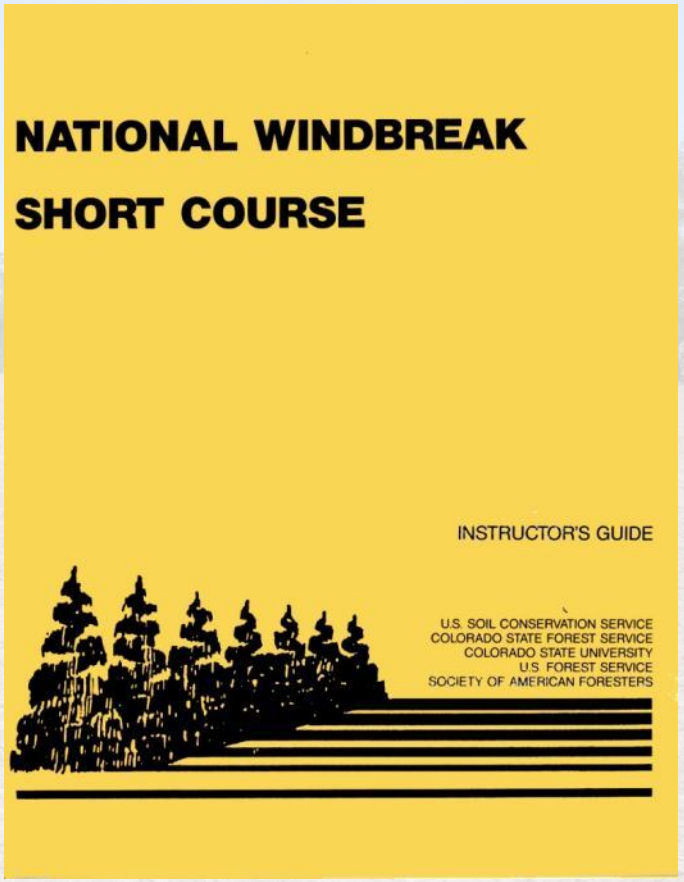
Windbreak Length

FOTG

Section I — General References
Section II — Soil and Site Information
Section III — Conservation Management Systems
Section IV — Practice Standards and Specifications
Section V — Conservation Effects

Sources of Information





Brush Up Your Shakespeare

TREE CROPS

A PERMANENT AGRICULTURE

BY

J. RUSSELL SMITH

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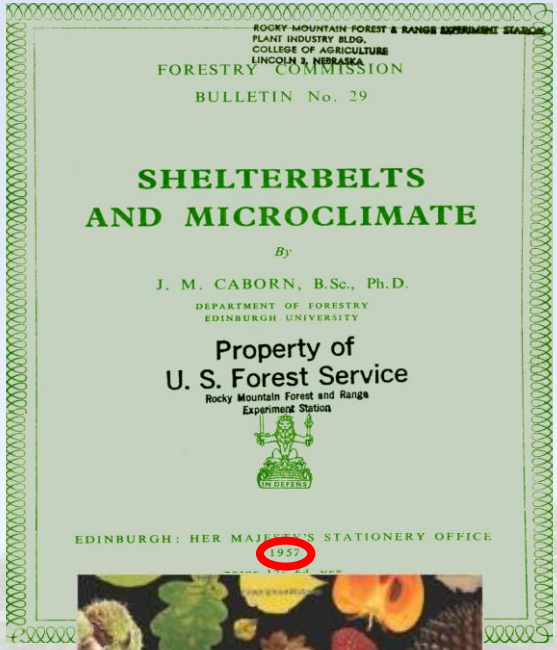
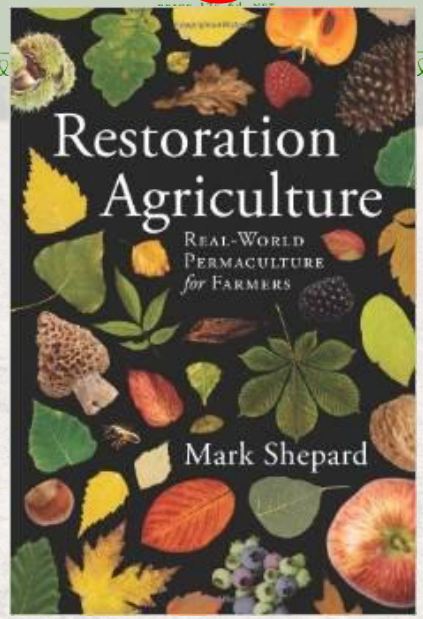
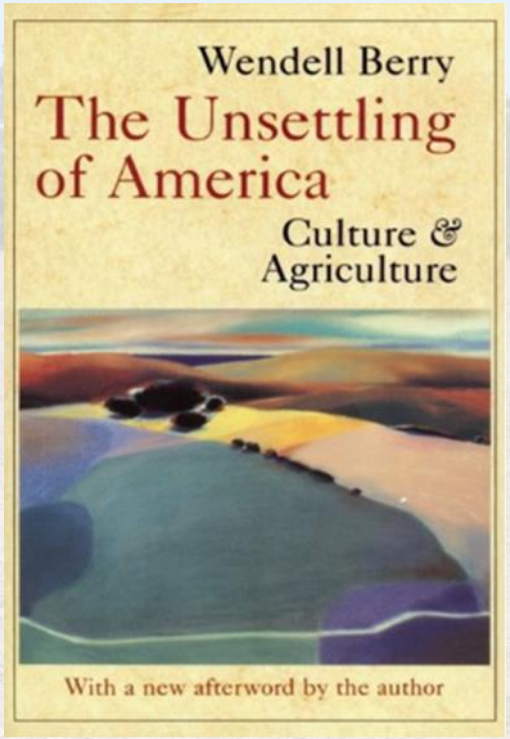




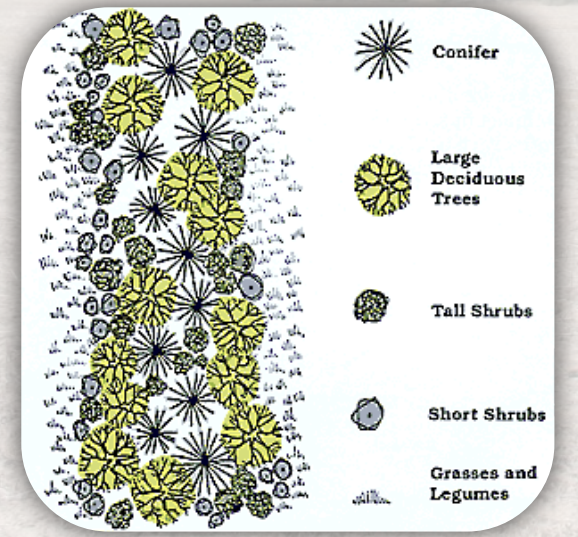


Windbreak Adoption or Annihilation ?

Multi Tasking – Not Always a Good Idea

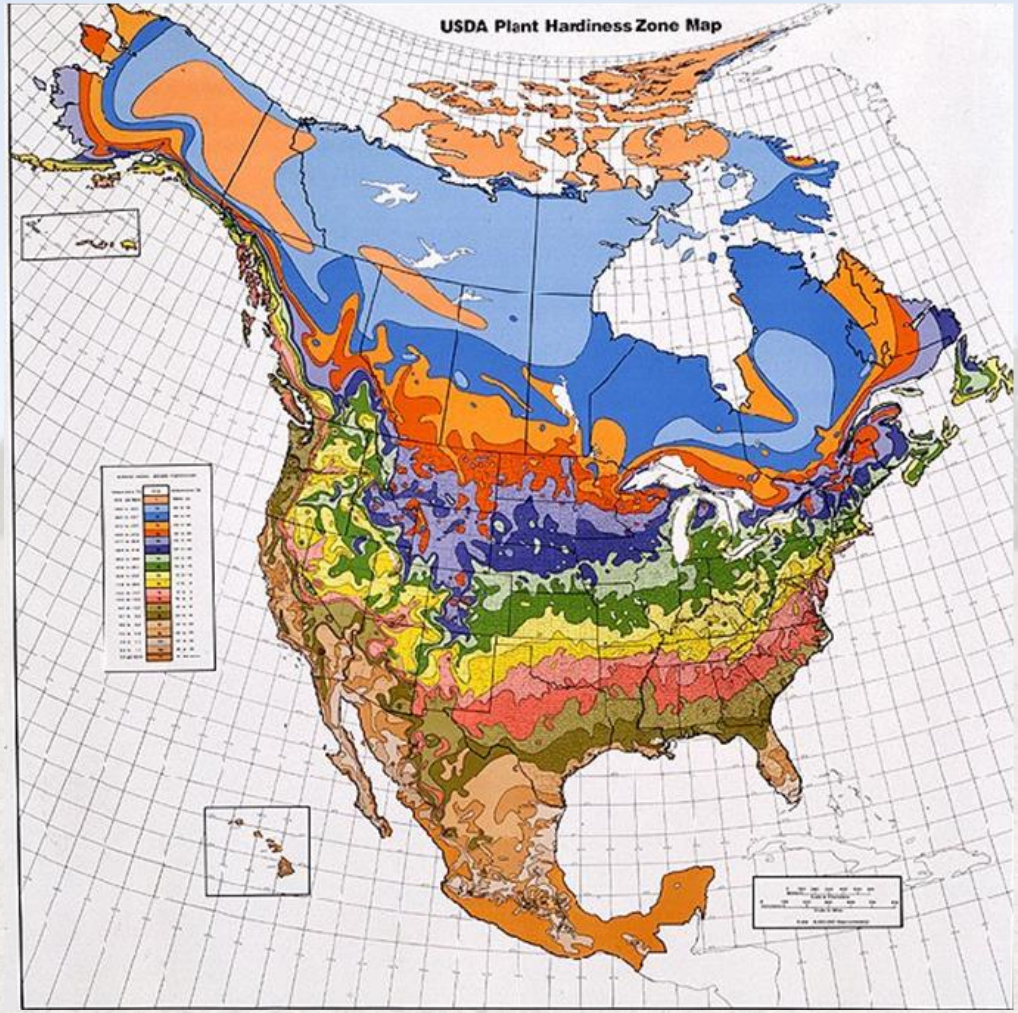
Multi-purpose windbreaks

- Bio-energy feedstock
- Food security
- Wildlife
- Income products



Wildlife Damage
or
if you build it they will come

Changing Weather -- Resilient Landscapes



Increased Crop Production

Relative responsiveness of various crops to shelter

CROP	FIELD YEARS	% YIELD INCREASE
Spring Wheat	190	8
Winter Wheat	131	23
Barley	30	25
Oats	48	6
Rye	39	19
Millet	18	44
Corn	209	12
Alfalfa	3	99
Hay (mixed grass & legumes)	14	20
Soybeans	17	15

Remember

The tree which moves some to tears of joy is in the eyes of others only a green thing which stands in their way. ~ William Blake

Thank You

Robert William Service

Trees, trees against the sky -
O I have loved them well!
There are pleasures you cannot buy,
Treasurers you cannot sell,
And not the smallest of these
Is the gift and glory of trees. . . .
So I gaze and I know now why
It is good to live - and to die. . . .
Trees and the Infinite Sky.