

# U.S. Dairy Forage Research Center

USDA, Agricultural Research Service

## Maximizing Yield and Quality of Alfalfa

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**4-State Forage Conference**

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**Baraboo, WI**

**[http://www.dfrc.ars.usda.gov/  
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# Maximizing Yield and Quality of Alfalfa

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## ■ Introduction

- Alfalfa production

## ■ Yield increases profit

## ■ Aggressive establishment techniques

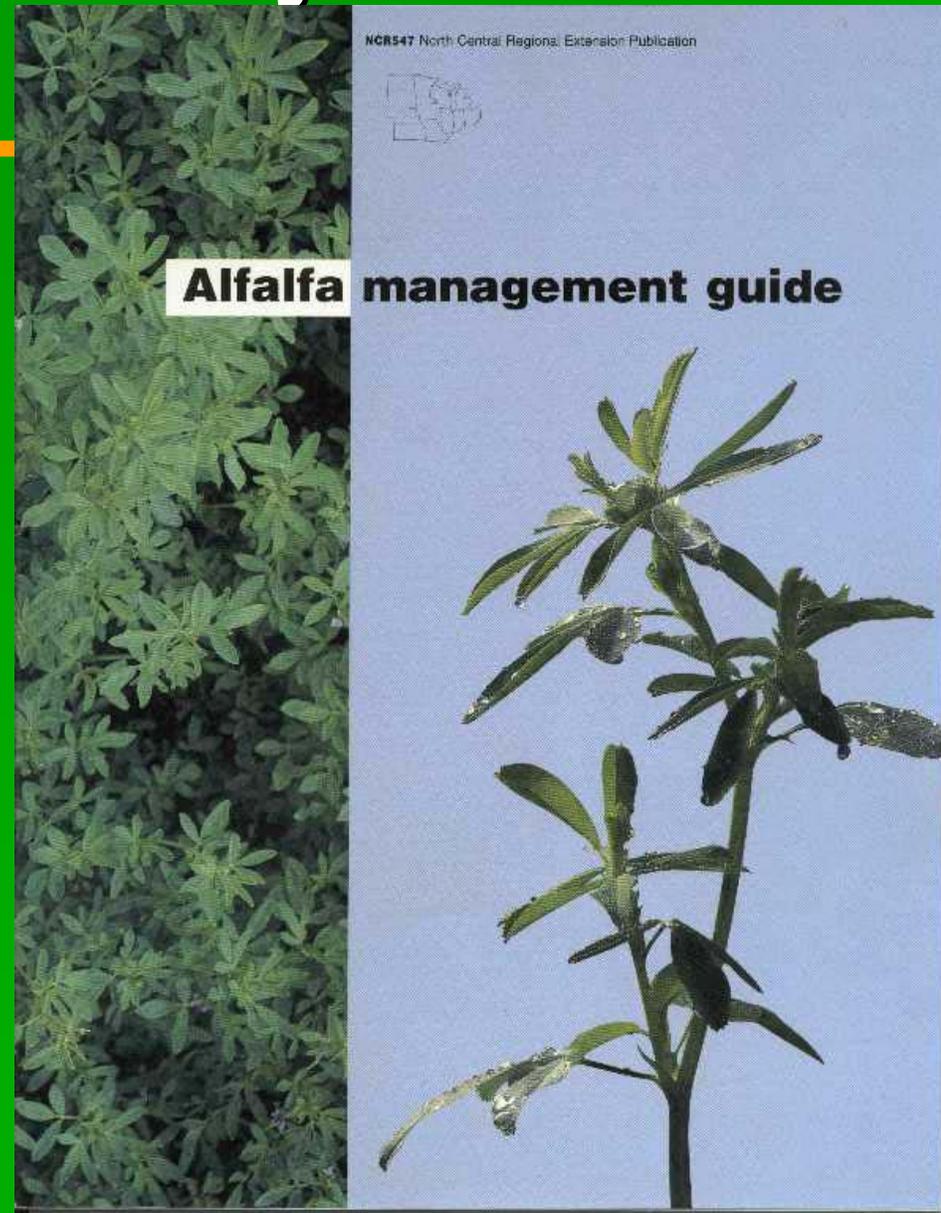
## ■ Manage production for high yield

## ■ Harvest for quality and yield

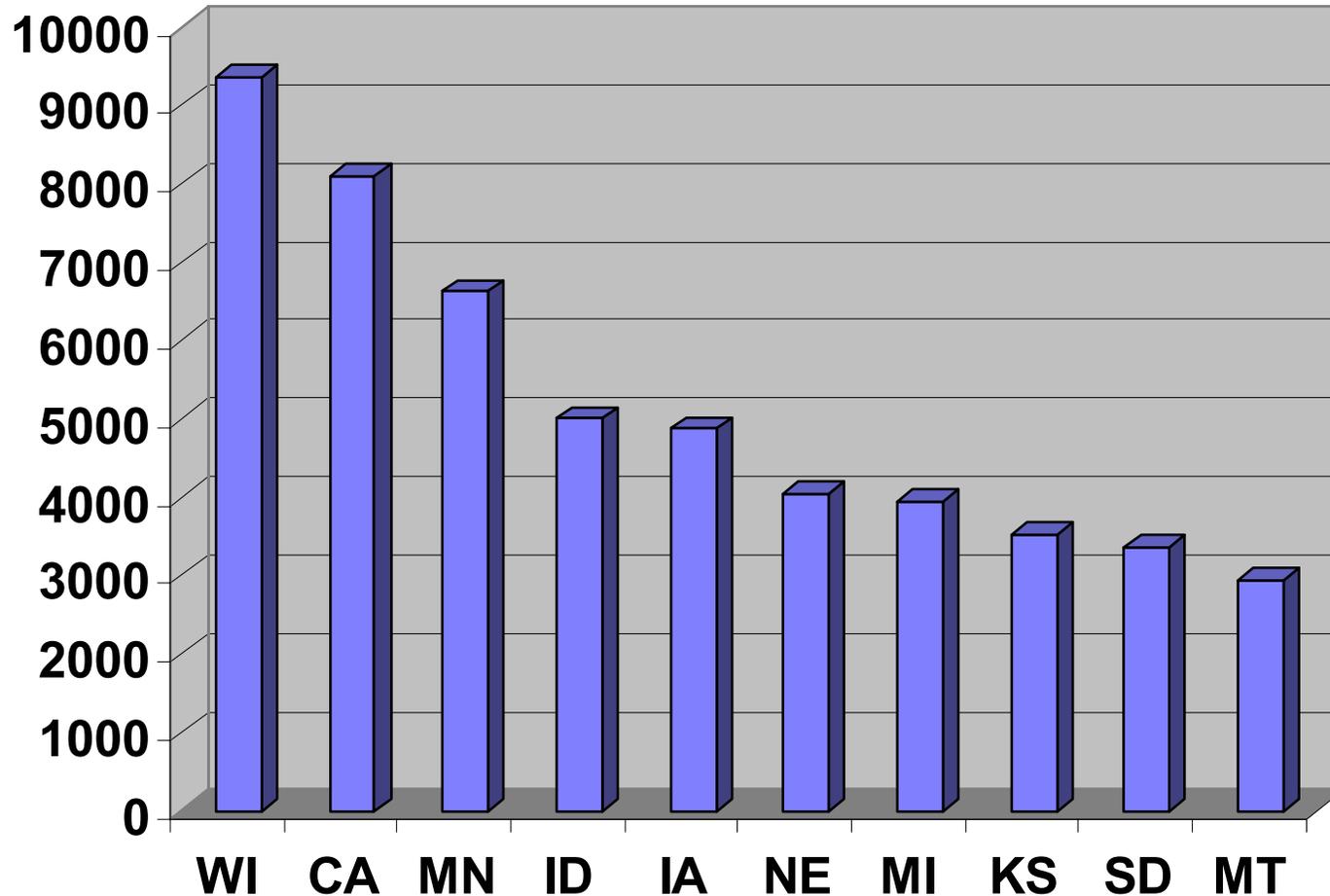
# Maximizing Yield and Quality of Alfalfa

## ■ Presentation Reference

- 2000 edition of Alfalfa Management Guide
- Available county extension offices, American Society of Agronomy, or Seed Companies



# Leading Alfalfa Forage Production States, 1,000 tons, 2002



## ■ Top 10 States

- 62 % of U. S.
- 61 % of Acre
- 4 states NC
- 6 states West
- 5 Lead Dairy

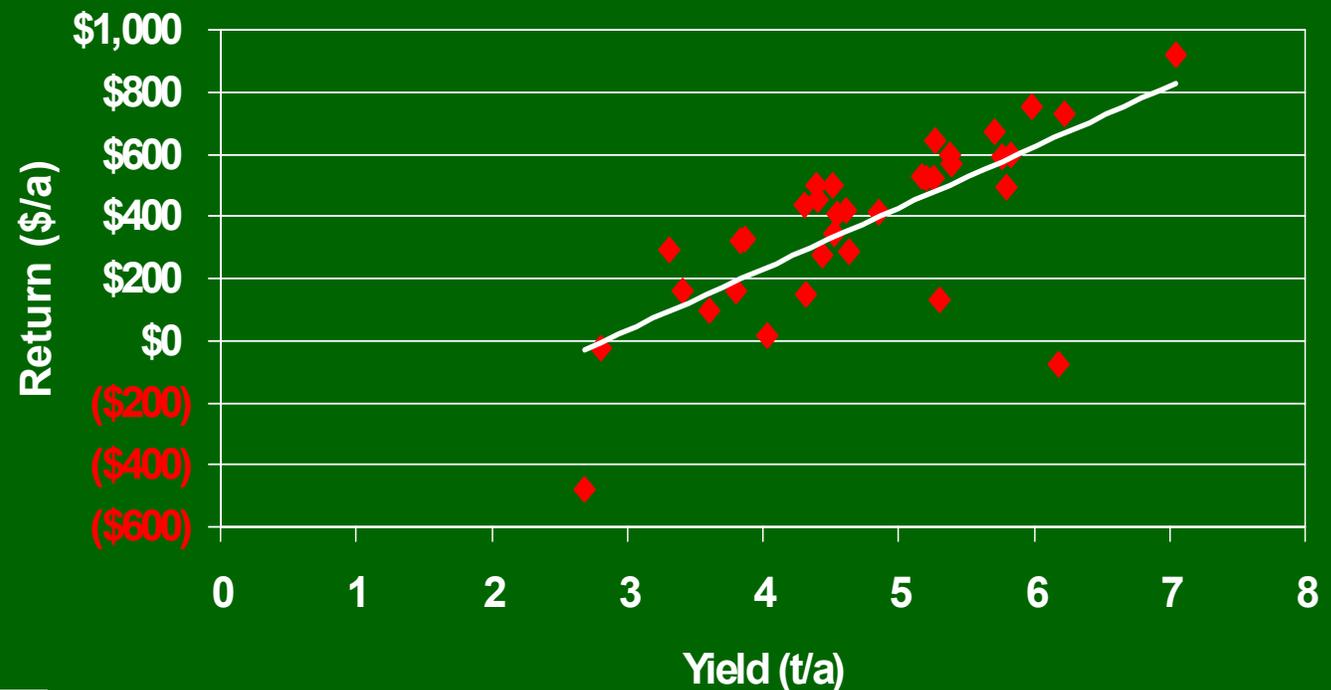
## ■ 4-State (WI, MN, IA, IL)

- 27 % of U. S.
- 22.6 million T
- \$ 2.3 billion

# Maximizing Yield and Quality of Alfalfa

■ Yield increases profit

Figure 1. Effect of Yield on Return Per Acre



UWEX

# Maximizing Yield and Quality of Alfalfa

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## ■ Aggressive establishment techniques



# Maximizing Yield and Quality of Alfalfa

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## ■ Aggressive establishment techniques

- Select a field carefully
- Soil test and correct deficiencies
- Select a good variety
- Establish alfalfa rapidly

# Aggressive establishment techniques

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## ■ Select a field carefully

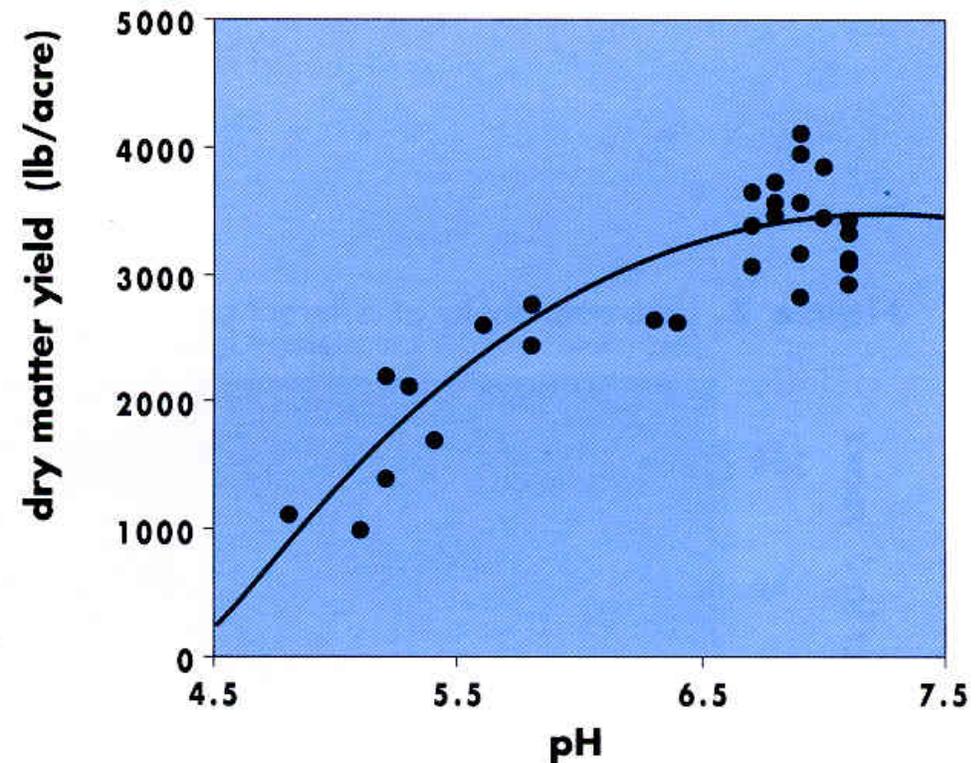
- Alfalfa requires a well-drained soil
- Wet soils create conditions suitable for diseases which may kill seedlings or established plants
- Use fungicides with seed inoculums
- Poor soil drainage reduces soil oxygen movement to roots
- Poor surface drainage – crusting and ponding
- Soils deep enough good water-holding capacity
- Fields must be free of perennial weeds - quackgrass

# Aggressive establishment techniques

## ■ Soil test and correct deficiencies

- Proper soil pH
- 6.7 – 6.9
- secondary and micronutrients during tillage
- Use manure properly

**Figure 2.** First-cutting alfalfa yield relative to soil pH.



Source: Wollenhaupt and Undersander,  
University of Wisconsin, 1991

# Aggressive establishment techniques

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- **Liming is the single most important fertility concern to establish and maintain high-yielding high-quality alfalfa stands.**
  - Increased stand establishment and persistence
  - More activity of nitrogen-fixing *Rhizobium*
  - Added calcium and magnesium
  - Improved soil structure and tilth
  - Increased availability of phosphorus and molybdenum
  - Decreased manganese, iron and aluminum toxicity

# Aggressive establishment techniques

- **Select a good variety**
  - yield
  - persistence
  - winterhardiness
  - disease resistance
  - forage quality

<http://www1.uwex.edu/ces/ag/alfalfa>

**Table 1.** Factors influencing dollar return per acre for alfalfa from milk production.

factors	return per acre
<b>standard yield</b> (18% CP <sup>1</sup> , 33% ADF, 45% NDF) assuming 5 ton/acre yield and \$10/cwt milk	\$778
<b>yield potential effect</b> 0.2 ton/acre lower yield	-\$50
<b>persistence effect</b> shorter stand life (3 vs 4 yr)	-\$24
<b>forage quality effect</b> higher quality forage (+1% CP, -1% ADF, -1% NDF)	+\$15
<b>seed cost effect</b> \$1/lb higher at 15 lb/acre seed	-\$4

Source: Undersander, University of Wisconsin, 1991

<sup>1</sup>CP = crude protein; ADF = acid detergent fiber;  
NDF = neutral detergent fiber.

# Aggressive establishment techniques

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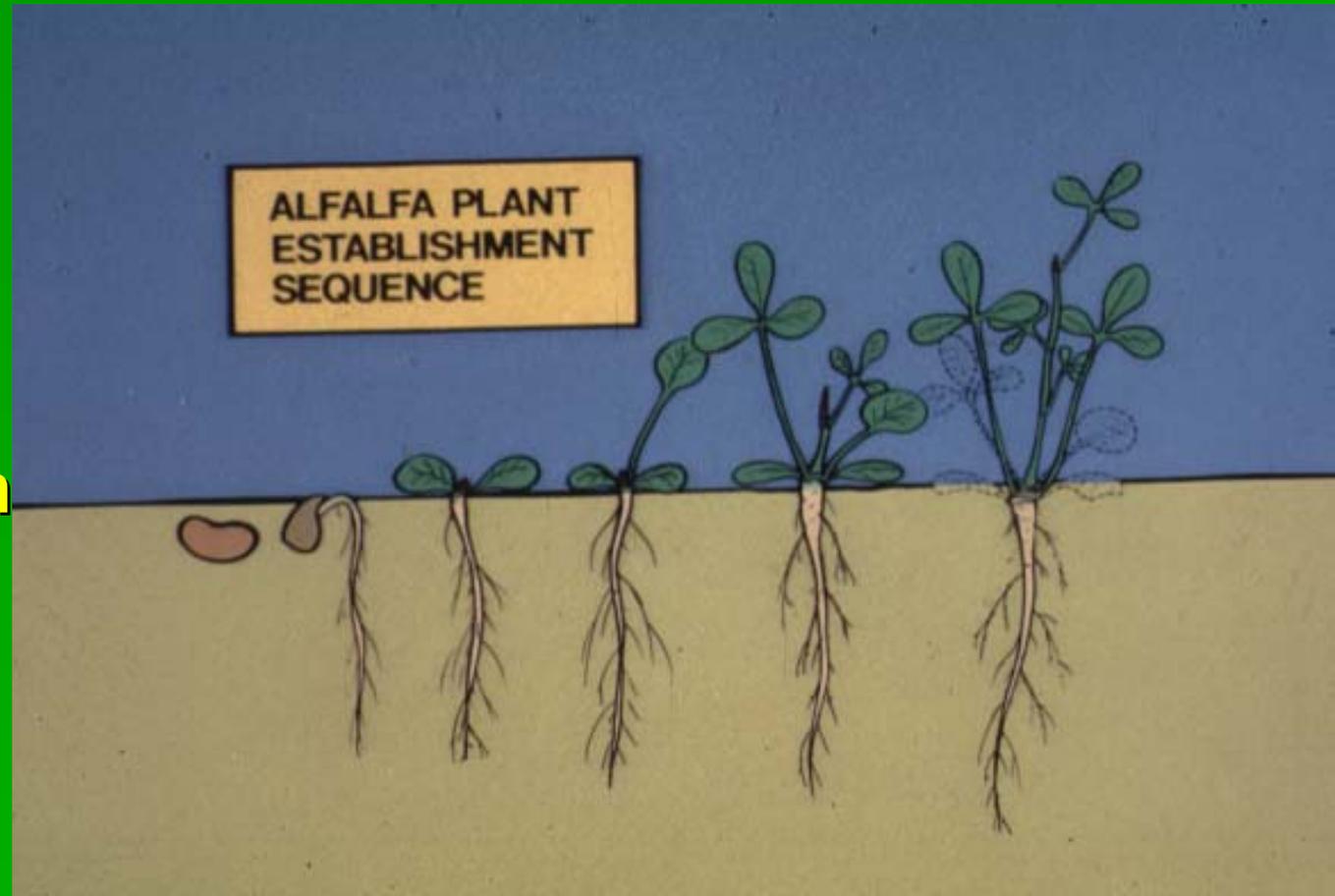
## ■ Establish alfalfa rapidly

- Seed germination
- Seedling emergence
- Seedling development
- Establishment methods
  - spring seeding
  - summer seeding
- Pest management
- Harvest management

# Aggressive establishment techniques

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- Early seedling development
- Nodulation
- Contractile growth
- Branching

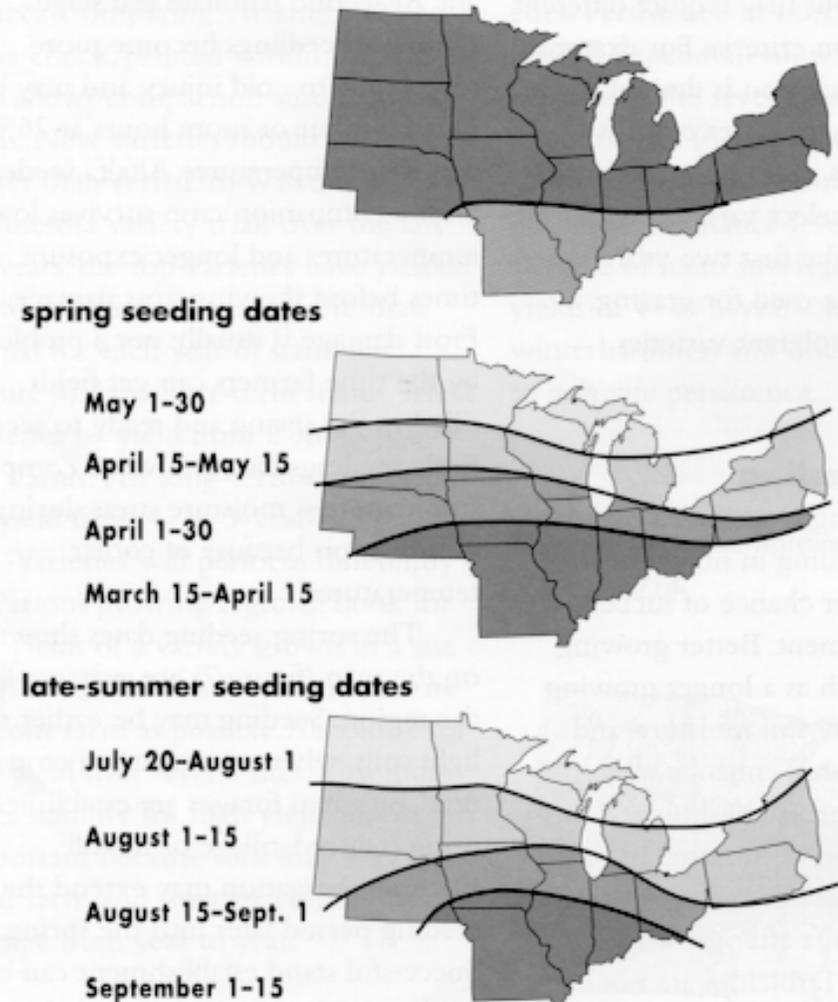


# Aggressive establishment techniques

- Spring seeding most used
- Summer seeding must be done early enough for 4 to 6 weeks of growth

**Figure 7.** Spring and late-summer seeding dates.

- spring seeding preferred
- late-summer seeding preferred



# Aggressive establishment techniques

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## ■ Spring

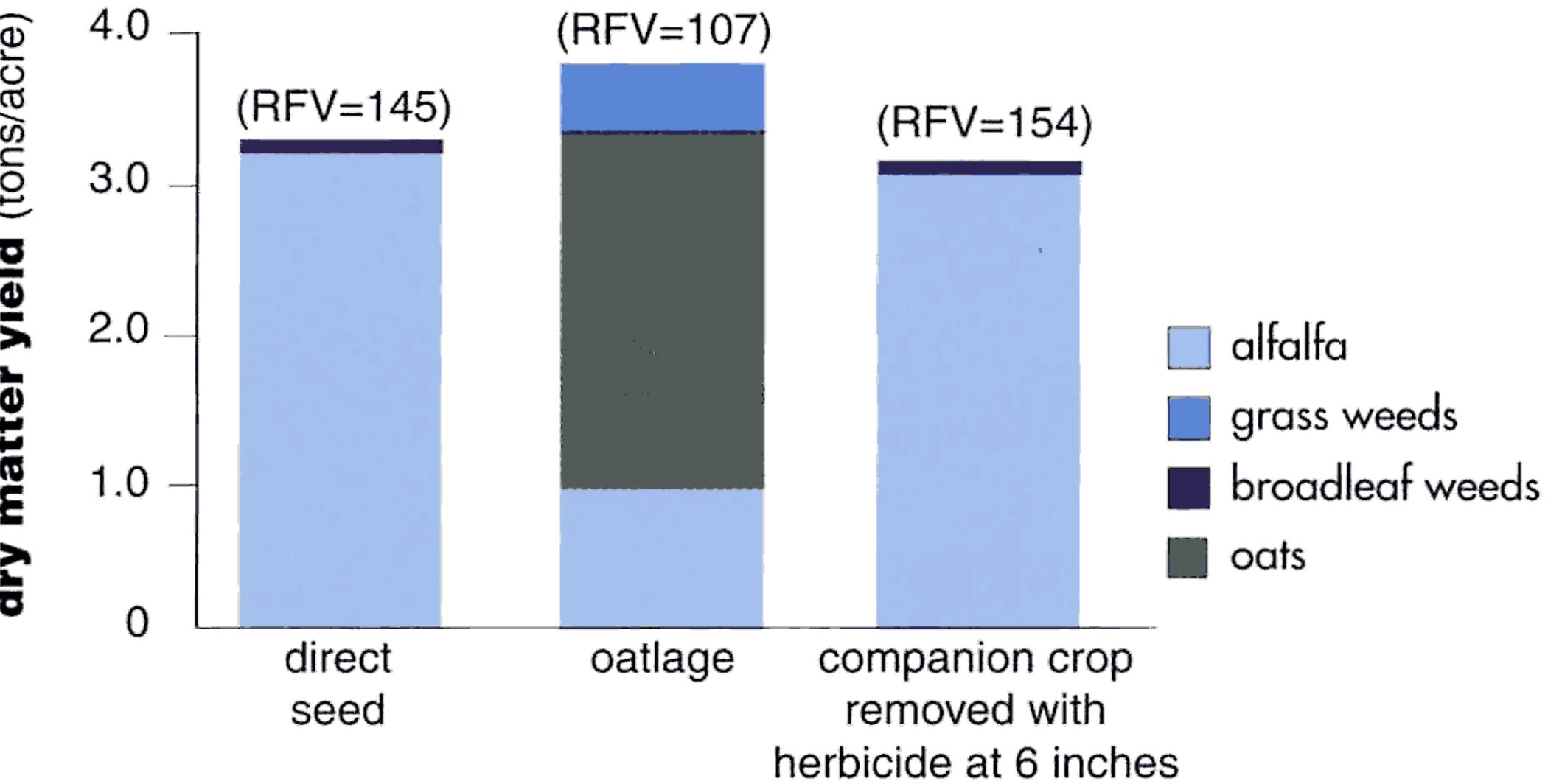
- seed with companion crop
- direct seed or solo seed or clear seed (pure stands only)
- seed with oats but spray oats w/ Poast

## ■ Summer

- seed after small grain crop
- no-till after small grain crop

# Aggressive establishment techniques

**Fig 3. First-season alfalfa yield from different establishment methods**



# Aggressive establishment techniques

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## ■ Establishment practice

- Spraying out the companion crop after adequate cover has grown to protect the soil from water or wind erosion
- Removes the possibility of competition from oats



# Aggressive establishment techniques

- Early plant date
- 4 cuttings in seed yr
- First cut taken 60 days after emergence
- Second cut 1/10 bloom
- Planting date after 50 % probability of frost

ALFALFA SEEDING YR YIELDS  
St. Paul, 1981

Emerg. Date	1st cut DAE	Hay yield	
		1st	Total
	-days-	-----T/A-----	
April 24	40	0.6	5.5
	60	1.8	5.9 <sup>1</sup>
	80	2.7	5.8
May 7	40	1.0	5.0
	60	1.5	5.2 <sup>2</sup>
	80	2.6	5.2
May 20	40	1.0	4.9
	60	2.0	4.7
	80	2.6	4.8

SOURCE: Sheaffer, 1983. Agron J

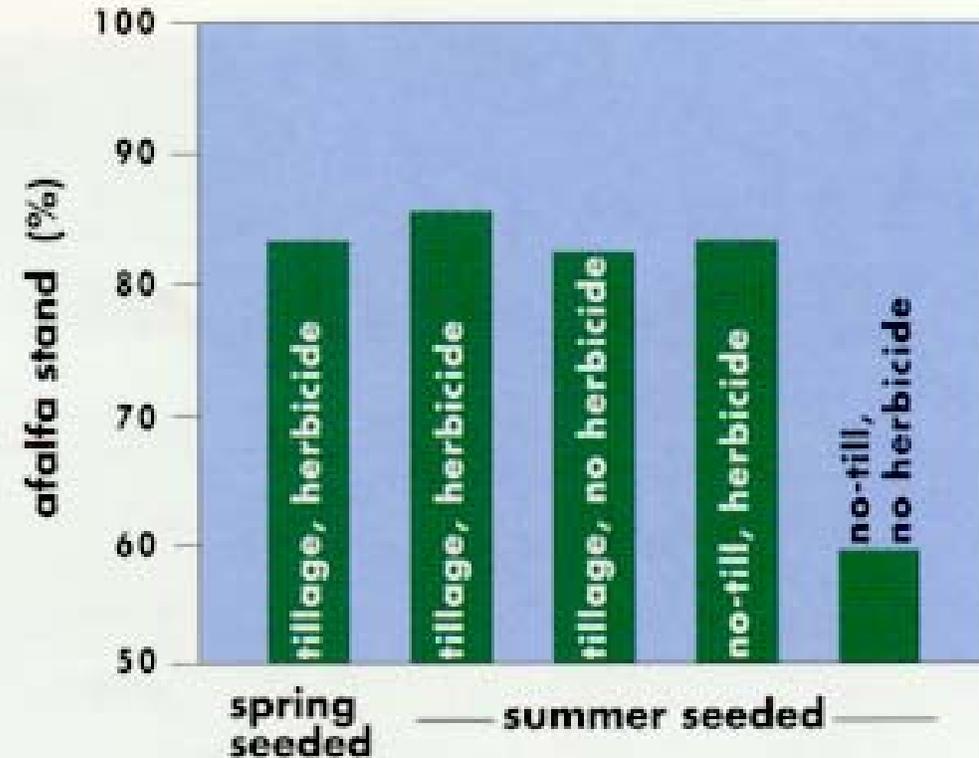
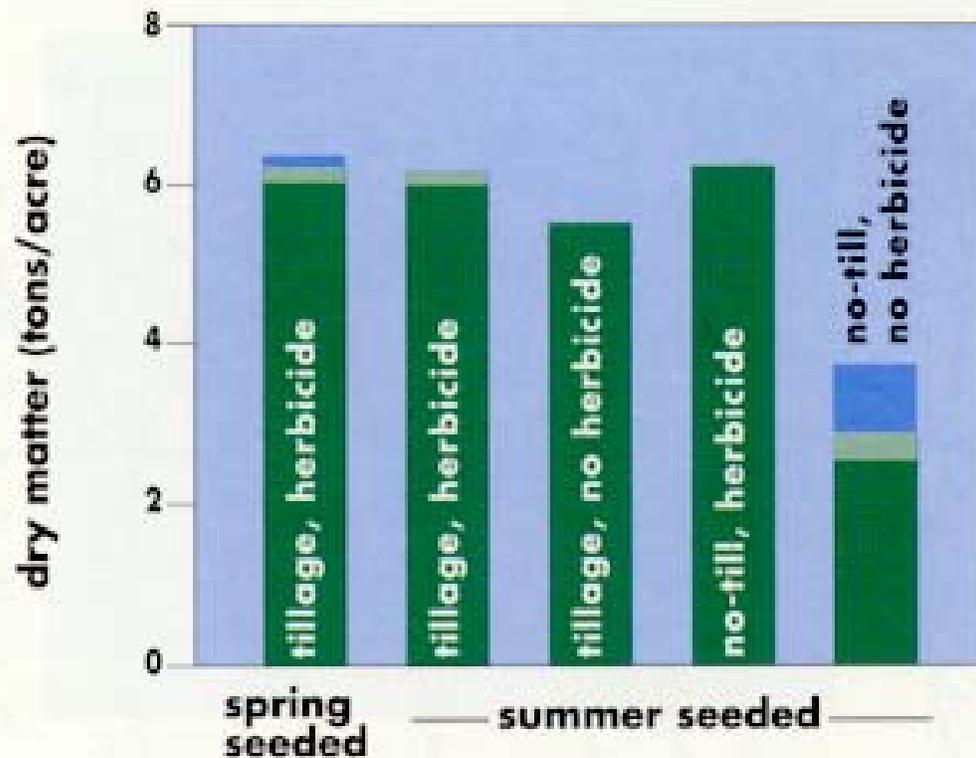
<sup>1</sup> 6/23, 7/24, 9/1, 10/19

<sup>2</sup> 7/6, 8/15, 10/19

# Aggressive establishment techniques

**Figure 8.** Effect of weed pressure on late-summer seedings.

■ alfalfa   ■ grass weeds   ■ broadleaf weeds



Source: Bulmer, University of Minnesota, 1993

# Manage Production for High Yield

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## ■ Fertilize annually

- Each ton of alfalfa removes 14 lb phosphate ( $P_2O_5$ ) and 58 lb of potash ( $K_2O$ ) from soil
  - Apply topdress nutrients immediately after harvest
  - Topdress after first cut
  - Avoid application when soil is soft
  - Split application to avoid salt damage (> 500 lb)
  - Base fertilizer purchases on cost of unit of plant food
- Manure is a complete nutrient source – application is critical

# Manage Production for High Yield

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## ■ Apply pest management skills

- Weeds reduce alfalfa production during establishment
- Weeds also invade established fields and reduce quality
- The most important factor in weed management is to establish and maintain vigorous stands

# Manage Production for High Yield

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## ■ Apply pest management skills

- Use proper timely weed management
- Several diseases occur in alfalfa that kill seedlings, limit yields, and shorten stand life
- Occurrence and severity of diseases depend on environmental conditions, soil type, and crop management
- Select resistant varieties at planting

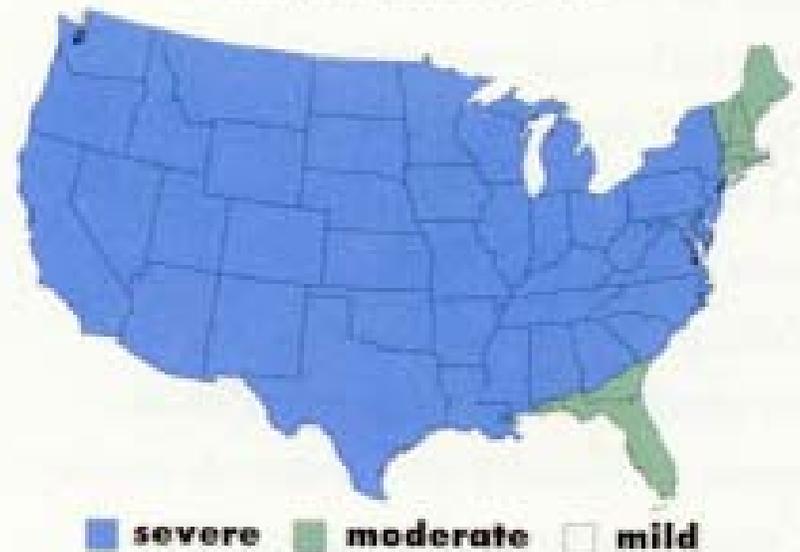
## Distribution and severity

### *Bacterial wilt*



## Distribution and severity

### *Phytophthora root rot*



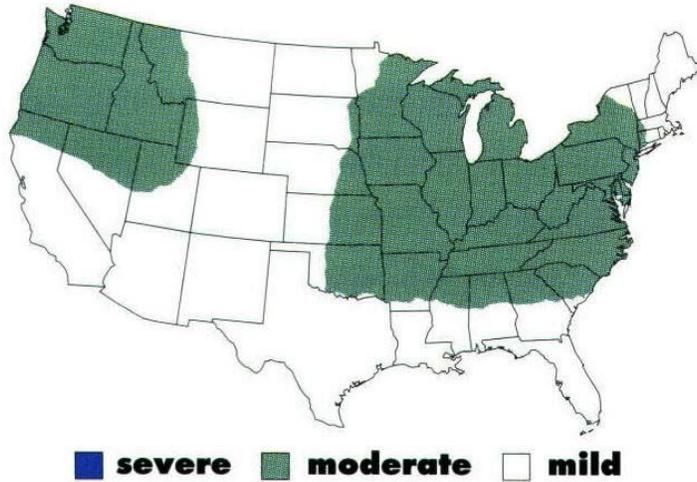
The entire plant is stunted and yellowed by bacterial wilt.



As the disease progresses (left to right), lesions develop and the taproot rots off.

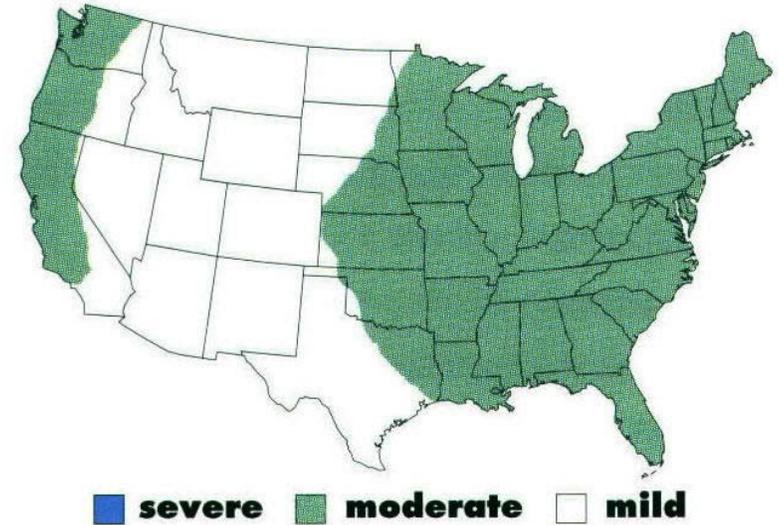
## Distribution and severity

*Aphanomyces*



## Distribution and severity

*Root-lesion nematodes*



Comparison of susceptible (left) and resistant (right) varieties shows stunting and slight yellowing caused by aphanomyces.



Stunted plants and stand thinning caused by root-lesion nematodes.

# Manage Production for High Yield

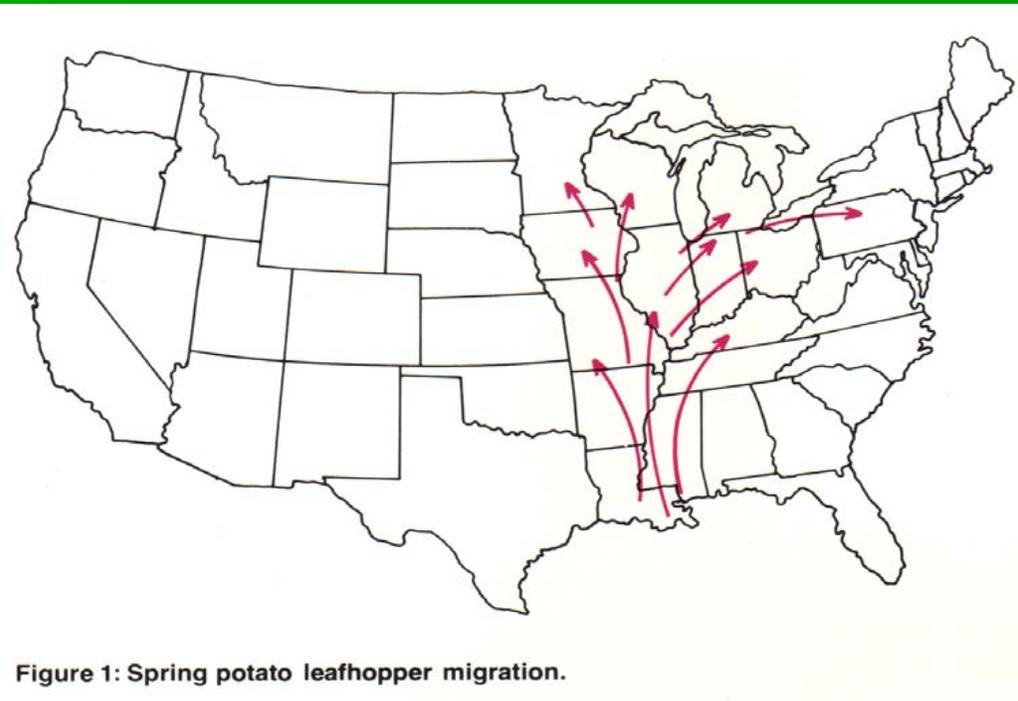
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## ■ Apply pest management skills

- Use proper timely weed management
- Select resistant varieties at planting
- Scout alfalfa fields for presence of insects and apply appropriate action

# Potato Leafhopper

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## ■ Potato leafhopper

- over winters in southern US near Gulf coast
- each spring migrates north on warm wind currents
- first cut not affected
- damages 2 nd & 3 rd cut

# Potato Leafhopper

*Empoasca fabae* L.



**Adult**



**Nymph**



**Hopperburn**

## Effective Timing of Control Requires Periodic Sampling



- ✓ Weekly sampling with a sweepnet.
- ✓ When PLH catch in 10 sweeps exceeds stand height in inches, the potential for economic injury exists.
- ✓ Cut early or spray.

# Alfalfa Resistance to PLH



**Leafhopper resistant alfalfa provides a non-chemical alternative to reduce losses due to PLH.**

**Table 12.** Economic thresholds for alfalfa varieties with high (greater than 50%) resistance and low (less than 30%) resistance to potato leafhoppers.<sup>a</sup>

Canopy height	>50% resistance			<30% resistance		
	Cost of treatment					
	\$8	\$12	\$16	\$8	\$12	\$16
leafhoppers/10 sweeps						
<b>Crop value of \$40/ton</b>						
4	136	200	265	40	91	123
8	140	204	269	44	95	127
12	144	208	273	48	99	131
16	148	212	277	52	103	135
<b>Crop value of \$80/ton</b>						
4	71	103	136	29	44	60
8	75	107	140	33	48	64
12	79	111	144	37	52	68
16	83	115	148	41	56	72
<b>Crop value of \$120/ton</b>						
4	49	71	93	18	29	39
8	53	75	97	22	33	43
12	57	79	101	26	37	47
16	61	83	105	30	41	51

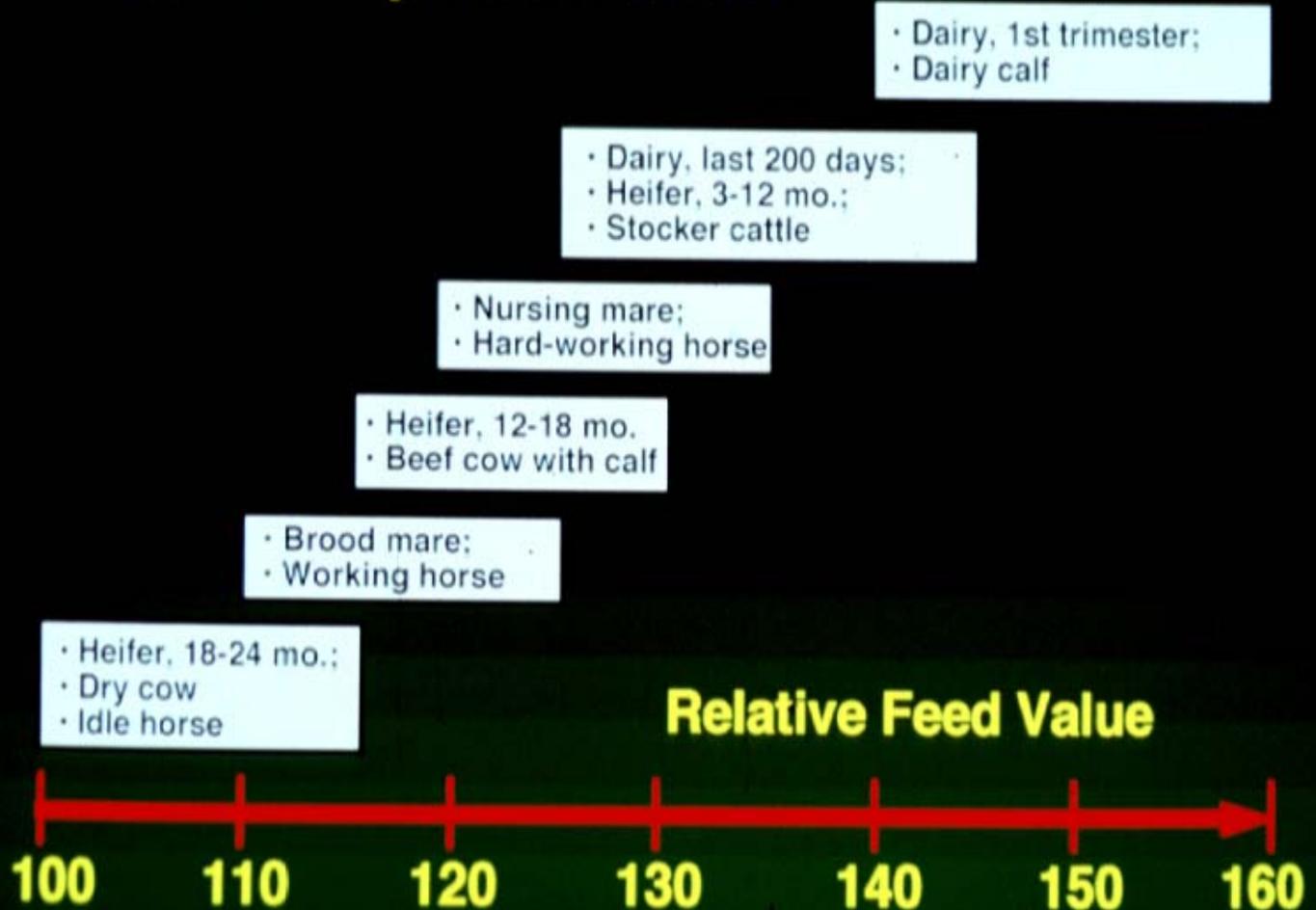
<sup>a</sup>Varieties with 30–50% resistance have intermediate spray thresholds.

Source: Marlin Rice and Steve Lefko, University of Missouri, 1999

# Harvest for Quality and Yield

## ■ Cut for dairy quality

### Forage Quality Needs of Cattle



# Harvest for Quality and Yield

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- **Cut for dairy quality**
- **Forecast quality of standing crop**

# Alfalfa Harvest Alert Approaches

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**Set harvest goals (140 to 160 RFV)**

- **adjust up for field losses (15 %)**

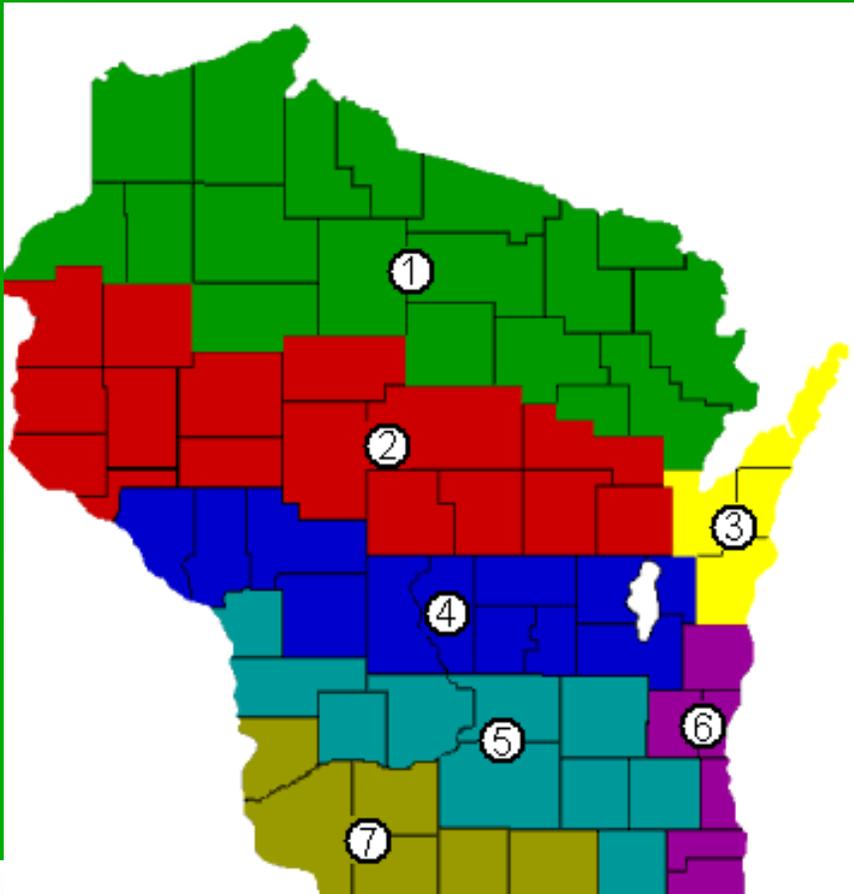
- **adjust up for harvest time  
(RFV/day X days)**

- **adjust for local conditions**

# Harvest for Quality and Yield

## Forecast alfalfa quality

- <http://cf.uwex.edu/ces/ag/scissorsclip/>



2001 Reagional Averages by Date

Date	Region						
	1	2	3	4	5	6	7
5/9	0	0	0	0	0	0	220
5/10	0	231	0	0	0	0	0
5/14	225	225	252	222	183	0	192
5/15	0	206	0	0	0	0	182
5/16	0	211	0	0	181	0	175
5/17	204	202	229	204	0	190	0
5/18	0	189	0	0	163	0	0
5/21	0	181	208	167	0	172	154
5/22	0	179	0	0	0	0	0
5/23	195	182	0	0	0	0	152
5/24	0	183	196	0	0	0	0
5/25	0	173	0	188	0	0	155
5/28	0	0	0	0	0	0	153
5/29	179	167	201	146	0	153	159
5/30	0	154	0	181	0	0	0
5/31	164	199	0	0	0	0	0
6/4	0	152	0	134	0	0	145
6/7	0	151	0	0	0	0	0
6/11	0	0	0	0	0	0	140
6/14	0	0	0	0	231	0	0
6/17	0	0	0	0	202	0	0
6/18	0	0	0	0	0	0	117
6/21	0	0	0	0	178	0	0
6/25	0	0	0	0	161	0	0

# Predictive Equations of Alfalfa Quality (PEAQ)

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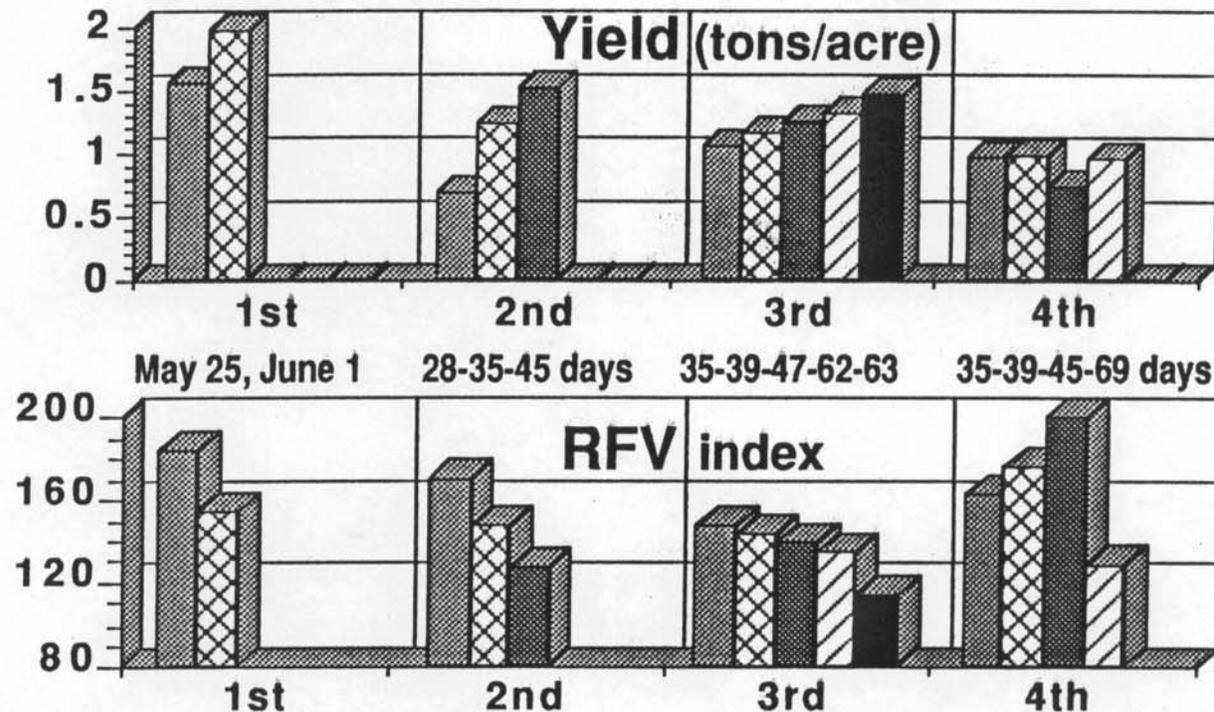
- Choose representative one square foot area of field
- Determine stage of most mature stem in area using following criteria:
  - late vegetative - stem over 12 inches tall no visible buds or flowers
  - bud - more than 2 nodes with visible buds, no flowers or seed pods
  - flower - 1 node with at least one open flower, no seed pods
- Measure the height of tallest stem in one square foot area (from soil surface)

*Rankin, Mike adapted from Hintz and Albrecht 1991. Crop Sci. 21: 267*

# Harvest for Quality and Yield

- Harvest early cuttings early and often

Fig. 2. The influence of date of first cutting and day interval between cuts on relative feed value of each of 4 cuttings, St. Paul, MN.



# Harvest for Quality and Yield

**Table 3. The influence of cuttings number and frequency on yield and quality, St. Paul, MN, average of 3-years.**

Cutting schedule	No cuts	DM T/A	Forage Quality Tests			RFV index	Milk lb/A <sup>1</sup>
			% CP	% NDF	% IVDMD		
A 3 ff by Aug 31	3	4.9	20	42	67	132	7720
B 2 ff + Sept 15	3	4.8	19	42	67	131	7490
F bud + 2 by 8/31	3	4.4	21	42	68	133	7100
C 3 ff + Oct 15	4	5.5	21	39	69	147	10,080
D bud, ff, fb, + 9/15	4	4.4	21	37	71	157	8810
E bud, ff, fb + 10/15	4	5.0	20	41	69	140	8620
G bud, ff, s, + 10/15	4	5.0	22	38	70	151	9520
H bud-ff by Aug 31	4	4.2	23	37	71	157	8410

**SOURCE:** Adapted from Brink and Marten. 1989. *J. Prod. Agr.* 1: 32.

<sup>1</sup>Milk95. Undersander et al. 1995.

# Harvest for Quality and Yield

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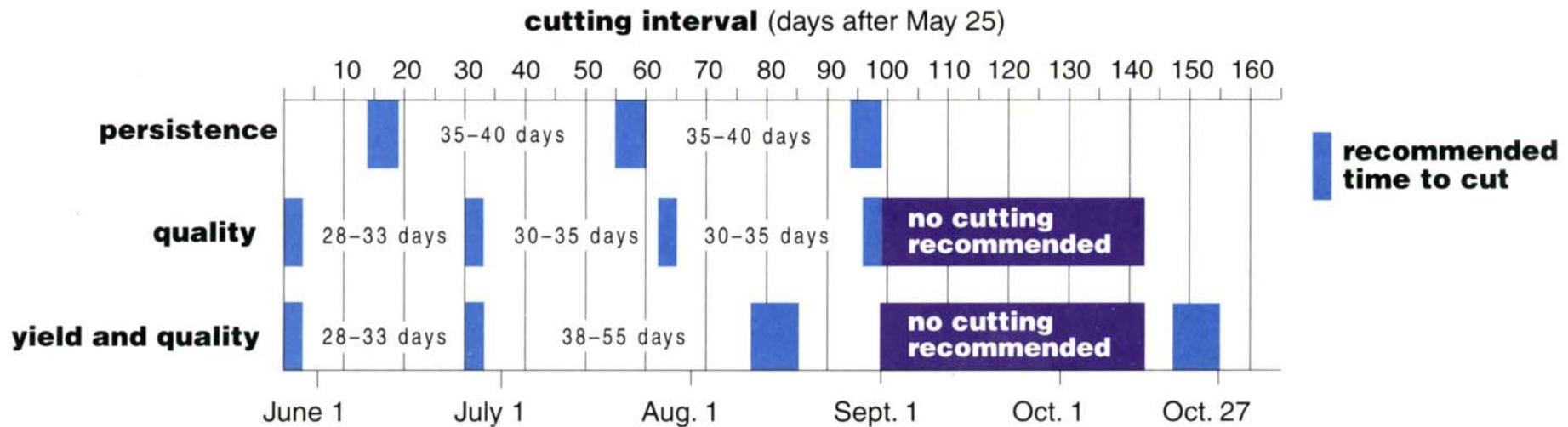
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# Harvest for Quality and Yield

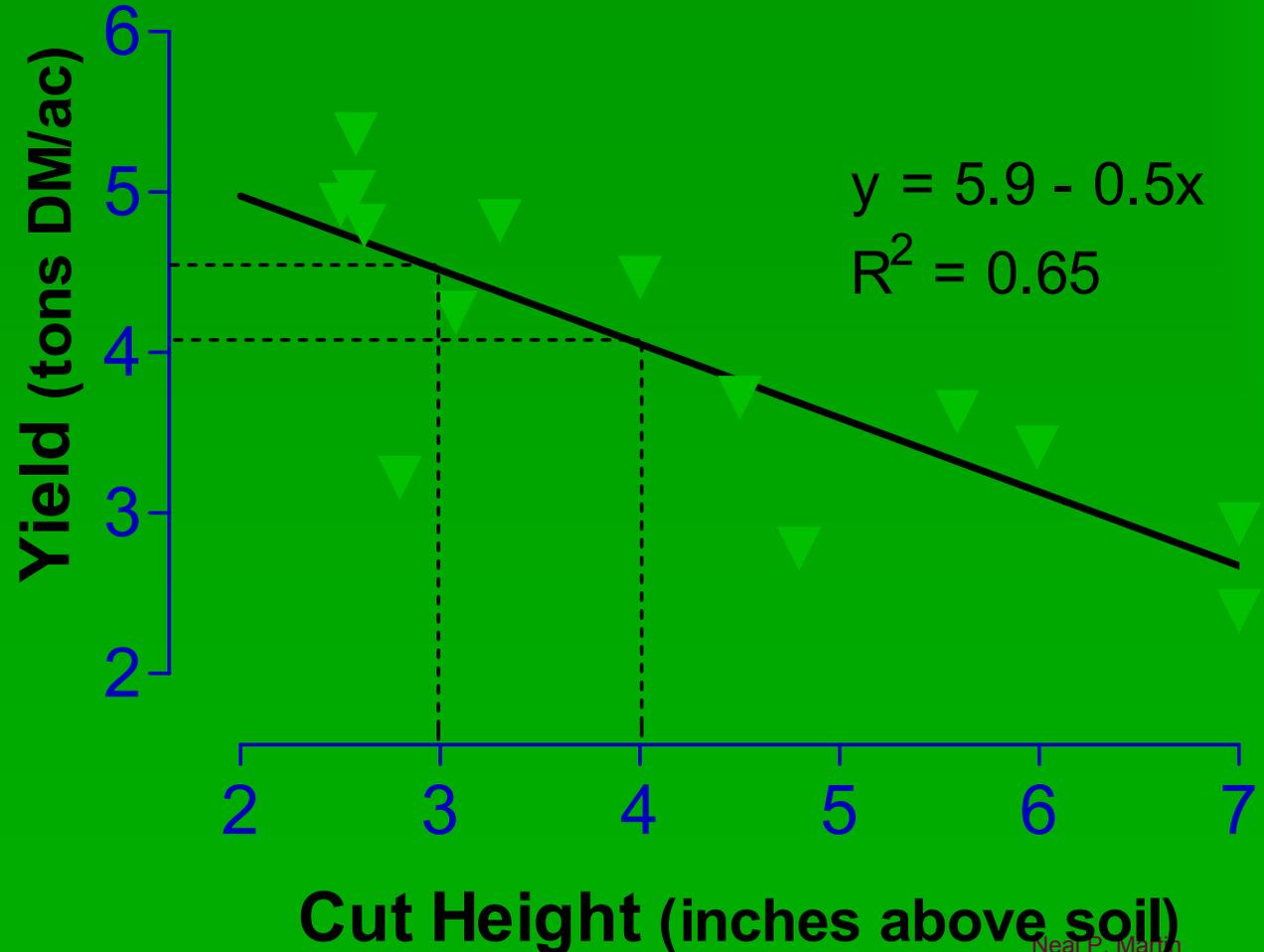
**Figure 21.** Cutting schedules for different management goals.



# Harvest for Quality and Yield

## Minimize harvest losses

- Total yield 3 cuts
- Clark and Wood County, WI 1999-2000



# Harvest for Quality and Yield

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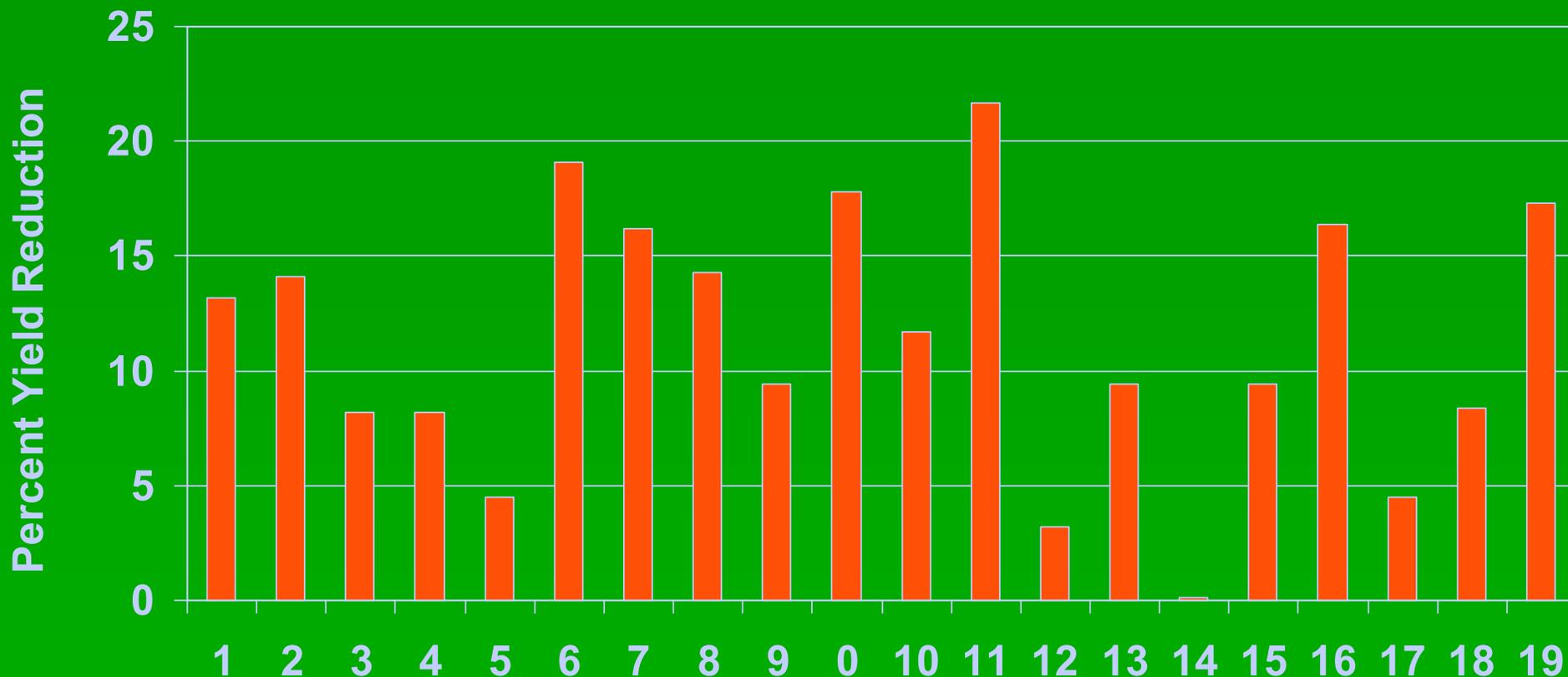
## ■ Minimize wheel traffic

- Study conducted in 4 states
- Wheel traffic within variety trials 2 and 5 days after cutting
- 8 – 9 % yield reduction – 2 days
- 28-29 % yield reduction – 5 days
- Demonstration at Arlington 9 vs 12 ft haybine – 1/2T/A/yr

## No wheel traffic – wheel traffic



# Percent yield reduction due to wheel traffic



**SOURCE:** Undersander, Dan and Jim Moutray. 2003.

[http://www.uwex.edu/ces/forage/wfc/proceedings2001/wheel\\_traffic.htm](http://www.uwex.edu/ces/forage/wfc/proceedings2001/wheel_traffic.htm)

Neal P. Martin  
USDFRC

# Harvest for Quality and Yield

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## ■ Minimize wheel traffic

- Use small tractors
- Avoid unnecessary trips
  - Mowing-conditioning
  - Transport of wagons
  - Collect dropped bales
- Consider using larger equipment
- Drive on fields as soon after cutting as possible



# Maximizing Alfalfa Yield and Quality

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- **Alfalfa yield is directly related to profit**
- **Managing yield and quality depends:**
  - **Selection of fields w/ well-drained soils, no perennial grass, correction of soil pH and other nutrients, planting high-yielding varieties, manage for rapid establishment**
  - **Manage production for high yield – annually fertilize based on needs, apply pest management skills**
  - **Harvest for quality and yield – cut for dairy quality, forecast quality of standing first crop, harvest early cuttings early and often, minimize harvest losses, and minimize wheel traffic**

# Maximizing Alfalfa Yield and Quality

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<http://www.dfrc.ars.usda.gov/SlideShows.html>