Crop Insurance for Hay and Forage

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Contributors:

Robert Dismukes
Glenn Zepp
Stacey Smith

Executive Summary

Hay is one of the most widely produced crops in the U.S. It is harvested in every state, and trails only corn and wheat in total acres harvested. In each of the past 10 years, U.S. farmers have harvested about 60 million acres of hay. According to the Census of Agriculture, nearly half of the farms in the U.S. harvest hay. The Northern Plains, among the 10 USDA Farm Production Regions, has the largest share of U.S. hay acreage, at 22 percent in 1994.

Alfalfa is the predominate type of hay harvested in the U.S. About 40 percent of U.S. hay acreage, 55 percent of hay production, and 60 percent of hay value over the past five years has been alfalfa and alfalfa mixtures. Alfalfa can be grown successfully in most areas of the U.S. It generally has higher nutrient content, yields higher tonnage, especially in the irrigated areas of the western U.S., and brings a higher price than other types of hay.

Most hay is consumed by livestock on the farms where it is grown. During 1975-79, 80 percent of hay in the U.S. was used on the farms where produced. (USDA discontinued estimates of on-farm use in 1979.) Hay that is sold off the farm is marketed through a number of different channels. A common avenue is farmer-to-farmer sales. Farmers who need hay contact farmers with excess hay and buy directly. A market news reporter in Missouri indicated that he thought that personal contacts between farmers accounted for the bulk of the hay sales in that state. In other parts of the country, hay is sold through hay auctions.

Because of its bulkiness and high transportation costs, hay is usually marketed in the area where it is produced. Premium hay, however, may be shipped long distances. Colorado's "Mountain Meadow" hay--native grasses grown at high altitude--is a preferred horse feed and reportedly is shipped as far away as Florida. Premium alfalfa from Utah and other mountain states is shipped throughout the U.S. and exported to Pacific Rim countries. Utah reportedly produces some of the highest quality hay grown in the U.S.

Alfalfa and alfalfa mixtures make up more than half of the hay acreage in many counties in the northern and western U.S. Small grain hay, about 5 percent of all U.S. hay acres, is found largely in the Great Plains states and California. Other tame hays--clovers, lespedeza, timothy, bromegrass, Sudan grass and millet--predominate in the South. Wild hay, about 12 percent of U.S. hay acreage, is found in all states. Nebraska, Kansas, North Dakota, and South Dakota, however, accounted for nearly half the U.S. wild hay acreage.

About 16 percent of all U.S. hay acreage and 44 percent of all U.S. alfalfa hay acreage is irrigated. Most irrigated acreage is in the western U.S., where almost all counties have more than 25 percent of their hay acreage irrigated.

The effects of rainfall is a major production peril faced by hay growers. Too little rainfall in the growing season slows plant growth and reduces yields. Too much rainfall can lead to flooding of the plants and root rot diseases. Rain on hay at harvest can reduce the quality of the hay. Rain on cut hay extends

drying time, increases shatter losses, decreases nutrient content, and reduces palatability. Rain damage is one of the biggest threats to hay yield and quality in the central and eastern U.S.

Winterkill is another major peril. Forage plants are vulnerable to winterkill where there is a lack of adequate snow cover in winter and when cold snaps follow periods of warm weather. Also, weakness of the plant can increase the risk of winterkill. Cutting hay too near the first killing frost, thus depriving the plant of sufficient time to build up its energy reserves for the winter, is a major cause of alfalfa winterkill. Insect and disease damage can also increase the vulnerability of a forage plant to winterkill.

The alfalfa weevil has been the most widespread and serious pest in hay production. Alfalfa weevil damage became so great in the 1960s and 1970s that many growers gave up trying to produce alfalfa. It is now possible, with good management techniques, to limit its damage. The potato leafhopper is a leading pest in some regions, and the silver whitefly has recently become a menace to alfalfa production in the low desert areas of southern California and Arizona.

Nearly $800,000,000 in ad hoc disaster payments were made for hay losses over the 1988-93 period. About 45 percent of all hay payments were made for alfalfa and alfalfa mixtures. A considerable share of the balance was listed as payments for mixed hay, which may include alfalfa. About 70 percent of the payments, $568 million, was made for the 1988 crop, when severe drought struck the Midwest. The top-ranked states in ad hoc payments for hay are Wisconsin, South Dakota, North Dakota, and Minnesota.

The demand for crop insurance for hay is probably the strongest in the Midwest and the Great Plains. Growers in these areas--hit by drought and winterkill in recent years--have received the bulk of disaster assistance. Changes in legislative procedures, by making ad-hoc disaster assistance more difficult to enact, have made ad-hoc payments a less reliable form of risk protection. Farmers harvesting hay in the Midwest and the Great Plains also are likely to be producing crops with Government income and price support programs; participants in the programs are required to purchase crop insurance for all crops of economic significance on their farms.

Simply expanding the existing APH-MPCI program does not appear to be an easy and effective way to meet the potential demand for crop insurance for hay in an actuarially sound manner. Servicing policies under the existing program has been costly and the lack of farm production records for hay has made development of rates and guarantees difficult. A GRP or other type of area risk insurance could overcome many of the problems with APH-MPCI, but expansion of GRP may be hampered by lack of suitable yield data. Hay insurance may present opporutnities for innovations such as yield insurance based on weather data.

Hay and Forage Contacts

Donald M. Ball
Department of Agronomy and Soils
Auburn University, AL
(205) 844-5491

Dan Putnam
Department of Agronomy and Range Science
University of California, Davis
(916) 752-8982

Dennis Cash
Plant, Soil and Environmental Science Department
Montana State University
(406) 994-5688

Marvin Hall
Department of Agronomy
Pennsylvania State University
(814) 863-1019

Dan Undersander
Department of Agromony
University of Wisconsin
(608) 263-5070

Notes on Data

Data on hay acreage, yield and production come from two sources: The annual crop production yields published by the National Agricultural Statistics Service, USDA and the Census of Agriculture. The annual series of acreage, yield and production are from NASS. Data on farms harvesting hay, acres of hay irrigated and production by types of hay--alfalfa, small grain hay, and other tame and wild hay--come from the 1992 Census of Agriculture, conducted by the Bureau of the Census, U.S. Department of Commerce.

Specific publications used:

U.S. Department of Agriculture, National Agricultural Statistics Service. *Agricultural Statistics*. Various issues.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Crop Values 1994 Summary*.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Crop Production 1994 Summary*.

U.S. Department of Commerce, Bureau of the Census. *Census of Agriculture, 1992*.

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INTRODUCTION

During the 1980s, the Federal Crop Insurance Corporation began offering Actual Production History-Multiple Peril Crop Insurance for forage. The insurance is now available in 17 states, though in only a few counties in most of the states. Most of the counties where insurance is available are in the upper Midwest and Northern Plains. Although these are major hay producing areas, hay is harvested widely in the U.S. Insurance is not currently available for most hay acreage, and the extent of U.S. hay acreage makes the potential size of the hay insurance program very large.

Recent changes in Government disaster assistance policies, which have made ad-hoc disaster assistance programs more difficult to enact and have made crop insurance the primary form of yield protection, have heightened interest in crop insurance for hay. Growers who participate in commodity income and price support programs are now required to take out at least the catastrophic level of crop insurance coverage, where available, on every crop of economic significance on their farms. Where insurance is not available, yield protection is provided by the Non-insured Assistance Program (NAP).

This report describes hay production in the U.S. and highlights issues relating to the provision of crop insurance for hay. The report begins with discussions of U.S. hay supply, use, and prices, and of farms harvesting hay. The next sections of the report describe the major types of hay harvested, production practices, costs of production, and production perils. Included is a regional analysis of these topics. The concluding sections analyze recent disaster assistance payments for hay and the existing crop insurance program for forage. They also outline insurance issues for further consideration.

HAY SUPPLY AND USE

Hay is one of the most widely produced crops in the U.S. It is harvested in every state, and trails only corn and wheat in total acres harvested. In each of the past 10 years, U.S. farmers have harvested about 60 million acres of hay (Figure 1). The Northern Plains, among the 10 USDA Farm Production Regions,[1] has the largest share of U.S. hay acreage, at 22 percent in 1994 (Table 1).

Alfalfa is the predominate type of hay harvested in the U.S. About 40 percent of U.S. hay acreage, 55 percent of hay production and 60 percent of hay value over the past five years has been alfalfa and alfalfa mixtures (Table 2). Alfalfa can be grown successfully in most areas of the U.S. It generally has higher nutrient content, yields higher tonnage, especially in the irrigated areas of the western U.S., and brings a higher price than other types of hay.

Table 1--U.S. Hay Acreage, Production and Value, by Type, by Farm Production Region and State,1994

Region/State	Harvested Acres			Production			Value		
	All	Alfalfa	Other	All	Alfalfa	Other	All	Alfalfa	Other

[1] A map of USDA Farm Production Regions is included as Appendix 1.

	1,000 acres			1,000 tons			Mil. dollars		
Appalachian									
Kentucky	2,250	300	1,950	5,400	1,110	4,290	427	120	307
North Carolina	510	20	490	1,187	60	1,127	96	7	89
Tennessee	1,700	50	1,650	3,795	165	3,630	193	15	178
Virginia	1,200	140	1,060	2,342	434	1,908	213	53	159
West Virginia	550	50	500	1,110	160	950	95	18	76
--Total	6,210	560	5,650	13,834	1,929	11,905	1,024	213	809
--Percent of U.S.	10.6	2.3	16.4	9.2	2.4	17.3	9.1	3.1	18.6
Corn Belt									
Illinois	1,100	650	450	3,175	2,275	900	260	199	61
Indiana	650	350	300	2,110	1,330	780	166	114	52
Iowa	1,750	1,250	500	5,775	4,625	1,150	445	379	66
Missouri	3,350	450	2,900	6,770	1,260	5,510	442	122	320
Ohio	1,280	660	620	4,384	2,772	1,612	398	299	98
--Total	8,130	3,360	4,770	22,214	12,262	9,952	1,711	1,113	597
--Percent of U.S.	13.8	13.9	13.8	14.8	15.1	14.5	15.3	16.2	13.7
Delta									
Arkansas	1,125	25	1,100	2,505	85	2,420	133	10	123
Louisiana	290	----	290	812	----	812	40	----	40
Mississippi	750	----	750	1,875	----	1,875	103	----	103
--Total	2,165	25	2,140	5,192	85	5,107	276	10	266
--Percent of U.S.	3.7	0.1	6.2	3.5	0.1	7.4	2.5	0.1	6.1
Lake States									
Michigan	1,400	1,050	350	4,865	4,095	770	338	291	47
Minnesota	2,300	1,600	700	7,530	5,920	1,610	528	447	81
Wisconsin	2,700	2,300	400	6,550	5,750	800	486	434	52
--Total	6,400	4,950	1,450	18,945	15,765	3,180	1,352	1,172	180
--Percent of U.S.	10.9	20.4	4.2	12.6	19.4	4.6	12.1	17.1	4.1
Mountain									
Arizona	195	160	35	1,326	1,200	126	136	127	9
Colorado	1,330	840	490	4,060	3,276	784	366	298	68
Idaho	1,250	1,020	230	4,438	3,978	460	361	330	31
Montana	2,200	1,550	650	4,540	3,565	975	310	250	60
Nevada	470	240	230	1,400	1,032	368	131	100	31
New Mexico	330	260	70	1,499	1,352	147	180	166	14
Utah	685	525	160	2,525	2,205	320	189	171	18
Wyoming	1,130	630	500	2,049	1,449	600	170	123	47
--Total	7,590	5,225	2,365	21,837	18,057	3,780	1,843	1,565	278
--Percent of U.S.	12.9	21.6	6.9	14.5	22.2	5.5	16.5	22.8	6.4
Northeast									
Connecticut	83	24	59	191	70	121	24	10	14
Delaware	15	5	10	61	26	35	7	3	4
Maine	213	18	195	406	45	361	38	5	32
Maryland	200	60	140	668	276	392	74	30	44
Massachusetts	106	29	77	217	78	139	26	10	15
New Hampshire	79	19	60	163	40	123	18	5	13
New Jersey	120	30	90	273	111	162	29	14	15
New York	1,660	620	1,040	3,961	1,829	2,132	334	179	155
Pennsylvania	1,920	800	1,120	4,528	2,400	2,128	469	273	196
Rhode Island	8	2	6	18	5	13	2	1	2
Vermont	325	105	220	649	231	418	57	23	33
--Total	4,729	1,712	3,017	11,135	5,111	6,024	1,078	553	523
--Percent of U.S.	8.1	7.1	8.7	7.4	6.3	8.8	9.6	8.1	12.0
Northern Plains									
Kansas	2,450	800	1,650	5,925	3,120	2,805	387	231	156
Nebraska	3,300	1,400	1,900	7,415	5,040	2,375	378	270	108
North Dakota	2,800	1,450	1,350	4,510	2,755	1,755	208	148	60
South Dakota	4,100	2,500	1,600	7,330	5,250	2,080	410	323	87
--Total	12,650	6,150	6,500	25,180	16,165	9,015	1,383	972	411
--Percent of U.S.	21.5	25.4	18.8	16.8	19.9	13.1	12.4	14.2	9.5
Pacific									
California	1,470	950	520	8,210	6,650	1,560	853	732	122
Oregon	1,010	410	600	2,840	1,640	1,200	254	167	86
Washington	710	470	240	2,785	2,209	576	273	192	81
--Total	3,190	1,830	1,360	13,835	10,499	3,336	1,380	1,091	289
--Percent of U.S.	5.4	7.6	3.9	9.2	12.9	4.9	12.3	15.9	6.7
Southeast									
Alabama	750	----	750	2,025	----	2,025	95	----	95
Florida	240	----	240	744	----	744	68	----	68
Georgia	650	----	650	1,950	----	1,950	122	----	122
South Carolina	250	----	250	650	----	650	51	----	51
--Total	1,890	----	1,890	5,369	----	5,369	336	----	336
--Percent of U.S.	3.2	0.0	5.5	3.6	0.0	7.8	3.0	0.0	7.7
Southern Plains									
Oklahoma	2,200	320	1,880	4,128	1,120	3,008	292	113	179
Texas	3,590	90	3,500	8,455	405	8,050	524	49	475
--Total	5,790	410	5,380	12,583	1,525	11,058	816	162	654
--Percent of U.S.	9.9	1.7	15.6	8.4	1.9	16.1	7.3	2.4	15.1
United States	58,744	24,222	34,522	150,124	81,398	68,726	11,198	6,854	4,344

---- = not estimated. Alfalfa = Alfalfa and Alfalfa Mixtures. Totals may not add due to rounding.
Source: National Agricultural Statistics Service, USDA.

Table 2--U.S. Hay Acreage, Production, and Value, by Type, 1985-94

Type/ Year	Harvested Acreage	Production	Value
	1,000 acres	1,000 tons	Mil. dollars
All Hay:			
1985	60,423	148,601	9,437
1986	62,419	155,529	8,611
1987	60,748	149,302	8,969
1988	65,055	126,010	10,457
1989	63,300	145,512	11,514
1990	61,407	146,802	10,462
1991	62,475	153,325	10,006
1992	58,903	146,903	10,436
1993	59,679	146,799	10,957
1994	58,744	150,124	11,198
Alfalfa and Alfalfa Mixtures:			
1985	25,608	85,048	N/A
1986	26,793	91,552	N/A
1987	25,535	84,794	N/A
1988	26,750	69,304	N/A
1989	25,944	77,370	N/A
1990	24,401	83,555	6,641
1991	25,585	83,795	6,025
1992	24,070	79,140	6,388
1993	24,723	80,305	6,797
1994	24,222	81,389	6,854
All Other Hay:			
1985	34,815	63,553	N/A
1986	35,626	63,977	N/A
1987	35,213	64,508	N/A
1988	38,305	56,706	N/A
1989	37,356	68,142	N/A
1990	36,006	63,265	3,821
1991	36,890	69,530	3,981
1992	34,833	67,763	4,048
1993	34,956	66,494	4,160
1994	34,522	68,726	4,344

N/A = not available.
Source: National Agricultural Statistics Service, USDA.

Table 3--U.S. Hay Supply and Disappearance, 1992/93-94/95

Season	Carryover May 1	Production	Imports	Supply	Exports	Carryover	Total Disappearance
			1,000 tons				
1992/93	28,216	146,903	50	175,169	647	21,010	154,159
1993/94	21,010	146,799	43	167,852	912	22,096	145,756
1994/95	22,096	150,124	48	172,268	1,436	20,786	151,482

Imports and exports exclude alfalfa products such as meal, cubes and pellets.
Source: National Agricultural Statistics Service, USDA and Bureau of Census, Dept. of Commerce.

Table 4A--U.S. Hay Prices, by Type, 1992/93-94/95

Type	Price	Percent of Alfalfa Price
	$ per ton	Percent
Alfalfa	83.20	--
Other hay	61.80	74
All hay	73.40	88

Prices are average of three seasons, weighted by production.
Source: National Agricultural Statistics Service, USDA.

Table 4B--Alfalfa Hay Prices, Selected Regions, 1992/93-94/95

Region	Price
	$ per ton
Northern Plains	59.70
Southwest	98.80
U.S.	83.20

Prices are average of three seasons, weighted by production.

Source: National Agricultural Statistics Service, USDA.

The bulk of the U.S. hay supply comes from current-year production. Only 10 to 15 percent of the total supply is carryover from the previous year. Growers reported 22 million tons of carryover on May 1, 1994 (Table 3). Imports account for a tiny amount of the hay supply. In the 1994 marketing year, just 48,000 tons of hay were imported, out of 172 million tons of total supply.

Almost all hay in the U.S. is fed to livestock. A small amount, usually low quality grass hay, is used for mulch and erosion control in construction projects. The U.S. exports a very small portion of its overall hay production--about one percent in 1994. Japan is the biggest export market; Mexico and Canada also import notable amounts of U.S. hay.

Most hay is consumed on the farms where it is grown. During 1975-79, 80 percent of hay in the U.S. was used on the farms where produced. (USDA discontinued estimates of on-farm use in 1979.) Hay that is sold off the farm is marketed through a number of different channels. A common avenue is farmer-to-farmer sales. Farmers who need hay contact farmers with excess hay and buy directly. A market news reporter in Missouri indicated that he thought that personal contacts between farmers accounted for the bulk of the hay sales in that state (Gill).

In other parts of the country, hay is sold through hay auctions. The Pennsylvania Department of Agriculture reports hay prices for at least 10 auction markets (McDonald). [2] Some hay auctions are operated in conjunction with livestock auctions. In the irrigated production areas of the West, some hay is marketed through marketing associations, which typically employ a sales manager. Some big dairies and hay dealers contract directly with producers to supply hay. Hay is also sold through dealers and brokers.

Because of its bulkiness and high transportation costs, hay is usually marketed in the area where it is produced. Premium hay, however, may be shipped long distances. Colorado's "Mountain Meadow" hay--native grasses grown at high altitude--is a preferred horse feed and reportedly is shipped as far away as Florida (Padgett). Premium alfalfa from Utah and other mountain states is shipped throughout the U.S. and exported to Pacific Rim countries. Utah reportedly produces some of the highest quality hay grown in the U.S.

HAY PRICES

Hay prices vary widely by the type of hay, the region of the country, and quality. Alfalfa generally fetches the highest price, because of its high nutritive value. The U.S. average alfalfa price for the three seasons from 1992 through 1994 was $83 per ton, compared with $62 for other hay (Table 4A). Other hay includes the grasses, clovers, small grains, and mixtures of these types of hay.

[2] The Pennsylvania Department of Agriculture Market News Service is on the Internet at "gopher://psupena.psu.edu:70/0%24d%201040121."

Hay prices tend to be highest in the Southwest (Arizona, California, Nevada and New Mexico) and lowest in the Northern Plains (Montana, Nebraska, North Dakota and South Dakota). Alfalfa in the Southwest averaged nearly $99 per ton during the past three seasons, compared with $60 in the Northern Plains (Table 4B). The Southwest is a hay deficit area, importing from surrounding areas. In the Southwest, most hay is purchased by large dairy operations that demand the highest quality. In the Northern Plains, a larger share of production is fed to beef cattle for which hay quality is less important.

Mid-month state-level hay prices received by farmers are reported monthly in USDA's *Agricultural Prices*. Monthly prices and season-average prices are published in July in the annual summary edition of *Agricultural Prices*. The Federal-State Market News reports current weekly cash hay prices for several markets. These are available through the Internet.[3] The Sioux City office of the Federal-State Market News prepares a weekly national summary of hay prices, which is available by subscription.[4]

FARMS HARVESTING HAY

According to the Census of Agriculture, nearly half of the farms in the U.S. harvest hay (Table 5). The Corn Belt, which contains the largest number of all U.S. farms, also contains the largest number of farms harvesting hay. In the Lake States and Northeast, the highest share--about 60 percent of each region's farms--harvested hay. In the Pacific region only 23 percent of the farms harvested hay, but these farms--just four percent of all hay farms--produced large amounts of alfalfa and accounted for about 12 percent of the total value of U.S. hay in 1994.

Most farms harvesting hay, like U.S. farms in general, are small (Table 6). About 60 percent of farms harvesting hay and of all U.S. farms sold less than $25,000 of agricultural products in 1992. A considerable portion of hay acreage--about 30 percent of the U.S. total--was on farms with sales of less than $25,000 (Table 7). About 10 percent of U.S. hay acreage was on farms that sold more than $500,000 of farm products. In the Pacific region, however, more than a third of the acreage was on farms with more than $500,000 in sales.

Higher proportions of farms harvesting hay than of all farms had livestock (Table 8). This is not surprising in that most hay is consumed on farms where it is grown. Nearly 70 percent of farms harvesting hay also had beef cattle, compared with about 50 percent of all farms. Sixty-three percent of farms harvesting hay also had dairy cattle, compared with 45 percent of all farms.

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[3] USDA Agricultural Marketing Service reports are available on the Internet at "gopher://unlvm.unl.edu:70/11//markets/grains".

[4] The telephone number of the office is (712) 252-3286.

Table 5--Distributions of Farms Harvesting Hay and of All Farms by Farm Production Region, 1992

Region	--- All Farms ---		---- Farms Harvesting Hay ----		
	Number	Percent of All US Farms	Number	Percent of US Hay Farms	Percent of All Farms in Region
Appalachian	276,453	14.4	144,827	16.0	52.4
Corn Belt	405,724	21.1	187,399	20.7	46.2
Delta	101,587	5.3	45,619	5.0	44.9
Lake States	189,600	9.9	111,859	12.4	59.0
Mountain	118,275	6.2	58,232	6.4	49.2
Northeast	124,916	6.5	77,113	8.5	61.7
Northern Plains	181,381	9.4	97,456	10.8	53.7
Pacific	139,825	7.3	31,748	3.5	22.7
Southeast	134,110	7.0	43,669	4.8	32.6
Southern Plains	247,581	12.9	107,135	11.8	43.3
--Total	1,919,452	----	905,057	----	47.2

Excludes Alaska and Hawaii.
Source: Census of Agriculture, Dept. of Commerce.

Table 6--Distributions of Farms Harvesting Hay and of All Farms by Total Value of Products Sold, 1992

Region	Farms	- - - - Total value of products sold - - - - More than $500,000	$100,000-$499,999	$50,000-$99,999	$25,000-$49,999	Less than $25,000
	Number	- - - - - - Percent of farms - - - - - -				
Appalachian:						
Farms harvesting hay	144,827	1.0	6.3	5.6	9.4	77.7
All farms	276,453	1.4	7.0	5.1	8.2	78.3
Corn Belt:						
Farms harvesting hay	187,399	1.6	19.4	12.6	12.5	53.8
All farms	405,724	1.8	19.2	12.4	12.5	54.0
Delta:						
Farms harvesting hay	45,619	2.6	10.5	4.3	6.2	76.4
All farms	101,587	3.5	14.7	5.4	5.9	70.4
Lake States:						
Farms harvesting hay	111,859	1.12	3.9	17.0	11.7	46.4
All farms	189,600	1.62	1.3	15.1	12.0	50.0
Mountain:						
Farms harvesting hay	58,232	3.3	18.3	12.9	12.3	53.3
All farms	118,275	3.3	15.1	10.6	10.8	60.2
Northeast:						
Farms harvesting hay	77,113	1.6	20.1	11.9	8.0	58.4
All farms	124,916	2.5	17.6	10.3	8.2	61.4
Northern Plains:						
Farms harvesting hay	97,456	2.6	26.2	20.1	17.2	33.9
All farms	181,381	2.5	22.5	17.0	16.0	42.1
Pacific:						
Farms harvesting hay	31,748	8.1	15.7	7.4	8.1	60.7
All farms	139,825	6.4	14.1	7.7	8.1	63.7
Southeast:						
Farms harvesting hay	43,669	3.4	9.9	4.6	6.8	75.2
All farms	134,110	3.6	10.6	5.4	6.7	73.6
Southern Plains:						
Farms harvesting hay	107,135	1.5	8.1	6.6	10.1	73.7
All farms	247,581	1.4	7.9	6.0	8.2	76.6
Total:						
Farms harvesting hay	905,057	2.0	16.2	11.1	11.0	59.7
All farms	1,919,452	2.4	14.9	9.8	10.1	62.8

Excludes Alaska and Hawaii.

Source: Census of Agriculture, Dept. of Commerce.

Table 7--Distribution of Acres of Hay Harvested by Total Value of Products Sold, 1992

Region	Hay harvested	More than $500,000	$100,000-$499,999	$50,000-$99,999	$25,000-$49,999	Less than $25,000
		- - - - Total value of products sold - - - -				
	Acres	- - - - - - Percent of acres - - - - - -				
Appalachian	5,268,960	3.6	16.8	11.2	14.0	54.4
Corn Belt	8,023,118	4.1	30.3	15.5	13.7	36.5
Delta	2,134,353	5.9	19.3	8.4	11.1	55.3
Lake States	7,293,001	3.9	42.6	19.7	10.1	23.7
Mountain	7,014,165	15.5	39.6	16.4	11.2	17.3
Northeast	5,047,070	5.9	40.7	14.9	8.4	30.1
Northern Plains	11,229,458	8.2	40.4	22.0	14.3	15.1
Pacific	3,144,351	35.5	31.0	9.4	7.1	16.9
Southeast	1,701,933	9.6	18.9	8.6	11.2	51.7
Southern Plains	5,720,097	6.6	19.9	12.0	14.3	47.1
--Total	56,576,506	8.7	32.9	15.8	12.1	30.5

Excludes Alaska and Hawaii.
Source: Census of Agriculture, Dept. of Commerce.

Table 8--Percent of Farms Harvesting Hay and of All Farms That Had Livestock, 1992

Region	Farms	- - - Farms having livestock - - - Dairy cattle	Beef cattle	Horses
	Number	- - - - Percent of farms - - - -		
Appalachian:				
Farms harvesting hay	144,827	64.4	76.5	16.4
All farms	276,453	47.0	57.5	14.8
Corn Belt:				
Farms harvesting hay	187,399	59.5	68.6	16.1
All farms	405,724	37.3	44.9	12.3
Delta:				
Farms harvesting hay	45,619	72.8	82.4	19.2
All farms	101,587	53.4	62.3	16.7
Lake States:				
Farms harvesting hay	111,859	61.7	57.0	14.4
All farms	189,600	42.3	41.1	12.5
Mountain:				
Farms harvesting hay	58,232	53.5	63.0	42.3
All farms	118,275	45.3	55.0	39.4
Northeast:				
Farms harvesting hay	77,113	58.8	51.4	22.0
All farms	124,916	41.5	37.7	21.1
Northern Plains:				
Farms harvesting hay	97,456	62.8	72.7	18.1
All farms	181,381	46.7	55.9	14.8
Pacific:				
Farms harvesting hay	31,748	50.6	56.6	29.8
All farms	139,825	27.7	32.8	22.9
Southeast:				
Farms harvesting hay	43,669	68.7	79.1	18.0
All farms	134,110	45.2	54.6	15.8
Southern Plains:				
Farms harvesting hay	107,135	71.6	81.4	22.4
All farms	247,581	61.8	73.0	21.6
Total:				
Farms harvesting hay	905,057	62.7	69.3	19.8
All farms	1,919,452	44.7	51.9	17.6

Excludes Alaska and Hawaii.
Source: Census of Agriculture, Dept. of Commerce.

TYPES OF HAY

Alfalfa and alfalfa mixtures is the most widely grown type of hay in the U.S. About 25 million acres of alfalfa and alfalfa mixtures, 40 percent of all hay acres, are harvested each year with yields averaging 3-3.5 tons per acre (Figure 2). Other types of hay--small grain, other tame, and wild--account for the rest of the U.S. hay acreage, and yield, on average, about 2 tons per acre (Figure 3).

Alfalfa and alfalfa mixtures make up more than half of the hay acreage in many counties in the northern and western U.S. (Figure 4). Small grain hay, about 5 percent of all U.S. hay acres, is found largely in the Great Plains states and California (Figure 5). Other tame hays--clovers, lespedeza, timothy, bromegrass, Sudan grass and millet--predominate in the South (Figure 6). Wild hay[5], about 12 percent of U.S. hay acreage, is found in all states (Figure 7). Nebraska, Kansas, North Dakota, and South Dakota, however, accounted for nearly half the U.S. wild hay acreage.[6]

About 16 percent of all U.S. hay acreage and 44 percent of all U.S. alfalfa hay acreage is irrigated. Most irrigated acreage is in the western U.S., where almost all counties have more than 25 percent of their hay acreage irrigated (Figure 8).

PRODUCTION PRACTICES[7]

Alfalfa

Alfalfa is a perennial legume that can be used for pasture[8], silage, green chop, soil improvements, soil conservation, as well as hay. In areas where it is well adapted, alfalfa has the highest yield potential of any perennial forage legume.

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[5] The Bureau of Census defines wild hay as that "cut chiefly from wild or native grasses, even if it had fill-in seedings of other grasses."

[6] The Nebraska Agricultural Statistics Service is the only state statistical office reporting wild hay production. It defines wild hay as that cut from native vegetation. In Nebraska, native vegetation is frequently growing on land that has never been tilled.

[7] A listing of extension specialists for forage production is contained in Appendix 2.

[8] Alfalfa has limited use as pasture because it does not withstand grazing well and because it causes bloat in cattle.

The productive life of an alfalfa stand ranges from 2 to 10 years or longer, though 3 to 5 years is most common. Stand life depends on the type of soil, climate, and management practices. It can be cut short by poor management, unpredictable weather, and pest problems, especially root diseases associated with poor soil drainage (Nebraska Cooperative Extension Service).

Although alfalfa can be grown under a wide range of climatic conditions, it requires well-drained soils with pH of 6.5 (slightly acid) or higher to reach its maximum yield potential and stand life. Lime applications are required on soils with a pH below 6.5. Alfalfa is relatively drought tolerant. Drought conditions, however, substantially limit yields.

Alfalfa converts atmospheric nitrogen, by nitrogen fixation,[9] to a plant-usable form. The only nitrogen fertilizer that usually needs to be applied to alfalfa is a small amount at planting, before the nitrogen fixing bacteria become established. In addition to supplying its own nitrogen, alfalfa leaves nitrogen in the soil, reducing fertilizer applications on subsequent crops.

Seeding

Alfalfa is usually planted in either the early spring or late summer and fall. The timing of seeding is influenced by precipitation, temperature, and cropping plans. Spring seeding allows for harvest during the planting year but usually requires weed control. Late summer and fall seeding can avoid weed competition and loss of plants due to hot and dry summer weather. Fall planting must be early enough, however, so that roots can develop to withstand the cold temperatures and freezing and thawing of winter.

Alfalfa seedbeds should be well drained, provide good seed-to-soil contact, and offer enough moisture to initiate germination and allow the seedlings to become established. A good seedbed is finely pulverized, leveled and firmed to the seeding depth. Inadequate seedbed preparation is a common cause of failure to achieve a good stand. In order to assure adequate nodulation for nitrogen fixation, it is important to use preinoculated seed or to treat seed with inoculant before planting.

Conventional seeding consists of planting on a prepared seedbed with a cultipacker or grain drill. Alfalfa can also be broadcast, frost seeded, or no-till planted. Frost seeding, done in late winter, uses the freezing and thawing action of the spring to work the seeds into the soil. No-till planting of alfalfa directly into corn stalks or small grain stubble requires special attention to weed and insect control, but can result in excellent stands while minimizing soil loss.

Seeding alfalfa immediately following alfalfa is not recommended. This practice has led to stand establishment problems, which are thought to result from insect and disease buildup. Attempts to reestablish alfalfa immediately following a previous alfalfa crop or to thicken an existing alfalfa stand

[9] Nitrogen fixation is the conversion of atmospheric nitrogen into nitrates by soil bacteria found on root nodules of certain legumes.

have led to autotoxicity, which occurs when by-products of decomposition of the old stand lower seed germination. Autotoxicity results in poor stand establishment and poor stand performance. It can be minimized by allowing at least two weeks between plowing an existing stand and seeding a new one, or allowing at least three weeks between the herbicide killing of an old stand and seeding.

Plant Density

In the northeastern and north-central U.S., two to three alfalfa plants per square foot is usually the recommended minimum number of plants for economical hay production. Alfalfa-grass mixtures can maintain productivity with only two alfalfa plants per square foot. Under drier conditions, in areas such as the Plains, less than one plant per square foot may be acceptable (Bosworth; Henning and Nelson).

Low populations allow each plant space to grow, producing more stems and resulting in a higher dry weight per plant. This is known as compensatory growth. Forage quality does not appear to be affected by stand density. Most research comparing different alfalfa plant populations has found little difference in leaf percentage, crude protein, or acid detergent fiber (an indicator of digestibility). However, thinner stands are more susceptible to weed encroachment, which can cause a reduction in forage quality.

Weed Control

Weed control relies heavily on competition from a healthy forage stand to crowd out weeds. Once weeds become established, they compete for light, nutrients, water, and space. Common chickweed infestations have been reported to reduce alfalfa stands by 30 percent or more. Unlike most grain and fibre crops, from which weeds are separated at harvest, weeds in hay are recovered along with the forage. Weeds can lower the protein content and reduce the palatability of hay.

Harvesting

The timing of harvest involves a trade-off between forage quality and stand longevity. Cutting alfalfa in the pre-bud stage results in the highest quality hay, but it depletes the carbohydrate root reserves and weakens the stand. Cutting at the one-tenth bloom stage is generally recommended to yield high quality hay and leave adequate root reserves for regrowth.

Stands should not be cut less than three to four weeks before the first killing frost. This provides adequate time for root carbohydrate reserves to replenish before the plant becomes dormant and reduces the chances of disease infection and winter injury.

Other techniques for extending stand life include planting cold-tolerant varieties with resistance to pests and diseases, maintaining phosphorus and potassium levels in the soil, and controlling the soil pH by applying lime. Avoiding mechanical damage to crowns also extends plant life. Crowns may be damaged by running machinery or livestock in the field when the soil is soft or wet.

Growers of alfalfa-grass mixtures need to consider the grass crop in the mixture when scheduling harvests. Orchardgrass, perennial ryegrass, reed canarygrass, and tall fescue can tolerate numerous cuttings without jeopardizing the stand and are compatible with frequently-cut alfalfa. Timothy and smooth bromegrass cannot tolerate frequent cutting and stands of alfalfa mixed with them cannot be cut as often as pure alfalfa.

Other Hay

Small Grain Hay

Small grains--oats, barley and wheat--may be planted with the intention of being harvested as hay, or a farmer may decide after planting to harvest the small grains as hay. Drought may reduce the plant's value as grain, or a shortage of other forage may make the grain crop more valuable as forage than as grain. Small grain hay tends to be fed to beef cattle where high protein content is less important than it is for dairy cattle.

The major quality factors in small grain hay are maturity at harvest, rain damage, and protection during storage. The dough stage of the kernel is usually the best stage for cutting small grains as hay. Cutting at this stage results in the optimum mix of dry matter yield and hay quality. Existing data suggest no consistent quality difference between oats, barley, and wheat used as hay (Oltjen, Bolsen, and Johnson.)

Other Tame Hay

Several species of grass and legumes are used for hay. Orchardgrass, smooth bromegrass, timothy, tall fescue and Bermuda grass are the most common grasses used for hay. Red clover is the major legume, besides alfalfa, used for hay. Several other grasses and legumes contribute minor portions of U.S. hay production.

Orchardgrass is a perennial, cool season, tall growing, bunch-type grass. It establishes rapidly from seed and is suitable for pasture, silage, or hay. It is especially well adapted for mixtures with alfalfa or red clover and withstands frequent cutting better than other cool season grasses.

Orchardgrass is more tolerant of heat and drought than perennial ryegrass, timothy, or Kentucky bluegrass. It is not as winter hardy or drought tolerant as smooth bromegrass, and it is not as heat and drought tolerant as tall fescue. Orchardgrass is found throughout much of the northern U.S., where it can be grown in dryland areas with at least 20 inches of precipitation or with irrigation.

Smooth bromegrass is a leafy, sod-forming perennial grass that is used for hay and early spring pasture in the north-central U.S. It is a deep-rooted cool-season grass. Smooth bromegrass requires relatively heavy applications of fertilizer, though if it is seeded with a legume, nitrogen fertilizer should be limited to promote nodulation of the legume.

The forage quality of smooth bromegrass compares well with other cool season grasses, depending primarily on the stage of maturity. Bromegrass matures later in the spring and makes less summer growth than orchardgrass. The plant can survive periods of drought and temperature extremes. Smooth bromegrass does not tolerate frequent cutting.

Timothy is a perennial, bunch-type, shallow-rooted, cool-season grass which is well adapted to the Northeast and upper Midwest. Its shallow root system, however, makes it poorly adapted to droughty soils. Consequently, timothy is most widely grown in areas with moist, cool environments, such as the northern half of Pennsylvania and New York. Timothy is the most popular grass in New York, with the majority of New York's hay crop acreage sown to timothy-legume mixtures. It is winter hardy and offers little competition to a legume in the mixture. Timothy is the hay of choice for horse owners and can also serve as a horse pasture.

Timothy stores energy reserves for regrowth and tillering in the enlarged bulbous structure at the stem base. Its energy storage pattern makes it a better hay crop than a pasture species. Timothy is intolerant to cutting during the jointing (stem elongation) and early-heading stages. This intolerance makes harvest management for high quality in an alfalfa mixture difficult because the alfalfa will generally be ready to harvest before the timothy. Management systems which include harvesting alfalfa at the early-heading stage in combination with high nitrogen fertilization rates reduce timothy stands. High nitrogen applications (greater than 200 pounds per acre per year) decrease storage of energy reserves and reduce persistence.

Tall fescue is a deep-rooted, long lived, sod forming grass that spreads by short underground stems called rhizomes. One of the most drought-tolerant forage grasses, it is also tolerant of poor drainage, alkalinity, and salinity (American Forage and Grassland Council).

Although it is adaptable to a wide range of climates, tall fescue performs best under cool-season conditions. It is the only cool-season grass that can persist in many parts of the South.

Tall fescue is widely used as pasture and hay for beef cattle and sheep in the southern and east-central U.S. It is grazed by animals during April, May, and early June, and again in the fall. Large quantities of tall fescue also are grown for seed in Oregon. In addition, it is used as a pasture grass in Washington and Oregon.

Because of differences in growth habits, palatability, and time of the year when they should be used, combinations of tall fescue and other grasses perform poorly. Legumes, however, can be used in mixtures with tall fescue, although such stands may eventually become pure fescue as fescue crowds out the legumes.

Bermuda grass is a major warm-season sod-forming grass used for pasture, hay, lawns, general-purpose turf, and erosion control. It is best adapted to relatively fertile soil in humid southern states, but is found as far north as Maryland and the southern part of the Corn Belt. Giant Bermuda grass, found in irrigated areas in the southwestern U.S., appears to be a diploid form of the species. It

displays greater vigor than common Bermuda grass and lacks the pubescence characteristic of the common type.

Numerous improved varieties of Bermuda grass are available for hay and pasture, but Coastal is the standard against which other varieties tend to be compared. Developed at the Georgia Coastal Plain Experiment Station, the Coastal variety is noted for its resistance to foliage diseases, nematodes, frost, and drought. It is much more efficient in nutrient and water use than common Bermuda grass and is more palatable and produces nearly twice as much forage and animal product. This superiority holds throughout most of the Bermuda-grass growing area. Once established, Bermuda grass stands can remain productive for many years.

Red clover is a short-lived perennial which is adapted to wetter and lower pH soils than alfalfa. It is easy to establish and yields well during the first year or two. It is well suited for use as the forage legume in short rotations with corn. Red clover is characterized by rapid spring growth, but has poor winter hardiness, which accounts for its short-lived nature. The tendency for its thick stems to dry slowly has been a deterrent to its widespread use.

Red clover grows moderately well on slightly acid soils. It performs best in areas having moderate summer temperatures and uniform moisture throughout the growing season.

Red clover is most widespread in the northeastern, north-central, and southeastern U.S. A small amount is grown under irrigation in the Pacific Northwest. Red clover is frequently grown in combination with orchardgrass, timothy, or small grains as a hay crop.

There are two types of red clover grown in the U.S.: 1) early flowering or medium red clover; and 2) late flowering or mammoth red clover. Medium red clover produces two or three hay crops a year and is usually treated as a biennial. Some new medium varieties can produce to their full capacity for three years or more. Mammoth red clovers usually produce one hay crop a year, and perform best in areas with short growing seasons.

Other grasses and legumes that are used for hay include reed canarygrass, native warm-season grasses, prairie grass, birdsfoot trefoil, white clover, alsike clover, and annual lespedeza. These are described in Appendix 3.

COSTS OF PRODUCTION

Table 9A shows estimated establishment and production year costs for alfalfa, timothy, and orchard grass in Pennsylvania. The biggest investments tend to be for alfalfa and orchard grass.

Table 9A--Estimated Costs and Returns for Hay in Pennsylvania, 1993

Species	Costs		Returns	
	Variable	Total	Yield	Market value
	Dollars per acre		Tons	Dollars per acre
Alfalfa:				
Establishment year	272	306	2.6	234
Established stand	197	254	4.75	437
Timothy:				
Establishment year	147	169	1.5	120
Established stand	150	184	3.5	280
Orchard grass:				
Establishment year	167	191	1.5	98
Established stand	151	184	5.0	360

Alfalfa established stand yield includes one ton hay equivalent harvested as haylage.
Source: Pennsylvannia Cooperative Extension Service.

Table 9B--Estimated Costs and Returns for Irrigated Alfalfa, Selected States

State	Variable Production Expenses	Amortized Establishment Expenses	Total Cost	Yield	Cost per Ton
	Dollars per acre			Tons	Dollars
Arizona:					
Yuma County	321	74	625	9.0	69
Colorado:					
Northern	154	*	198	5.0	40
California:					
Imperial County	499	90	598	8.0	75
Nebraska:					
Panhandle	200	35	280	6.0	47
Minnesota:					
Southeast	49	73	227	4.5	50
Pennsylvania	197	61	315	4.75	66

Total costs include variable production expenses, amortized establishment expenses and fixed overhead costs; excludes land rent and allocated returns to land investment.
Minnesota and Pennsylvania costs are for non-irrigated alfalfa.
Minnesota costs does not include charge for unpaid family labor.

* = Establishment costs included in annual production expenses.
Source: see Appendix 4.

Although its establishment costs are somewhat higher than for orchard grass and timothy, alfalfa produces a somewhat higher return during its first year than the other species.

Irrigated alfalfa production expenses range from $227 per acre in Southeast Minnesota to $625 per acre in Yuma County, Arizona (Table 9B). Western Arizona and southern California show the highest costs per ton. This may be due partly to the greater use of hired labor and custom services for field operations than in the other areas. Although Colorado, Nebraska, and Minnesota report somewhat lower costs per ton than in the Arizona and California areas, the average value per ton is also likely to be somewhat lower. Because of greater chance of rain during harvest, quality is more likely to be depreciated by rain damage in the Great Plains and Midwest than in the southwest U.S. Detailed establishment and production year budgets are included in Appendix 4.

PRODUCTION PERILS

The effects of rainfall and winterkill are the main production perils faced by hay growers. Too little rainfall in the growing season slows plant growth and reduces yields. Too much rainfall can lead to flooding of the plants and root rot diseases. Rain on hay at harvest can reduce the quality of the hay. Exposure to extremely cold temperatures can kill a dormant forage plant in winter.

Drought

Drought reduces plant growth and the yield potential of all hay species. Some species, however, survive drought conditions better than others and recover more quickly following dry weather. Alfalfa has extensive roots, including a long tap that can extract moisture from deep in the soil during dry periods. Although it is relatively drought tolerant, alfalfa yields depend on available water. A rule of thumb is that approximately six acre-inches of water will yield one ton of cured hay.

Dry conditions are the greatest peril for newly planted forage because the plant roots have not yet been firmly established. For example, alfalfa seedlings, which have not developed extensive root systems, are easily killed by hot, dry conditions.

Flooding and Wet Soils

As with drought, different hay species have different tolerances to flooding and excessively wet soils. Alfalfa is particularly vulnerable to losses from flooding and wet soil.

Alfalfa should be seeded only on well-drained soils. Fungi that cause diseases such as Phytophthora root rot thrive in wet soils. Alfalfa roots are sensitive to low soil oxygen levels and will die if the soil remains inundated for several days. One or two days of flooding can kill alfalfa plants that are actively growing, though alfalfa can survive longer periods of immersion when the plants are dormant.

Rain on Cut Hay

Rain on cut hay extends drying time, increases shatter losses, decreases nutrient content, and reduces palatability. Rain damage is one of the biggest threats to hay yield and quality in the central and eastern U.S. In Wisconsin, for example, it has been shown that 30 hours of sunshine (three days) is normally needed to field dry hay. U.S. Weather Bureau reports indicate that the probability of receiving three consecutive drying days in southern Wisconsin is less than 30 percent in June, less than 40 percent in July, and less than 50 percent in August. This means that the chances are high that hay will receive some rain damage. This situation is not unique to Wisconsin, as many other areas receive similar amounts of precipitation (Pioneer).

Extended drying time can lead to large dry matter losses. Forage plants continue to breathe and burn-up carbohydrate energy after they are cut. This respiration continues until the moisture content falls below 40 percent. Usually about five or six percent of the total dry matter is lost during this process, but when drying is slowed, respiration losses may reach 15 percent.

The plant dies when the moisture content reaches 40 percent. Further dry matter losses are from physical damage, primarily leaf shatter, caused by raking and baling. Shatter losses are especially damaging to hay quality because they are mostly leaves, which comprise about 70 percent of the nutritive value of hay. A good hay operation may capture 60 percent of the leaves. If rain falls on hay when it is in a windrow, the hay may require several turnings to dry, which can result in as little as 40 percent of the leaves being recovered (Baldridge, Bowman, and Ditterline).

The potential for yield and quality losses make it very important to get hay, especially legumes that shatter more than grasses, off the field as soon as possible.

Winterkill

Winterkill is plant death from exposure to cold temperatures. Forage plants are vulnerable to winterkill where there is a lack of adequate snow cover in winter and when cold snaps follow periods of warm weather.

Weakness of a forage plant can increase the risk of winterkill. Cutting hay too near the first killing frost, thus depriving the plant of sufficient time to build up its energy reserves for the winter, is a major

cause of alfalfa winterkill. Insect and disease damage can also increase the vulnerability of a forage plant to winterkill.

Insects

The alfalfa weevil has been the most widespread and serious pest in hay production. Alfalfa weevil damage became so great in the 1960s and 1970s that many growers gave up trying to produce alfalfa. It is now possible, with good management techniques, to limit its damage (White). The potato leafhopper is a leading pest in some regions, and the silver whitefly has recently become a menace to alfalfa production in the low desert areas of southern California and Arizona.

Alfalfa Weevil

The alfalfa weevil causes its most serious damage during April and May, when recently hatched larvae feed on new shoots. Severely damaged fields have a frosted appearance. The alfalfa weevil larvae may feed on the shoots that emerge after cutting, severely retarding regrowth.

Alfalfa weevils can be controlled by making the first cutting when most of the alfalfa plants are in the bud stage and removing the hay promptly. A field free of crop remnants deprives larvae of food and shelter and exposes them to the sun, which is usually fatal. A species of parasitic wasp is very effective in helping control alfalfa weevils. The tiny wasps lay eggs into the larvae body, eventually killing the larvae. Control of weevils by insecticides is generally not recommended until 50 percent of the growing tips begin to show damage. Alfalfa weevil control is usually not needed on new stands the first year after seeding, but may be necessary by the second year.

Potato Leafhopper

The potato leafhopper ranks near the alfalfa weevil in the amount of damage it causes. It is found in many areas, but its infestation is most severe in the eastern Midwest.

The potato leafhopper causes severe stunting of the plant and yellowing or reddening of the foliage. Its feeding activity lowers the protein content of the plant by injecting a toxin that causes the plant to produce less protein and more sugars, lowering the feed value of the forage. A small leafhopper population can cause a marked decrease in protein content.

Leafhopper infestations slow the plants' regrowth following cutting and increase the amount of winterkill, as plants enter dormancy in a weakened condition. Infestations are usually most severe following the first and second cuttings. However, first cuttings may be damaged if harvesting is delayed.

Silverleaf Whitefly

In the past five years, the silverleaf whitefly has become a limitation to summer alfalfa production in Imperial County, California and in western Arizona. Although whiteflies prefer other plants to alfalfa, the lack of preferred hosts during the summer leads the whiteflies to alfalfa (Wrona).

Whiteflies feed on the alfalfa plant's juices and exude a sweet, sticky honeydew, which serves as a host for molds. The sticky honeydew gums-up harvesting machinery, and the molds produce a substance toxic to livestock. The whitefly feeding also stresses the alfalfa plants, which combined with heat stress, has resulted in increased stand loss in the low desert. Growers are trying to find management systems that enable them to deal with whiteflies, but have had limited success to date.

Aphids

The ***pea aphid***, which is bright green, overwinters on alfalfa, clovers, and other perennial plants. In the spring, populations increase on the winter host and begin migrating to other hosts. The pea aphid is common on alfalfa during June and July. It builds up huge populations on stems and terminal buds in cool, wet weather. The aphid sucks plant juices, causing wilting. Usually as drier, warmer weather develops, natural predators provide adequate control, but pesticide use may be necessary.

The ***blue alfalfa aphid***, first found in California in 1974, is now found in several western and midwestern states. It is similar to the pea aphid in appearance, but can be distinguished by its bluish-green coloration. It causes damage by sucking alfalfa plant juices, causing plants to wilt.

The ***spotted alfalfa aphid*** is light yellowish-green or straw-colored, with rows of dark spots on its back. Unlike the pea aphid, it thrives under hot, dry conditions. It is most severe in the arid areas of the West and Southwest, and cannot survive temperatures below 10 degrees Fahrenheit. The spotted alfalfa aphid causes severe stunting and yellowing of alfalfa plants and will kill seedling stands. It secretes a sticky honeydew on which a sooty black fungus may develop. The adults and nymphs feed on the underside of lower leaves, causing them to yellow, become dry, and fall off.

Other Pests

Other pests that attack alfalfa include alfalfa snout beetles, clover leaf weevils, meadow spittlebugs, alfalfa blotch leafminers, grasshoppers, variegated cutworms, fall Armyworms, red knot nematodes, and stem nematodes. These pests are described in Appendix 5.

Diseases

Diseases often are stealthy thieves in hay production, lowering yields without causing any apparent damage. Sometimes diseases reduce output 10 to 20 percent without the grower's notice. Diseases reduce stand density and diminish the vigor of the surviving plants, thereby lowering forage yield and quality. All forage plants are subject to disease losses. Alfalfa, however, probably is susceptible to more diseases than are other species.

Bacterial Wilt

Bacterial wilt is a soil borne disease that attacks alfalfa plants through crown and root wounds caused by winter injury, harvesting, or other physical force. After entering the plant, the bacteria make their way to the vascular tissue where it restricts the flow of water and plant nutrients. Infected stands may become unproductive in three to four years (Peaden and Johnson).

The bacterial wilt organism survives to a limited extent in seeds and very readily in infected plant root material. The bacteria are spread by water and farm equipment. Infected plants are usually scattered throughout the stand and are stunted and yellow-green in color. Leaflets of infected plants cup or curl upwards and are smaller than normal. The taproots have a yellowish-brown discoloration in the outer vascular tissues.

Although bacterial wilt is present in the northern and western U.S., it can be controlled by growing resistant varieties and by minimizing injury to crowns and roots. Most alfalfa varieties now recommended for use in the northern areas of the U.S. have a high level of resistance to bacterial wilt.

Phytophthora Root Rot

Phytophthora root rot occurs in poorly drained soils and can cause extensive stand losses. Infected plants contain yellowish-brown rotted areas on the roots that may extend to the crown. In the disease's advanced stage, the rotted areas turn black and eventually kill the plant. Phytophthora can be found by digging surviving plants in areas where stands have been thinned. If the tap roots are rotted off, then Phytophthora was the likely cause of the stand loss. Phytophthora has affected alfalfa west of the Hudson River.

Fusarium Wilt

Fusarium wilt is characterized by brown to brick-red streaks in the woody cylinder of the tap root. Infections may wilt stems on just one side of the plant or may kill the entire plant. As the disease progresses, the entire outer portion of the woody cylinder becomes discolored and the plant dies. The fusarium wilt fungus lives in the soil and enters the plant through wounds or fine roots. Fusarium wilt is most serious in the Southeast and Pacific regions.

Crown Rot

Several different disease organisms cause crown rot in alfalfa. The rot begins as a small cone-shaped discoloration below the base of a cut stem. The rotted area enlarges and may merge with rot from other infection sites. Crown and bud rot are usually initiated during the first or second season and become progressively more severe until the entire crown is destroyed. Crown rot is a peril in all alfalfa growing areas.

Sclerotinia Crown and Stem Rot

Sclerotinia crown and stem rot attacks both alfalfa and clovers, but is most severe in fall-planted alfalfa. Losses may be limited to small areas within a field, or an entire field may be destroyed. Plants of all ages are susceptible, but the incidence and severity appear to be greatest in young seedlings.

The first symptoms occur in the fall as small brown spots on leaves and stems. The infected plant parts wilt and die, and the fungus spreads to the crown. In early spring the crown or basal part of the stem becomes soft and discolored. Noticeable stand reductions become evident in February or March when affected plants fail to green up. No alfalfa cultivars are known to be resistant to Sclerotinia so control must be achieved by following management practices that minimize the chances of infection (Palm and Jennings).

Verticillium Wilt

Verticillium wilt, which has been prevalent in alfalfa in northern Europe, has only recently been found in the U.S. It was discovered in the Pacific Northwest in 1976 and in Wisconsin in 1980. Currently it is found in Michigan, Minnesota, and Wisconsin (Palm). Control consists of selecting resistant varieties.

Verticillium wilt begins as temporary wilting of the upper leaves on warm days at the pre-bud to floral stage. Eventually the leaves turn yellowish and develop V-shaped segments at their tips. Leaflets also may curl along the midrib. The stems, however, remain erect and green. Regrowth appears normal in most infected plants, but symptoms reappear as top growth approaches the pre-bud stage. Plants become progressively weaker and may die later in the season or during the winter. The disease can spread rapidly and may infect more than 50 percent of the plants in a hay field within two to four years.

Anthracnose

Anthracnose infection is characterized by diamond-shaped tan lesions containing small black bodies that produce spores. The fungus may girdle and kill stems, crown buds, and eventually the crown. Dead, straw-colored stems scattered through a field may indicate anthracnose infection.

Anthracnose may significantly reduce stands during warm, moist weather. It is considered the major reason for decline of alfalfa yields during late summer in the eastern U.S. The general weakening of the plant makes it more vulnerable to winterkill. Anthracnose can be controlled through the use of resistant varieties.

Other Diseases

Other diseases affecting forage crops include common leaf spot, leptosphraerulina leaf spot, stemphylim leaf spot, spring black stem, summer black stem, leaf spot, and alfalfa mosaic virus. These diseases are described in Appendix 5.

REGIONAL ANALYSIS

The following section presents discussions of hay production in five regions of the U.S. The hay regions conform generally to the USDA Farm Production Regions:[10]

- Northeast is identical to the Northeast USDA Farm Production Region, which includes New England, New York, Pennsylvania and the mid-Atlantic states.
- Midwest is the Lake States and Corn Belt regions, except for southern areas of the Corn Belt, which are part of the South hay region.
- Great Plains includes the Northern Plains states plus parts of Kansas, Texas, and Oklahoma.
- West is the Mountain and Pacific regions and includes the low desert areas of southern California and western Arizona.
- South is the Appalachian, Southeast, and Delta regions plus parts of Texas and Oklahoma.

Northeast

Production Practices and Use

About 11 million tons of hay, 7 percent of U.S. output, were produced in the ten states of the Northeast in 1994. New York and Pennsylvania accounted for 8.4 million tons, or about three-fourths of the region's production.

The bulk of the Northeast's production is fed to cattle, especially dairy cattle, on the farms where it is produced. One estimate is that 80 percent of the hay fed to dairy cows in Pennsylvania was harvested

[10] A map of USDA Farm Production Regions is included as Appendix 1.

on the farm where fed (Hall). Some hay is sold off the farm for dairy cattle, beef cattle, horses, and landscape seeding. Horse owners in the Northeast prefer grass hay, especially timothy, and want only good quality, dust- and mold-free forage (Hall). Generally only the lowest quality hay is used for landscaping and erosion control.

The Northeast normally receives 20 to 30 inches of rainfall during the April-October growing season, but can experience extended periods of drought during these months. Despite the potential for drought, almost all of the hay in the Northeast is grown without irrigation.

Alfalfa is the predominate species in the Northeast. Alfalfa and alfalfa mixtures made up 44 percent of the region's production in 1994. In Pennsylvania, 53 percent was either alfalfa or alfalfa mixtures. Other important species include orchard grass, timothy, bromegrass, and red clover.

Alfalfa is often grown in rotation with corn and small grains. A typical rotation is alfalfa for three to four years, followed by corn and perhaps oats or wheat. Although three to four years is the typical stand life, in some cases the stand may be kept for five to six years or longer.

Alfalfa in the Northeast is planted typically in the spring, as soon as a good seedbed can be prepared. Some is planted from mid- to late-summer, after a small grain or other crop has been harvested. Alfalfa is normally cut four to five times a season, from May through September. Annual yields in the Northeast typically range from two to five tons per acre. Under optimum growing and soil conditions, and with proper management, yields can exceed seven to eight tons.

Some growers graze alfalfa in the early spring and use the first cutting as silage, delaying the harvesting of hay until warmer weather. The warmer weather dries the forage faster, reducing curing time and diminishing the chances of rain damage on cut hay. Grazing also becomes a way of harvesting alfalfa in the fall, when cool, wet weather makes curing difficult. In addition, removing fall alfalfa growth may reduce the severity of alfalfa weevil infestation the following spring.

Production Perils and Demand for Insurance

Summer drought and rain on cut hay cause the biggest yield losses in the Northeast. Drought reduces plant growth and, therefore, hay yield. It also may weaken or kill plants, diminishing the stand in future seasons. Rain on cut hay extends the drying time, which reduces dry matter content, increases leaf shatter, and diminishes color. Rain, however, usually damages only a portion of the hay crop, because harvesting consists of a number of cuttings extending throughout the summer.

The potato leafhopper is the primary insect pest of alfalfa in the Northeast. The alfalfa weevil also occasionally causes significant yield losses, usually associated with lax management. Although at one time alfalfa weevil was the major insect pest in the Northeast, improved pest management practices now minimize economic losses. In recent years, the alfalfa snout beetle has become a production

threat in New York. Grasshoppers have not traditionally been a production peril in the Northeast. However, during the summer of 1995 there have been isolated reports of hay yield losses due to grasshopper infestations in Pennsylvania (Hall). The magnitude of these reported losses have not been documented.

Bacterial, fusarium, and verticillium wilts are the major alfalfa wilt diseases. Phytophthora root rot, anthracnose, and crown and root rot complex are the most serious root rots. Sclerotinia crown and stem blight occasionally cause seeding failures, especially in fall-seeded alfalfa. Foliar diseases are common throughout the Northeast during the growing season and can cause significant quality and yield loss through defoliation.

There is likely to be limited demand for crop insurance for hay in the Northeast. Hay producers often have the flexibility to adjust their feeding program to their hay supply. Dairymen, for example, may feed poor quality hay to young stock or dry cows, or supplement with additional grain and concentrate. In other cases, additional forages, such as corn silage, substitute for reduced hay supplies. A spokesperson for the Pennsylvania Forage and Grasslands Council indicated that he has not heard farmers raise the issue of crop insurance for hay (Hall).

Midwest

Production Practices and Use

About 34 million tons of hay, 23 percent of U.S. production, was harvested in the Midwest in 1994. About 27 million tons, or 80 percent of the region's hay, was alfalfa or alfalfa mixtures. Less than one percent of the region's hay was irrigated. Midwest hay is predominately fed on the farm where grown, especially in the dairy areas of Michigan, Wisconsin, and Minnesota. Nevertheless, growers are increasingly producing alfalfa specifically for the cash market.

Although alfalfa is the predominate hay species in the Midwest, timothy, orchardgrass, and bromegrass are grown where soils are poorly suited for alfalfa. These grasses also are grown in mixtures with alfalfa. Although still widely grown, timothy-red clover mixtures are less common than in the past, because red clover is difficult to cure sufficiently for hay without incurring excessive leaf shatter (Elgin).

Growers typically harvest two to four cuttings of alfalfa per season. In the northern part of the alfalfa range, growers may take only two cuttings, while in southern areas, growers may be able to take four. Three or four years is a typical stand life in the Midwest. Some stands, however, may last 10 years or longer if they are on well-drained soil and given good management.

Production Perils and Demand for Insurance

Drought following planting, rain on curing hay, and winterkill of established stands are the biggest production perils (Hesterman; Undersander). Alfalfa needs adequate moisture for seeds to germinate and for the young plants to become established. Extended drought following planting kills the seedling plants and reduces stand density.

Rain on curing hay reduces the quality and the yield. Some dairymen lessen the chances of rain damage by harvesting the first cutting as haylage or green chop instead of hay.[11] This may reduce the risk of rain falling on the cut hay, because the drying time for hay is usually longer in the spring than later in the summer.

Those alfalfa growers in the Midwest producing for the cash market may perceive rain on their cut hay as a greater risk than those growers producing for their own dairy cows. Dairy farmers may be able to minimize rain damage by green chopping a portion of their crop or making haylage during rainy periods. Growers producing strictly for the cash market do not have this flexibility for minimizing rain damage.

Winterkill frequently claims alfalfa stands, especially in Minnesota and Wisconsin. Serious stand losses usually are associated with the lack of a snow cover and excessively wet soils. Inadequate snow cover was cited as a reason for substantial winterkill in Minnesota and Wisconsin in 1994 (Undersander).

The demand for hay insurance is likely to be high in the Midwest. Growers in this region have experienced substantial yield losses in recent years, as evidenced by Government disaster assistance payments; changes in legislative procedures make passage of further ad-hoc disaster payments less likely. A sizeable proportion of farms that harvest hay in the Midwest also grow crops whose income and price support programs require insurance of all crops on the program participant's farm.

Great Plains

Production Practices and Use

[11] Haylage is forage that is chopped and ensiled. Typically the forage is cut and wilted for a time before being placed in a silo. The wilting time for haylage is substantially shorter than the curing time needed for hay. Depending on weather conditions, alfalfa haylage may require one day or less between cutting and removal from the field, while hay may require a three day period. This shorter exposure for haylage lowers the risk of rain damage relative to the risk associated with making hay.

The five states that cover most of the Great Plains produced 29.3 million tons of hay in 1994, about 20 percent of all U.S. output. Alfalfa is the predominate hay species in the Great Plains, accounting for about 60 percent of the region's crop. The Great Plains also produce substantial amounts of wild hay and other tame hay. Prairie grass and native grasses are widely used for hay. Stands of these species are typically very old and are neither rotated nor tilled. Small grain hay accounted for six percent of the region's production in 1992.

A high proportion of Great Plains hay, especially the non-alfalfa hays, is fed to beef cattle on the farms where produced. A substantial amount of the cash crop alfalfa goes into hay pellets and a portion of the alfalfa is shipped out of the area.

The number of alfalfa cuttings per season depends on moisture and climate. Dryland alfalfa in the northern Great Plains may yield only one or two cuttings a season. In contrast, irrigated alfalfa in the warmer areas may yield four or five cuttings.

Production Perils and Demand for Insurance

Drought has been a major peril in the Great Plains in recent years. Drought caused yields to decline in the region in 1988 and 1989, and resulted in large disaster assistance payments.
Rain at harvest time is also a production risk in the Great Plains. Although rain lowers hay quality, cattlemen may not view lowered quality as gravely as do dairymen. Beef cattle can utilize poor hay with little loss of output, whereas low quality hay markedly reduces milk output and boosts the need for expensive supplemental feeds.

Winterkill is more of a problem with alfalfa than with grasses, and it is more of a concern in the northern range of the Great Plains than further south. In Montana, it was reported that cold snaps following late winter thaws destroy alfalfa stands (Cash). Winterkill is viewed as a minor problem in Nebraska and Kansas.

The demand for crop insurance for hay is likely to be high in the Great Plains. This region contains the largest share of total U.S. hay acreage. As in the Midwest, growers in the Great Plains have received a large proportion of disaster assistance payments for hay and many growers also produce crops whose programs are linked to the purchase of crop insurance. Yield variability, as illustrated later in this report, appears to especially high in parts of the Great Plains.

West

Production Practices and Use

Alfalfa, grown under irrigation, is the predominate hay in the West. About 80 percent of the hay produced in 1994 in the 11 western states was alfalfa and alfalfa mixtures. Most of the alfalfa acreage,

79 percent in 1992, was irrigated. Other hay produced in the West is mostly tame and wild grasses and small grains. Oat and other small grain hays are especially prevalent in California, where they constituted 20 percent of hay acreage in 1992.

Orchard grass, timothy, and tall fescue play an important role in the forage programs of dairy farmers in western Oregon and Washington. This area, west of the Cascade Mountains, is a relatively high rainfall area where grasses are more dependable for hay than alfalfa.

Most irrigated alfalfa is grown for sale off the farm. Dairies are the largest market and demand high quality. The horse market also requires good quality, but accounts for a much smaller share of hay consumption than dairy. The lowest quality hay, and that with the lowest value, is usually fed to beef cattle.

Hay is marketed through a variety of channels--hay brokers, direct sales, contracts, and marketing associations. The San Joaquin Hay Growers Association in California, for example, provides its members a market for their hay and guarantees payment.

Nutrient testing plays an important role in marketing alfalfa hay in the West. It is reported that about 70 percent of the hay sold in California is sampled, and that a given lot of hay may be sampled several times: by growers to know the value of the hay they are selling; by buyers to know the quality of what they are buying; and by the dairy to balance the feed ration (Putnam).

The number of cuttings and the average yield from alfalfa varies from area to area, depending on the climate and management system. Irrigated fields in the cooler climates, such as western Montana, average only two or three cuttings a year. Irrigated fields in warmer areas, such as the low desert, average nine or ten cuttings. Dryland alfalfa in the northern states average as few as one to two cuttings a season.

In the low desert area of southern California and in western Arizona,[12] mild winters allow alfalfa to be produced on a year-round basis, though summer yields are lower than spring and fall yields because of the extreme heat. Total precipitation in this area averages less than three inches of rain per year, so all crops must be irrigated.

Alfalfa accounts for the largest share of hay production in the low desert area. It is normally cut and baled nine or ten times a year, from February until November. Annual yields average seven to nine tons per acre. Some growers lease established fields to lamb feeders for grazing between September and March, to provide a steady income through the winter (Wrona).

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[12] Imperial and Riverside counties in California; largely Maricopa, Yuma and La Paz counties in Arizona.

Dairies in Arizona and southern California purchase most of the high quality hay grown in the low desert. Some is bought by feed lot owners for their cattle, some goes to horse owners, and some goes to processors for making cubes, pellets, and compressed bales for domestic and export markets.

Production Perils and Demand for Insurance

In the irrigated West, excessive rain is a notable peril. Unusually heavy rains and flooding in California during the winter and spring of 1995, for example, killed alfalfa plants in areas where the roots remained submerged for extended periods. Stands surviving the flooding reportedly yielded 15-25 percent below normal, due to root damage and increased disease infections (Putnam). An outbreak of sclerotinia in California's central valley also was attributed to excessive rains.

Rain on cut hay, especially in the spring, lowers quality and value more than it reduces the tonnage yield. Prices for rained-on hay are discounted, and the hay is fed to beef cattle. An analysis in California indicates that prices for premium hay average about $30 per ton more than hay classed as fair (Putnam). Premium hay in California averages only 2-4 percent higher in total digestible nutrients (TDN) than fair hay.

In intermountain areas, such as northern California and western Montana, winterkill is a cause of stand loss. In Montana, for example, alfalfa is particularly vulnerable to cold damage following mid-winter warm spells. It is not unusual to have periods of 50 degrees Fahrenheit temperatures in February, followed by a cold spell in which temperatures fall to minus 20 degrees. The plants break dormancy during the warm temperatures, only to have their tender new buds killed by cold temperatures (Cash).

In most cases, insects are a manageable problem. An exception may be the silverleaf whitefly in the low desert areas of California and Arizona. The silverleaf whitefly has become a severe problem in recent years, reportedly causing 15-25 percent yield losses in the Imperial Valley (Putnam). Growers have not yet discovered satisfactory control measures for the whitefly. Although the silverleaf whitefly has become a major alfalfa pest in the low desert, it has not yet caused much damage in other western areas. Nevertheless, growers in the San Joaquin Valley reportedly are apprehensive that it will become a damaging insect in their area (Putnam).

The demand for hay insurance is likely to be variable in the West. Because most hay is irrigated, drought, a major peril in other regions, is essentially eliminated as a production risk. Winterkill in localized areas could contribute to interest in insurance.

Growers in the low desert may be especially interested in insurance for alfalfa because of losses associated with the whitefly. Some growers in the Imperial Valley have lost their stands following severe whitefly infestations. The greatest interest may be for insurance on the alfalfa stand rather than on the hay production.

South

Production Practices and Use

Bermuda grass and tall fescue are the two major hay species grown in the South hay region. They are grown in relatively distinct east-west belts, defined by climate. The tall fescue belt lies north of the Bermuda grass belt.

The tall fescue belt extends from eastern Oklahoma and the southeastern corner of Kansas to North Carolina. It's northern boundary extends through the southern portions of Illinois, Indiana and Ohio. It includes, portions of east Texas and eastern Oklahoma, most of Louisiana, all of Arkansas, Kentucky, and Tennessee, the northern half of Mississippi and Alabama, and western Georgia.

The southern range of the tall fescue belt is determined by the amount of summer heat. Tall fescue has poor tolerance for excessive heat, yielding less than Bermuda grass in the Atlantic and Gulf Coast lowlands. In addition, tall fescue performs poorly on the sandy soils that predominate in the Atlantic and Gulf Coast areas.

Although other species, such as alfalfa, orchardgrass, bluegrass, and timothy are grown in the fescue belt, tall fescue predominates. It is the most dependable at producing a forage crop year after year. High humidity and frequent summer showers create poor haying weather for alfalfa in the South. Stand life for species other than fescue is usually shorter in the South than in areas further north. Fescue stands may last for many years in the South. Establishment costs, also, are reportedly substantially lower for tall fescue than for alfalfa and orchardgrass (Ball).

The Bermuda grass belt lies to the south of the tall fescue belt, but there is a great deal of overlap between the two areas. Some Bermuda grass is grown well north into what is defined as the tall fescue belt.

Both tall fescue and Bermuda grass are frequently planted for pasture, and the harvesting of hay is incidental to its use for grazing. Both are lower in TDN than alfalfa and are fed primarily to beef cattle. Dairy farmers who feed fescue and Bermuda grass hay have to supplement more concentrates than farmers with good alfalfa. Some dairymen in the South purchase alfalfa from other areas of the country.

Most of the hay produced in the South is fed on the farm where produced. One specialist estimated that only five percent of the fescue hay and 20 percent of the Bermuda grass are sold off the farm, most being marketed by direct farmer-to-farmer sales (Ball).

Production Perils and Demand for Insurance

Extended drought is the main production peril for fescue in the South. Although fescue is relatively drought resistant, extended dry weather reduces forage production. Fescue is affected by few insect and disease perils. Fescue, being a cool season grass, does not perform well in the extreme heat and sandy soils in the southern coastal areas.

Some fescue hay harvested late in the season (after the 1st of October) or during the winter has been associated with animal health problems. Fescue foot is a non-infectious disease sometimes found in cattle grazing tall fescue or being fed hay contaminated with the disease-producing toxins. Researchers suspect that the toxin is produced by a fungus in the grass. Some fields have a history of repeated fescue foot outbreaks. It has not been determined , however, whether the recurring outbreaks are due to high levels of the toxin in the field or to herds or individuals within the herds that are more sensitive than others. Hay harvested before October has not been reported to be toxic.

Although alfalfa and orchard grass are grown in the South, they are a less dependable source of forage than fescue and stands only last a few years. Frequent rains and high humidity result in frequent rain damage to alfalfa. Alfalfa is particularly susceptible to root rots in the South and frequent leaf hopper and weevil infestations. Orchard grass stands do not persist well in the far South, lasting for fewer years than in the North.

The demand for insurance in the South is likely to be weak. Hay is grown on proportionally fewer farms in this region. Fescue and Bermuda grass, the predominate types of hay in this region, are fed primarily to beef cattle, which do not require as high quality hay as dairy cattle.

DISASTER ASSISTANCE PAYMENTS FOR HAY

Ad-hoc disaster assistance payments for hay were made by USDA to growers in each year from 1988 through 1993. Payments for hay were made generally in disaster counties at 65 percent of the per-acre average value of hay over the previous five years, omitting the highest and lowest values. Nearly $800,000,000 was paid for losses of hay production over the six years. About 45 percent of all hay

payments were listed as being for alfalfa and alfalfa mixtures. A considerable share of the balance was listed as payments for mixed hay, which may include alfalfa.

About 70 percent of the payments, $568 million, was made for the 1988 crop, when severe drought struck the Midwest (Table 10). Nearly 40 percent of the 1988 payments were made for production in Wisconsin, where the 1988 hay yield was 44 percent below its 1985-94 average. Wisconsin, with payments in 1992 because of winterkill, and in 1993, because of flooding, accounted for slightly more than 30 percent of all disaster assistance payments for hay from 1988 through 1993. South Dakota, North Dakota, and Minnesota, ranked second through fourth in disaster assistance for hay. County-level summaries of disaster assistance payments are shown in Figures 9-11.

CROP INSURANCE FOR FORAGE AND FORAGE SEEDING, 1980-94

Table 10--Disaster Payments for Hay, by State, 1988-93

State	1988	1989	1990	1991	1992	1993	Total 1988-93	Share of Total
				1,000 dollars				Percent
Alabama	295.1	62.2	408.9	143.1	41.4	905.6	1,856.2	0.2
Alaska	34.3	61.9	49.6	13.4	71.8	260.6	491.7	0.1
Arizona	43.7	0.0	7.9	9.4	1.7	632.5	695.2	0.1
Arkansas	264.5	67.1	128.3	62.3	11.8	354.5	888.4	0.1
California	1,517.9	172.9	501.1	1,527.0	1,221.6	631.9	5,572.4	0.7
Colorado	1,251.9	2,143.6	857.7	560.8	59.5	754.8	5,628.2	0.7
Connecticut	5.0	14.0	0.0	46.6	15.4	555.9	636.9	0.1
Delaware	0.0	1.0	0.5	0.0	0.0	42.7	44.2	0.0
Florida	1,819.1	123.2	132.6	159.5	138.8	1,054.3	3,427.4	0.4
Georgia	938.1	49.1	289.7	42.6	24.9	1,776.5	3,120.8	0.4
Idaho	8,934.0	1,290.6	612.0	1,878.7	4,009.9	214.1	16,939.3	2.1
Illinois	24,533.6	1,186.5	16.0	600.3	63.7	1,134.4	27,534.6	3.5
Indiana	4,394.0	4.7	3.7	338.5	18.7	13.1	4,772.7	0.6
Iowa	18,476.0	2,891.6	51.3	256.0	290.0	10,859.6	32,824.5	4.1
Kansas	10,347.5	3,426.7	325.5	2,391.3	42.9	2,123.6	18,657.6	2.4
Kentucky	5,870.0	65.4	36.7	111.2	10.2	8.8	6,102.3	0.8
Louisiana	12.9	25.1	0.0	63.3	0.0	0.0	101.3	0.0
Maine	5.6	1.0	4.0	321.5	257.5	741.4	1,331.0	0.2
Maryland	385.5	7.6	0.0	78.0	0.0	102.8	574.0	0.1
Massachusetts	14.1	0.0	0.3	69.2	60.0	828.0	971.6	0.1
Michigan	16,825.6	319.4	177.4	336.9	6,127.8	1,007.5	24,794.6	3.1
Minnesota	47,050.6	4,299.4	960.7	242.0	987.0	5,333.6	58,873.4	7.4
Mississippi	3,934.3	163.9	617.7	962.0	26.2	231.5	5,935.5	0.7
Missouri	14,962.6	1,436.3	175.6	773.4	514.7	1,185.1	19,047.5	2.4
Montana	27,012.0	1,249.9	946.4	223.3	2,722.7	1,199.7	33,353.9	4.2
Nebraska	4,112.8	4,256.5	279.4	735.5	710.1	1,213.4	11,307.7	1.4
Nevada	1,981.0	991.4	494.6	1,446.3	1,586.3	309.3	6,808.9	0.9
New Hampshire	3.2	2.7	0.7	47.8	199.3	133.6	387.3	0.0
New Jersey	159.9	207.2	2.8	6.9	0.8	123.6	501.1	0.1
New Mexico	829.9	363.8	263.9	534.9	224.0	1,015.3	3,231.8	0.4
New York	2,788.4	236.0	61.4	700.9	1,341.8	2,208.7	7,337.2	0.9
North Carolina	124.5	18.9	29.2	11.2	15.8	390.2	589.9	0.1
North Dakota	41,197.1	10,627.9	3,000.8	1,087.0	1,839.6	3,825.4	61,577.8	7.8

Ohio	6,026.4	610.5	44.1	1,094.1	79.9	348.8	8,203.8	1.0
Oklahoma	13,496.8	176.7	670.1	554.6	234.2	1,469.7	16,602.0	2.1
Oregon	1,670.0	64.0	437.4	715.3	1,950.5	37.1	4,874.3	0.6
Pennsylvania	2,061.8	352.6	17.6	1,887.1	148.9	552.6	5,020.5	0.6
Rhode Island	0.0	0.0	0.0	0.0	0.0	44.7	44.7	0.0
South Carolina	505.2	68.5	106.7	57.4	53.8	836.1	1,627.6	0.2
South Dakota	43,424.0	17,667.4	2,467.4	1,164.3	2,205.6	3,445.1	70,373.8	8.9
Tennessee	665.7	135.7	69.2	162.9	43.6	90.0	1,167.1	0.1
Texas	22,499.6	7,895.5	2,141.2	1,406.5	336.0	5,516.2	39,795.1	5.0
Utah	5,537.3	3,854.5	1,267.7	820.4	1,026.3	193.9	12,700.1	1.6
Vermont	302.2	1.1	1.8	435.7	24.8	306.6	1,072.2	0.1
Virginia	168.2	4.9	20.3	96.0	6.0	344.9	640.3	0.1
Washington	1,864.0	998.0	377.7	1,054.5	953.8	278.8	5,526.7	0.7
West Virginia	1,843.4	61.0	4.1	363.1	12.4	272.1	2,556.1	0.3
Wisconsin	221,845.0	4,930.3	442.7	870.8	8,929.3	9,567.8	246,585.8	31.1
Wyoming	6,121.4	2,482.4	327.5	128.6	1,624.8	265.8	10,950.4	1.4
--Total	568,155.5	75,070.4	18,831.6	26,592.2	40,265.5	64,742.3	793,657.5	----

Source: ASCS data files.

During the 1980s, the Federal Crop Insurance Corporation began offering Actual Production History Multiple-Peril Crop Insurance (APH-MPCI) for hay in 17 states, though in many of the states insurance was available in only a few counties[13]. APH-MPCI policies were available for forage seeding, covering the first year of a stand, and for forage production, covering the following years.

There was little initial interest in crop insurance for hay. Fewer than 100 forage policies were sold in each year, 1980-88. The number of policies sold jumped in 1989, however, as producers who received ad-hoc disaster payments in 1988 were required to purchase insurance, where available.

Insured acres of forage peaked at about 500,000 in 1989 (Table 11A). Most of the insured forage acres were in Wisconsin, where forage insurance was offered in all but 10 counties (Table 11B). Wisconsin accounted for 62 percent of all forage acres insured in 1989.

Forage seeding insurance had a similar pattern of low participation. Although the number of forage seeding policies increased sharply in 1990 and ranged from about 900 to 1,300 a year between 1990 and 1994, total acres insured only slightly exceeded 40,000 in any single year (Table 12A).

Both the forage and forage seeding insurance programs paid considerably more in indemnities than they took-in in premiums from 1980-94. The aggregate loss ratio for the approximately 25,000 forage policies sold from 1980-94 was 2.57 (Table 11A). During the years when the acres insured exceeded 100,000, 1989-94, the loss ratio for forage insurance exceeded 1.0 in every year except 1994. Forage seeding insurance had a similar pattern of losses and an overall loss ratio of 2.07 for 1980-94 (Table 12B).

[13] Group Risk Plan insurance for forage was offered in several counties in Wisconsin and Minnesota in 1994. Few policies were sold. Interest in GRP is said to have increased in 1995.

ISSUES IN CROP INSURANCE FOR HAY

Although initial interest in crop insurance for hay has been small, the potential market is very large. There are about 60 million acres of hay harvested annually, and hay is harvested on nearly half of the farms in the U.S. Hay yields are variable, particularly in non-irrigated areas, from year to year. (Figures 12 and 13 illustrate the variation in harvested hay yields for the 429 counties with complete yield series from 1974-92.)

Crop insurance reform, which took effect in 1995, has increased interest in insurance for hay.[14] The reform act requires a farmer to purchase crop insurance, where available, for every crop of economic significance on the farm (10 percent of the farm's value of production) when the farmer

[14] One estimate is that 15,000-17,000 MPCI policies were sold for hay in Wisconsin in 1995, more than three times the previous high number of policies sold.

Table 11A--Crop Insurance for Forage, 1980-94

Year	Policies Insured	Net Acres Insured	Total Premiums Paid	Indemnities Paid	Loss Ratio
	Number	Acres	Dollars		Ratio
1980	59	3,445	16,419	56,017	3.41
1981	51	2,657	13,204	42,781	3.24
1982	98	4,272	32,451	72,368	2.23
1983	34	1,068	7,577	19,575	2.58
1984	32	1,172	9,351	13,421	1.44
1985	24	1,039	6,605	18,647	2.82
1986	9	421	1,656	0	0
1987	7	295	2,101	0	0
1988	34	3,460	31,991	92,118	2.88
1989	7,545	500,925	1,693,959	4,422,576	2.61
1990	5,736	379,076	2,545,026	9,078,490	3.57
1991	2,993	182,072	1,374,081	2,571,187	1.87
1992	1,925	120,564	1,126,741	4,409,347	3.91
1993	3,664	224,574	1,775,551	5,279,264	2.97
1994	3,070	209,834	2,322,323	2,123,336	0.91
--Total	25,281	1,634,874	10,959,036	28,199,127	2.57

Source: FCIC Expersum data file.

Table 11B--Crop Insurance for Forage, Selected States,1980-94

State/ Year	Policies Insured	Net Acres Insured	Total Premium Paid	Indemnities Paid	Loss Ratio
	Number:	Acres	Dollars		Ratio
Minnesota					
1990	929	50,875	505,247	5,229,654	10.35
1991	881	39,984	452,507	439,551	0.97
1992	674	32,025	385,048	594,744	1.54
1993	541	24,830	318,1576	54,048	2.06
1994	497	23,882	375,862	523,892	1.39
-- Total	3,522	171,596	2,036,821	7,441,889	3.65
Montana					
1989	465	42,562	139,173	221,978	1.59
1990	134	10,727	38,264	93,336	2.44
1991	70	6,054	19,591	8,324	0.42
1992	41	4,539	17,046	88,287	5.18
1993	145	15,643	43,453	55,826	1.28
1994	60	7,737	27,869	45,386	1.63
-- Total	915	87,262	285,396	513,137	1.80
North Dakota					
1980	20	1,762	6,010	45,869	7.63
1981	18	1,122	3,830	12,732	3.32
1982	7	185	705	2,579	3.66
1983	3	65	276	168	0.61
1984	7	261	995	0	0.00
1985	6	224	811	877	1.08
1986	3	124	425	0	0.00
1987	2	132	543	0	0.00
1988	2	62	187	1,637	8.75
1989	2,015	127,337	333,016	1,691,212	5.08
1990	1,397	82,713	209,212	1,160,903	5.55
1991	820	52,945	127,684	186,500	1.46
1992	422	30,688	89,319	178,810	2.00
1993	416	33,429	88,864	31,437	0.35
1994	186	16,233	61,548	10,540	0.17
--Total	5,324	347,282	923,425	3,323,264	3.60
Wisconsin					
1980	37	1,669	10,324	10,148	0.98
1981	32	1,527	9,323	30,049	3.22
1982	91	4,087	31,746	69,789	2.20
1983	31	1,003	7,301	19,407	2.66
1984	24	910	8,344	13,421	1.61
1985	15	693	4,777	11,692	2.45
1986	5	260	1,128	0	0.00
1987	3	37	169	0	0.00
1988	3	27	119	540	4.54
1989	4,800	308,170	1,118,683	2,144,214	1.92
1990	3,155	224,978	1,739,569	2,368,643	1.36

1991	1,148	76,811	731,794	1,762,702	2.41
1992	748	51,127	617,303	3,441,786	5.58
1993	2,446	141,485	1,262,765	4,500,877	3.56
1994	2,281	159,441	1,834,129	1,499,320	0.82
-- Total	14,819	972,225	7,377,474	15,872,588	2.15

If year is not shown then no records in file.
Source: FCIC Expersum data file.

Table 12A--Crop Insurance for Forage Seeding, 1980-94

Year	Policies Insured	Net Acres Insured	Total Premiums Paid	Indemnities Paid	Loss Ratio
	Number	Acres	Dollars		Ratio
1980	97	2,499	7,502	44,192	5.89
1981	127	4,079	12,152	56,356	4.64
1982	134	3,447	10,031	27,008	2.69
1983	84	2,072	6,385	5,432	0.85
1984	76	1,551	5,838	10,825	1.85
1985	62	1,580	5,957	9,715	1.63
1986	46	1,097	3,933	6,489	1.65
1987	44	1,020	4,322	3,543	0.82
1988	33	766	2,743	10,299	3.75
1989	188	6,453	23,505	80,052	3.41
1990	1,215	39,239	191,440	685,121	3.58
1991	995	30,899	152,544	450,775	2.96
1992	932	31,238	163,468	467,501	2.86
1993	1,025	36,704	213,743	370,756	1.73
1994	1,221	41,041	301,328	56,322	0.19
--Total	6,279	203,685	1,104,891	2,284,386	2.07

Source: FCIC Expersum data file.

Table 12B--Crop Insurance for Forage Seeding, Selected States, 1980-94

State/ Year	Policies Insured	Net Acres Insured	Total Premiums Paid	Indemnities Paid	Loss Ratio
	Number	Acres	Dollars		Ratio
Minnesota					
1990	809	24,266	126,613	464,149	3.67
1991	605	14,108	77,113	124,539	1.62
1992	463	9,922	54,171	53,479	0.99
1993	406	9,277	56,120	65,859	1.17
1994	394	9,660	74,355	32,723	0.44
-- Total	2,677	67,233	388,372	740,749	1.91
Montana					
1989	12	307	1,085	960	0.88
1990	11	533	1,665	8,372	5.03
1991	6	330	1,170	2,560	2.19
1992	5	232	1,101	3,882	3.53
1993	3	130	666	3,131	4.70
1994	2	43	244	0	0.00
-- Total	39	1,575	5,931	18,905	3.19
North Dakota					
1980	41	1,582	4,862	39,179	8.06
1981	83	3,385	10,247	53,375	5.21
1982	45	1,585	5,107	23,368	4.58
1983	24	797	2,935	3,894	1.33
1984	18	374	1,521	4,289	2.82
1985	24	896	3,479	6,794	1.95
1986	14	429	1,772	954	0.54
1987	12	327	1,370	408	0.30
1988	10	307	1,085	6,851	6.31
1989	71	3,536	13,271	62,683	4.72
1990	106	5,836	23,714	110,829	4.67
1991	158	9,548	39,862	179,240	4.50
1992	119	6,233	29,414	62,030	2.11
1993	94	4,260	23,061	11,765	0.51
1994	46	2,173	13,859	1,304	0.09
-- Total	865	41,268	175,559	566,963	3.23
Wisconsin					
1980	49	682	1,838	857	0.47
1981	38	568	1,470	2,981	2.03
1982	86	1,754	4,577	3,082	0.67
1983	53	1,083	2,733	188	0.07
1984	46	948	2,927	3,989	1.36
1985	32	561	1,751	821	0.47
1986	29	604	1,879	4,407	2.35
1987	23	408	1,305	789	0.60
1988	19	415	1,420	3,448	2.43
1989	97	2,292	7,657	15,075	1.97
1990	280	8,210	37,348	95,651	2.56
1991	218	6,742	33,389	143,783	4.31
1992	337	14,709	77,786	346,004	4.45
1993	514	22,906	132,901	288,353	2.17
1994	761	28,747	210,168	18729	0.09

-- Total	2,582	90,629	519,149	909,428	1.75

If year is not shown then no records in file.
Source: FCIC Expersum data file.

Table 13--Percent of Farms Harvesting Hay and of All Farms That Harvested a Program Crop or a Crop Linked to Crop Insurance, 1992

Region	Farms	Harvested a Program Crop	Harvested a Linked Crop
	Number	- - - - - - Percent of farms - - - - - -	
Appalachian:			
Farms harvesting hay	144,827	21.0	48.2
All farms	276,453	20.5	52.2
Corn Belt:			
Farms harvesting hay	187,399	58.8	62.2
All farms	405,724	59.6	65.2
Delta:			
Farms harvesting hay	45,619	8.5	9.6
All farms	101,587	20.2	23.9
Lake States:			
Farms harvesting hay	111,859	68.6	69.9
All farms	189,600	62.4	65.5
Mountain:			
Farms harvesting hay	58,232	37.0	37.2
All farms	118,275	30.5	30.9
Northeast:			
Farms harvesting hay	77,113	42.6	43.2
All farms	124,916	33.4	35.5
Northern Plains:			
Farms harvesting hay	97,456	74.5	75.4
All farms	181,381	68.7	70.0
Pacific:			
Farms harvesting hay	31,748	20.4	20.6
All farms	139,825	11.3	11.4
Southeast:			
Farms harvesting hay	43,669	18.1	20.6
All farms	134,110	18.0	22.3
Southern Plains:			
Farms harvesting hay	107,135	19.9	20.8
All farms	247,581	19.7	20.6
Total:			
Farms harvesting hay	905,057	42.4	48.1
All farms	1,919,452	38.0	44.9

Program crops are corn, grain sorghum, wheat, barley, oats, rice, and cotton.
Crops linked to crop insurance are the program crops and soybeans, sugar beets, sugarcane, tobacco, peanuts, canola, industrial rapeseed, mustard seed, and sunflower.
Source: Census of Agriculture, Dept. of Commerce.

participates in USDA commodity income and price support programs. In 1992, nearly half of the 900,000 farms harvesting hay also harvested one of the crops linked to crop insurance (Table 13).[15] The connection between hay and the crops that can trigger the insurance requirement is especially strong in the two regions with the largest hay acreage: Northern Plains and Corn Belt.

In counties where crop insurance is not available, which is the case for most hay, non-insured crops are covered by the Non-insured Assistance Program (NAP). Although NAP is less costly to farmers than crop insurance--no charge for NAP versus a $50 per-crop processing fee for basic crop insurance--NAP yield protection is generally lower and its trigger more restrictive than MPCI.

Demand for Insurance

The demand for crop insurance for hay is probably the strongest in the Midwest and the Great Plains. Growers in these areas--hit by drought and winterkill in recent years--have received the bulk of disaster assistance. Changes in legislative procedures, by making ad-hoc disaster assistance more difficult to enact, have made ad-hoc payments a less reliable form of risk protection. Farmers harvesting hay in the Midwest and the Great Plains also are likely to be producing crops with Government income and price support programs; participants in the programs are required to purchase crop insurance for all crops of economic significance on their farms.

There may also be markets for hay insurance in areas where production risks cannot be well managed without insurance. Intermountain areas are subject to cold snaps that can cause winterkill.. And alfalfa growers in the low desert area of southern California and western Arizona have been battling the silverleaf whitefly and have yet to devise an effective management strategy against this pest.

Expense of Servicing Policies

Servicing a hay insurance policy is costly to insurance agents and companies. In many cases it is necessary for the insurer to inspect a hay stand in order to establish its age (yields on over-age stands decline over time and are not insurable), its plant density, and to make multiple appraisals for loss adjustments. Current expense reimbursement rates may not offer sufficient incentives to the sellers and servicers of insurance.

[15] It was not possible to estimate the proportion of farms where each of these crops and hay exceeded the 10 percent of total value of production. The crop insurance requirement also only applies to growers that participate in the commodity programs.

Farm Records of Hay Production

Very few farms maintain records of hay production. Most hay is fed on the farms where it is grown, so there are few records of hay sales. This makes it difficult to establish an accurate guarantee level for a farm and accurate insurance rates. Many growers do have records of the *acres* of hay on the farm, however, because they are required to maintain records of all cropland when they participate in Government commodity programs.

Quality Loss

The nutrient quality of hay, rather than tonnage yield, is a major concern of hay producers and users. Although a farmer can feed lower quality hay to beef cattle and horses, grain and feed supplements may have to be added to dairy cattle rations when hay quality falls.

The current forage insurance program has no provision for quality loss. Adding quality loss protection would involve setting a measurable quality standard, assessing the probability that quality will fall below the standard, testing hay produced for quality, and making sure the quality loss is due to an insurable cause.

Quality loss insurance may be plagued by moral hazard problems. The control of damage from rain on cut hay, a major cause of quality loss, can largely be a matter of good farm management.

Diversity in Hay Production

Hay yields vary by type of hay and by location and production practices. Different yield levels imply different yield guarantees, and different yield risks imply different insurance rates. The risks to be insured in irrigated production in the West are considerably different from dryland production in the Great Plains, for example. The diversity in hay production may be accounted for with insurance policies that differ by type and production practice.

Hay prices differ widely by type and quality of hay and by region of the country. Price elections available need to reflect the local prices.

Moral Hazard

Moral hazard may be a major problem with hay insurance. A farmer's management practices often influence yield risk. For example, cutting a stand close to the first frost, which may increase production in the fall, increases the risk of winterkill. Policing moral hazard can add to the costs of servicing hay insurance policies.

Adverse Selection

Adverse selection is likely to be a problem in the insurance program for hay for several reasons. The lack of yield records makes it difficult to classify correctly a farm's hay yield risk. In addition, the variation in yield with the age of a stand means that the risk on a given production unit is likely to change from year to year.

Alternative Forms of Insurance

As outlined above, simply expanding the existing APH-MPCI program does not appear to be an easy and effective way to meet the potential demand for crop insurance for hay in an actuarially sound manner. GRP or another type of area risk insurance overcomes most of the problems outlined above. Catastrophic coverage from GRP could offer growers higher levels of protection than the current APH-MPCI program at a relatively low cost.

There are, however, problems in expanding GRP coverage for hay. Yield data series at the county level appear to be limited. The NASS data base has only 429 counties with continuous 19-year yield histories for hay. In addition, winterkill or other perils that can completely destroy a stand may not be adequately accounted for in the per-harvested-acre yield data.

Hay insurance presents opportunities for innovation. Canadian provinces have developed different approaches to forage insurance. In Ontario, a simulated yield model which uses data about soil type, hay species, and rainfall is the basis of forage insurance. Insurance contracts based on weather indexes may offer growers protection from the major production perils of drought and winterkill.

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APPENDIX 1

Map of USDA Farm Production Regions

APPENDIX 2

Extension Specialists for Forage

Prepared by: David B. Hannaway
Crop Science Building
Department of Crop & Soil Science
Oregon State University
Corvallis, OR 97331
Tel: 503-737- 5863
Fax: 503-737- 5063
Email: david@forages.css.orst.edu

Alabama:
Donald M. Ball
Room 120 Extension Hall
Department of Agronomy & Soils
Auburn University, AL 36849-5633
Tel: 205-844-5491
Fax: 205-844-4586
Email: dball@acenet.auburn.edu
Subject speciality areas: forage legumes,tall fescue

Alaska:
Kenneth Krieg (Extension Livestock Specialist)
P.O. Box 756180
University of Alaska - Fairbanks
Fairbanks, AK 99775-6180
Tel: 907-474-6357
Fax: 907-474-5139
Email: none

Arizona:
Michael Ottman
Department of Plant Sciences
University of Arizona
Tucson, AZ 85721
Tel: 602-621-1583
Fax: 602-621-7186
Email: mottman@ccit.arizona.edu
Subject speciality areas: alfalfa, irrigation requirements

Arkansas:
Charles P. West
276 Altheimer Drive
University of Arkansas
Fayetteville, AR 72703
Tel: 501-575-3982
Fax:501-575-3975
Email: cpwest@comp.uark.edu

California:
Dan Putnam
Department of Agronomy and Range Science
Hunt Hall
University of California, Davis
Davis, CA 95616
Tel: 916-752-8982
Fax:
916-752-4361
Email: dhputnam@ucdavis.edu
Subject speciality areas: alfalfa, forage quality, alternative crops

Colorado:
Robert Croissant (Extension Livestock Specialist)
Department of Agronomy
Colorado State University
Fort Collins, CO 80523
Tel: 303-491-6201
Fax: 303-491-0564
Email: rcroissa@shep.agsci.colostate.edu

Connecticut:
Thomas Morris (Extension Agronomist)
U-67
Storrs, CT 06269-4067
Tel: 203-486-2928
Fax: 203-486-0682
Email: none

Delaware:
Richard Taylor (Extension Agronomist)
Plant Science Department
151 Townsend Hall
University of Delaware
Newark, DE 19711-1303
Tel: 302-831-2531
Fax: 302-831-3651
Email: none

Florida:
Carrol G. Chambliss
Agronomy Department
University of Florida
Institute of Food & Agricultural Sciences
303 Newell Hall
P.O. Box 110500
Gainesville, FL 32611-0500
Tel: 904-392-1817
Fax: 904-392-1840
Email: cgc@gnv.ifas.ufl.edu

Georgia:
Troy Johnson
Cooperative Extension Service
Barrow Hall
University of Georgia
Athens, Georgia 30602-4356
Tel: 706-542-2978
Fax: 706-542-7133
Email: eagyat@uga.cc.uga.edu

Hawaii:
Burt Smith
P.O. Box 237
Kamuela, HI
Tel: 808-885-7318
Fax: 808-885-1041
Email: none

Idaho:
Robert Romanko
SW Idaho Research and Extension Center
29603 U of I Lane
Parma, ID 83660
Tel: 208-722-6701
Fax: 208-722-6708
Email: parma@udui1.csrv.uidaho.edu

Illinois:
Don W. Graffis
W-301 Turner Hall
1102 S. Goodwin Avenue
University of Illinois
Urbana, IL 61801
Tel: 217-333-4424
Fax: 217-333-5299
Email: graffisd@idea.ag.uiuc.edu

Indiana:
Keith D. Johnson
1150 Lilly Hall of Life Science
Department of Agronomy
Purdue University
West Lafayette, IN 47907-1150
Tel: 317-494-4800
Fax: 317-496-1368
Email: kjohnson@dept.agry.purdue.edu

Iowa:
Steve Barnhart
Agronomy Extension
2104 Agronomy Hall
Iowa State University
Ames, IA 50011
Tel: 515-294-1923
Fax: 515-294-3163
Email: agronomy@exnet.iastate.edu

Kansas:
James Shroyer (Alfalfa Specialist)
Paul Ohlenbusch (Range and Pasture Specialist)
219 Throckmorton Hall
Kansas State University
Manhattan, KS 66506
Tel: 913-532-5776
Fax: 913-532-6315
Email (secretary):hallerl@ksuvm.ksu.edu

Kentucky:
Jimmy C. Henning
N-122 Ag Science Building North
Department of Agronomy
University of Kentucky
Lexington, KY 40546-0091
Tel: 606-257-3144
Fax: 606-323-1952
Email: jhenning@ca.uky.edu
Subject speciality areas: Forage quality, pasture management, forage establishment

Garry Lacefield
West Kentucky Research & Education Center
P.O. Box 469
Princeton, KY 42445
Tel: 502-365-7541
Email: glacefie@ca.uky.edu
Subject specialty areas: pasture and hay management, renovation, legumes, tall fescue-endophyte, alfalfa.

Louisiana:
Wade F. Faw
252 Knapp Hall
Louisiana Cooperative Extension Service
Baton Rouge, LA 70803
Tel: 504-388-2118
Fax: 504-388-2478
Email: xtplant@lsuvm.sncc.lsu.edu

Maine:
Timothy Griffin
5722 Deering Hall
Orono, Maine 04469-5722
Tel: 207 581-2942
Fax: 207-581-2941
Email: tgriffin@umce.umext.maine.edu
Subject speciality areas: grazing management, pasture and hay fertility, using forages in crop rotations

Maryland:
Les Vough
Department of Agronomy
University of Maryland
College Park, MD 20742
Tel: 301-405-1322
Fax: 301-314-9041
Email: lv14@umail.umd.edu
Subject speciality areas: integrated alfalfa management practices, forage quality and utilization, rotational grazing management and year-round grazing systems.

Massachusetts:
Steve Herbert (Extension Agronomist)
Department of Plant and Soil Science
Bowditch Hall
University of Massachusetts
Amherst, MA 01003
Tel: 413-545-2250
Fax: 413-545-0260
Email: sherbert@pssci.umass.edu

Michigan:
Oran B. Hesterman
Plant & Soil Science Building
Department of Crop and Soil Sciences
Michigan State University
East Lansing, MI 48824
Tel: 517-355-0264
Fax: 517-353-5174
Email: none

Minnesota:
Neal P. Martin
Department of Agronomy and Plant Genetics
University of Minnesota
411 Borlaug Hall
1991 Buford Circle
St. Paul, MN 55108
Tel: 612-625-3747
Fax: 612-625-4797
Email: marti007@maroon.tc.umn.edu

Mississippi:
Lamar Kimbrough
Department of Agronomy
Mississippi State University
Box 9555
Mississippi State, MS 39762
Tel: 601-325-4077
Fax: 601-325-8742
Email: none

Missouri:
Craig Roberts (Forage Quality and Pasture Specialist)
214 Waters Hall
Department of Agronomy
University of Missouri
Columbia, MO 65211
Tel: 314-882-2001
Fax: 314-884-4317
Email: robertsc@ext.missouri.edu

Richard Joost (Hay and Soil Fertility for Forages Specialist)
214 Waters Hall
Department of Agronomy
University of Missouri
Columbia, MO 65211
Tel: 314-882-2002
Fax: 314-884-4317
Email: joostr@ext.missouri.edu

Montana:
Dennis Cash
Plant, Soil, and Environmental Science Department
Montana State University
Bozeman, MT 59717
Tel: 406-994-5688
Fax: 406-994-3933
Email:usssc@msu.oscs.montana.edu

Nebraska:
Bruce Anderson
353 Keim Hall
Department of Agronomy
University of Nebraska
Lincoln, NE 68583-0910
Tel: 402-472-6237
Fax: 402-472-7904
Email: none

Nevada:
Sharon Bryant (Extension Agronomist position open)
Cooperative Extension Service
Fairgrounds
Winamucca, NV 89445-2927
Tel: 702-623-6304<
Fax: 702-623-6307
Email: bryants@unr.edu

New Hampshire:
J. R. Mitchell (Extension Agronomist)
Nesmith Hall
University of New Hampshire
Durham, NH 03824
Tel: 603-862-3204
Fax: 603-862-4757
Email: none

New Jersey:
Richard Ilnicki (Extension Agronomist)
Department of Plant Science
Cook College Lipman Hall
P.O. Box 231
New Brunswick, NJ 08903-0231
Tel: 908-932-9423
Fax: 908-932-8899
Email: none

New Mexico:
Charles R. Glover (Extension Agronomist)
New Mexico State University
Box 3AE
Las Cruces, NM 88003
Tel: 505-646-4125
Fax: 505-646-5975
Email: none

New York:
Jerry Cherney
Department of Soil, Crop, and Atmospheric Sciences
153 Emerson Hall
Cornell University
Ithaca, NY 14853-1901
Tel: 607-255-0945
Fax: 607-255-6143
Email: jhc5@cornell.edu

North Carolina:
James T. Green Jr.
Box 7620
North Carolina State University
Raleigh, NC 27695-7620
Tel: 919-515-2390
Fax: 919-515-7959
Email: jgreen@wolf.ces.ncsu.edu

North Dakota:
Kevin Sedivec (Rangeland Management Specialist)
Department of Animal and ange Sciences
North Dakota State University
Fargo, ND 58105
Tel: 701-237-7642
Fax: 701-237-7590
Email: none

Ohio:
Mark Sulc ("Schultz")
Room 224 Kottman Hall
2021 Coffey Road
Ohio State University
Columbus, OH 43210-1086
Tel: 614-292-9084
Fax: 614-292-7162
Email: sulc.2@osu.edu
Subject speciality areas: alfalfa and forage production

Oklahoma:
Forage Extension Agronomist position currently open
John Caddell (Extension Agronomist; alfalfa)
Department of Agronomy
Oklahoma State University
Stillwater, OK 74078
Tel: 405-744-9643
Fax: 405-744-5269
Email: jlc@soilwater.agr.okstate.edu

Oregon:
David B. Hannaway
125 Crop Science Building
Department of Crop & Soil Science
Oregon State University
Corvallis, OR 97331-3002
Tel: 503-737-5863
Fax: 503-737-5063
Email: david@forages.css.orst.edu
Subject speciality areas: alfalfa, forage quality, mineral nutrition, computer applications

Pennsylvania:
Marvin Hall
Department of Agronomy
Penn State University
116 Agri. Sci. Ind. Bldg.
University Park, PA 16802
Tel: 814-863-1019
Fax: 814-863-7043
Email: mhh2@psuvm.psu.edu
Subject speciality areas: forage management and utilization, alfalfa physiology, growth, and development

Rhode Island:
W. Michael Sullivan (Extension Agronomist)
Plant Science Department
University of Rhode Island
Kingston, RI 02881
Tel: 401-792-4540
Fax: 401-792-2494
Email: lth101@uriacc.uri.edu

South Carolina:
Bruce Pinkerton
Department of Agronomy & Soils
275 Poole Agricultural Center
Clemson University
Box 340359
Clemson, SC 29634-0359
Tel: 803-656-2822
Fax: 803-656-3443
Email: bpnkrtn@clust1.clemson.edu
Subject speciality areas: perennial pastures, low input pasture management, burning management, Bermuda grass in northern transition zone

South Dakota:
Ed Twidwell
Department of Plant Science
South Dakota State University
Brookings, SD 57007
Tel: 605-688-4754
Fax: 605-688-4602
Email: none (Route to Kevin Kephart: kephartk@mg.sdstate.edu)

Tennessee:
Gary Bates
Department of Plant & Soil Science
P.O. Box 1071
University of Tennessee

Knoxville, TN 37901-1071
Tel: 615-974-7208
Fax: 615-974-8850
Email: none

Texas:
Don Dorsette
Department of Soil and Crop Science
Texas A&M University
College Station, TX 77843
Tel: 409-845-2761
Fax: 409-845-0604
Email: none

George D. Alston (agronomy specialist)
TAES-Stephenville Center
Rt. 2, Box 00
Stephenville, TX 76401

David H. Bade (area forage specialist)
P.O. Box 2150
Bryan, TX 77806
Tel: 409-845-6800
Fax: 409-845-6501
Email: none

Sim Reeves Jr. (area forage specialist)
TAMU Agricultural Research & Extension Center
Drawer E
Overton, TX 75684
Tel: 903-834-6191
Fax: 903-834-7140
Email: none

Utah:
Ralph Whitesides (Extension Agronomist)
Department of Plants, Soils, and Biometeorology
Utah State University
Logan, UT 84322-4820
Tel: 801-797-2259
Fax: 801-797-3376
Email: ralphw@ext.usu.edu
Subject speciality areas: weed control, alfalfa, pasture, corn silage, hay sampling and quality, and small grains.

Vermont:
Sid Bosworth
Hills Building
department of Plant and Soil Science
University of Vermont
Burlington, VT 05405
Tel: 802-656-0478
Fax: 802-656-4656
Email: pss_dept@uvmvax.uvn.edu

Virginia:
Vivien G. Allen
Department of Crop and Soil Sciences
Smyth Hall
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061
Tel: 703-231-9797
Fax: 703-231-3431
Email: felician@vtvm1.cc.vt.edu
Subject speciality areas: grazing management, pastures, grazing land terminology.

Washington:
Steve Fransen
Washington State University
Research & Extension Center
7612 West Pioneer
Puyallup, WA 98371
Tel: 206-593-8516
Fax: 206-840-4669
Email: fransen@wsuvm1.csc.wsu.edu
Subject speciality areas: grass silage; orchardgrass, perennial ryegrass, tall fescue; dairy forages.

West Virginia:
Ed Rayburn
Agriculture Science Building
West Virginia University
P.O. Box 6108

Morgantown, WV 26506-6108
Tel: 304-293-5229
Fax: 304-293-6954
Email: rayburn@wvnvms.wvnet.edu

Wisconsin:
Dan Undersander
Department of Agronomy
1575 Linden Drive
Madison, WI 53706
Tel: 608-263-5070
Fax: 608-262-5217
Email: undersan@macc.wisc.edu
Subject speciality areas: alfalfa management and production, pasture design and management, forage quality, hay
marketing

Wyoming:
Alan Gray
P.O. Box 866
Riverton, WY 82501
Tel: 307-856-1305
Fax 307-766-5549
Email: none

APPENDIX 3

Other Types of Hay

Birdsfoot Trefoil

Although it is used primarily as a pasture legume, birdsfoot trefoil is managed as a hay crop in some regions where alfalfa is poorly adapted. It has less yielding ability than most legumes when managed as a hay crop, and in some cases it has been damaged when cut for hay (Null and Wheaton). Birdsfoot trefoil is grown in the northeastern and north-central states, and intermountain areas, and in the coastal Pacific Northwest.

Birdsfoot trefoil is a long-lived perennial adapted to production on poorly drained, low pH soils. Its ability to produce on wet and acid soils (pH as low as 5.5) makes it a valuable alternative for areas not suited for alfalfa production. As a forage, birdsfoot trefoil is comparable to alfalfa, but can withstand heavier grazing than either alfalfa or red clover.

Like alfalfa, birdsfoot trefoil produces best on fertile, well-drained soils with near-neutral pH levels. Trefoil can, however, tolerate short periods of flooding better than alfalfa. It can also tolerate periods of drought, which allows for production on both sandy and clay soils.

Birdsfoot trefoil has more resistance to Phytophthora root rot and several insect pests that attack alfalfa. It also responds well to fertilizer and does not cause bloat in animals. The northern United States and southern Canada have seen expansion of this legume into their regions, due to these favorable characteristics (Hall).

Birdsfoot trefoil, however, has several limitations relative to alfalfa. It performs poorly in extreme heat and the trefoil plants are shorter than alfalfa plants, reaching only 18 to 20 inches. In addition, it tends to lodge more than alfalfa because its stems are smaller in diameter and less rigid than alfalfa stems.

Because it yields less than alfalfa, birdsfoot trefoil usually is not widely grown in areas that are well adapted to alfalfa. Maximum yields for trefoil in fertile, well drained soils are only about 50 to 80 percent of the alfalfa yield. In addition, trefoil is less effective at nitrogen fixation than alfalfa and red clover.

Birdsfoot trefoil can be difficult to establish because it is a poor competitor in the seedling stage of growth. During the seedling period (first 60 to 90 days), it is less aggressive than most plants, so competition from others plants must be controlled. Competition produces shade and competes for available moisture.

Trefoil may be seeded in late winter, early spring, or fall. Usually, late winter or early spring (February or early March) has proven the most satisfactory time to plant. Fall seedings have the advantage of less competition from weeds, but seedling failure is possible due to inadequate moisture, increased insect numbers, winterkill, and heaving.

Birdsfoot trefoil is relatively free of insect and disease damage, and is very winter hardy once established. The most serious of the diseases affecting birdsfoot trefoil are crown and root rots.

Losses may be difficult to assess because the plants are not killed immediately. Instead, infections take their toll in the form of lowered productivity over the life of the stand. Sometimes, diseases weaken plants so that they are unable to withstand adverse weather conditions such as drought or low winter temperatures (Hall).

White Clover

Used primarily in pasture mixtures, white clover-grass mixtures also may be used for high-quality hay or silage. White clover's contribution to the total forage yield in a mixed stand is generally relatively small, but it enhances the quality of grass hay. Being a legume, it fixes atmospheric nitrogen, which reduces the amount of nitrogen fertilizer needed for grass-clover mixtures. Sometimes, white clover is grown in mixtures with red clover to boost yields when it is used for hay or silage.

White clover (Trifolium repens) is found throughout the temperate regions of the world and is limited only by extreme cold or heat, or by drought. In the United States, white clover is found in the humid eastern half of the country and in the Pacific Northwest. It is also utilized in irrigated pastures throughout the intermountain region.

White clover is a short-lived, perennial legume which can reseed itself under favorable conditions. It is a low-growing legume which is predominantly used in forage mixtures with grasses. It grows rapidly and spreads via stolons. White clover is intolerant to droughty soils because it has a shallow root system. Its best growing conditions are cool, moist weather and well-drained, fertile soils having a pH between 6 and 7.

White clover can be used in wet areas that have a low pH, but does best in well-drained silt loam and clay soils of pH 6.0 to 7.0. It does not tolerate saline or highly alkaline soils.

Because white clover usually contributes only a small portion of the hay yield, its harvest is scheduled to maximize the production and quality of other species in the mixture. White clover retains relatively high quality at maturity and can, therefore, be held until other species are ready for harvest.

Alsike Clover

Alsike clover (Trifolium hybridum) is a minor hay species grown in the Pacific Northwest and the upper Midwest. It is well adapted to wet, heavy soils and is tolerant of flooded conditions. It produces well on soils that are either too cold and wet or too acid or alkaline for red clover.

Alsike clover is a short-lived legume (3 years average) that is most useful in short-rotation pastures and hay mixtures on wetlands. It can be used in combination with grasses for pasture or hay in areas that have high precipitation or are poorly drained.

Alsike has a tendency to lodge when grown alone but stands up better when grown along with a grass. Alsike clover produces only one crop of hay each season.

Annual Lespedeza

Annual lespedeza is a summer annual legume that is used for pasture, hay, and soil improvement. It is relatively easy to establish, and is tolerant of acid soils and droughty conditions. Except under severely dry conditions, it can reseed itself.

One advantage of lespedeza is that it produces a nutritious forage during hot summer conditions, when the quality and yield of cool-season grasses decline. Another advantage as a hay crop in areas with frequent rains is that it dries quickly. This reduces the chances of yield and quality losses due to rain falling on the cut hay. With favorable weather, it is possible to cut lespedeza in the morning and bale it in the afternoon of the same day. One of lespedeza's limitations, however, is that it is an annual and does not begin to produce until June.

The dry matter yields of annual lespedeza are lower than alfalfa and red clover under favorable weather conditions. Lespedeza makes a good hay for sheep and beef cattle, but has proven inferior to alfalfa when fed to lactating dairy cows.

Reed Canarygrass

Reed canarygrass is a tall, leafy, high yielding, cool season, perennial grass. It is particularly well adapted to wet soils and soils with pH below 6.0. Reed canarygrass is more tolerant of flooding and standing water than other hay plants, making it a good choice for poorly drained soils and flood prone fields. Under proper management, it also produces well on most upland sites as it is one of the most drought tolerant of the cool season grasses. It does not produce very well, however, on droughty sands (Hall).

Although not a major hay crop, reed canarygrass is planted for hay, silage, and pasture in the northcentral and northeastern United States. It has unjustly gained a reputation as a low quality, undesirable forage, due partly to the high alkaloid content of native varieties and the practice of delaying harvest until the plant is mature. Newer varieties, such as *Palaton* and *Venture*, however, are equal in quality to other cool-season grasses when harvested at similar stages of maturity.

When making hay, reed canarygrass must be cut before heads begin to appear to keep it from becoming coarse and stemmy. Because of its very early spring growth, some growers may graze the first growth in the spring to delay the haying period. Reed canarygrass makes excellent hay for horses -- they reportedly prefer it over good quality timothy hay (Wheaton).

When given adequate nitrogen, reed canarygrass provides good forage yields. It recovers quickly after harvest, especially in spring and early summer. Approximately 60 percent of its total yield is produced in July. In the fall the plant is very frost sensitive and will quickly turn brown after the first frost.

As with other hay crops, maximum hay yield and highest quality occur at different times. Typically the highest yield comes at heading, but highest quality comes before seed heads appear. If the hay producer waits until the head develops, then the stem has increased in size relative to the leafy materials, lowering the quality of the crop.

One disadvantage of reed canarygrass is that it is slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially harmful. Companion crops can be used for spring seedings, but should not be used for late-summer seedings. Oats is the most

common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture.

Reed canarygrass has good winter hardiness and is resistant to foliar diseases.

Native Warm-season Grasses

Native warm-season grasses, such as switchgrass, big bluestem, and indiangrass, establish relatively slowly, but can last for many years. Due to the expense and difficulty in establishing these grasses, they are usually treated as permanent sod pastures or hay fields and not included in crop rotations like cool-season forage crops. They can, however, be a source of relatively high quality forage during the summer months when cool-season grass pastures are at a disadvantage. When managed properly, warm season grass hay can provide good quality forage, especially for beef animals (Henning, 1993a).

Both switchgrass and big bluestem are tall-growing, bunch grasses. Switchgrass tolerates poorly drained soils and flooding better than other warm-season grasses, while big bluestem is the most drought tolerant. Warm-season grasses produce most of their growth from June-August.

Warm season grasses are relatively free of insect and disease pests. They do not, however, compete very well against weeds during the establishment period.

Prairie Grass

Prairie grass is a tall growing, deep-rooted perennial grass that is suited to well drained soils with medium to high fertility levels and a pH of 6.0 or greater. It provides early spring growth and excellent fall growth to extend the grazing season. Herbage and immature seedheads of prairie grass are highly palatable and are used as a hay crop.

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APPENDIX 4

Costs of Production

Appendix Table 1--All Hay: Acres Harvested, Acres Irrigated and Tons Produced, by Farm Production Region and State, 1992

Region/State	Acres Harvested	Acres Irrigated	Tons	Percent Irrigated	Percent of U.S. Acreage	Percent of U.S. Production
Appalachian						
Kentucky	1,787,581	2,740	3,667,858	0.2	3.6	3.1
North Carolina	448,984	4,676	885,085	1.0	0.9	0.7
South Carolina	224,305	1,114	381,979	0.5	0.5	0.3
Tennessee	1,369,642	2,776	2,548,617	0.2	2.8	2.1
Virginia	1,050,538	3,976	2,082,137	0.4	2.1	1.8
West Virginia	442,202	892	736,813	0.2	0.9	0.6
--Total	5,323,252	16,174	10,302,489	0.3	10.7	8.7
Corn Belt						
Illinois	829,286	2,598	2,306,079	0.3	1.7	1.9
Indiana	641,611	3,842	1,619,033	0.6	1.3	1.4
Iowa	1,642,718	1,693	4,848,820	0.1	3.3	4.1
Missouri	3,384,232	6,876	5,986,079	0.2	6.8	5.0
Ohio	1,086,912	1,346	2,707,427	0.1	2.2	2.3
--Total	7,584,759	16,355	17,467,438	0.2	15.3	14.7
Delta						
Arkansas	1,088,345	8,745	2,074,067	0.8	2.2	1.7
Louisiana	371,432	5,558	833,633	1.5	0.7	0.7
Mississippi	622,615	1,409	1,290,356	0.2	1.3	1.1
--Total	2,082,392	15,712	4,198,056	0.8	4.2	3.5
Lake States						
Michigan	1,065,324	7,103	2,430,536	0.7	2.1	2.0
Minnesota	1,912,249	20,699	4,733,479	1.1	3.9	4.0
Wisconsin	2,744,599	13,226	6,764,593	0.5	5.5	5.7
--Total	5,722,172	41,028	13,928,608	0.7	11.5	11.7
Mountain						
Arizona	175,326	173,032	1,003,785	98.7	0.4	0.8
Colorado	1,409,207	1,104,728	3,398,009	78.4	2.8	2.9
Idaho	1,020,512	778,243	3,257,143	76.3	2.1	2.7
Montana	1,946,713	946,797	3,612,038	48.6	3.9	3.0
Nevada	368,606	368,606	1,045,483	100.0	0.7	0.9
New Mexico	254,767	224,353	900,602	88.1	0.5	0.8
Utah	639,476	574,499	2,025,031	89.8	1.3	1.7
Wyoming	997,153	788,398	1,729,806	79.1	2.0	1.5
--Total	6,811,760	4,958,656	16,971,897	72.8	13.7	14.3
Northeast						
Connecticut	68,276	57	144,152	0.1	0.1	0.1
Delaware	9,710	155	25,832	1.6	0.0	0.0
Maine	174,884	92	262,713	0.1	0.4	0.2
Maryland	194,330	779	481,606	0.4	0.4	0.4
Massachusetts	91,806	333	190,985	0.4	0.2	0.2
New Hampshire	65,542	0	112,537	0.0	0.1	0.1
New Jersey	110,195	816	223,207	0.7	0.2	0.2
New York	1,566,997	3,401	3,375,102	0.2	3.2	2.8
Pennsylvania	1,498,850	1,304	3,488,559	0.1	3.0	2.9
Rhode Island	7,188	- -	14,898	0.0	0.0	0.0
Vermont	272,552	533	535,993	0.2	0.5	0.5
--Total	4,060,330	7,470	8,855,584	0.2	8.2	7.5
Northern Plains						
Kansas	2,427,926	233,297	5,778,183	9.6	4.9	4.9
Nebraska	2,803,758	373,959	5,898,696	13.3	5.7	5.0
North Dakota	2,412,107	29,517	3,208,986	1.2	4.9	2.7
South Dakota	3,249,226	87,217	5,560,374	2.7	6.5	4.7
--Total	10,893,017	723,990	20,446,239	6.6	22.0	17.2
Pacific						
California	1,390,216	1,174,495	7,083,490	84.5	2.8	6.0
Oregon	834,241	565,012	2,180,647	67.7	1.7	1.8
Washington	650,381	355,762	2,324,261	54.7	1.3	2.0
--Total	2,874,838	2,095,269	11,588,398	72.9	5.8	9.8
Southeast						
Alabama	662,648	3,859	1,387,460	0.6	1.3	1.2

Florida	251,438	17,694	615,371	7.0	0.5	0.5
Georgia	488,188	11,922	1,180,073	2.4	1.0	1.0
--Total	1,402,274	33,475	3,182,904	2.4	2.8	2.7
Southern Plain						
Oklahoma	2,065,794	65,898	3,936,268	3.2	4.2	3.3
Texas	3,488,883	191,589	7,812,199	5.5	7.0	6.6
--Total	5,554,677	257,487	11,748,467	4.6	11.2	9.9
Alaska	1,802	- -	1,624	- -	0.0	0.0
Hawaii	- -	104	- -	- -	- -	- -
--Total	49,615,068	8,167,764	118,797,601	16.5	100.0	100.0

- - = data not reported.
Source: Census of Agriculture, Dept. of Commerce.

Appendix Table 2--Alfafa and Alfalfa Mixture Hay Acres Harvested, Acres Irrigated and Tons Produced. by Farm Production Region and State, 1992

Region/State	Acres Harvested	Acres Irrigated	Tons	Percent Irrigated	Percent of U.S. Acreage	Percent of U.S. Production
Appalachian						
Kentucky	298,922	504	881,449	0.2	1.3	1.3
North Carolina	34,332	263	99,332	0.8	0.2	0.1
South Carolina	- -	199	- -	- -	0.0	0.0
Tennessee	88,813	148	252,673	0.2	0.4	0.4
Virginia	229,609	1,499	552,865	0.7	1.0	0.8
West Virginia	103,359	303	213,111	0.3	0.5	0.3
--Total	421,781	1,950	1,018,649	0.5	1.9	1.5
Corn Belt						
Illinois	564,384	2,076	1,792,941	0.4	2.5	2.7
Indiana	392,455	3,526	1,128,858	0.9	1.7	1.7
Iowa	1,367,935	1,488	4,315,698	0.1	6.0	6.4
Missouri	749,327	2,315	1,674,912	0.3	3.3	2.5
Ohio	658,206	847	1,887,046	0.1	2.9	2.8
--Total	3,732,307	10,252	10,799,455	0.3	16.4	16.1
Delta						
Arkansas	40,290	558	124,212	1.4	0.2	0.2
Louisiana	3,332	- -	10,234	- -	0.0	0.0
Mississippi	22,603	119	72,574	0.5	0.1	0.1
--Total	66,225	677	207,020	1.0	0.3	0.3
Lake States						
Michigan	888,691	6,763	2,186,202	0.8	3.9	3.3
Minnesota	1,342,787	18,180	3,862,307	1.4	5.9	5.8
Wisconsin	2,201,007	11,257	5,748,350	0.5	9.7	8.6
--Total	4,432,485	36,200	11,796,859	0.8	19.4	17.6
Mountain						
Arizona	140,978	140,978	904,396	100.0	0.6	1.3
Colorado	790,227	674,375	2,484,316	85.3	3.5	3.7
Idaho	834,450	673,875	2,954,965	80.8	3.7	4.4
Montana	1,220,792	628,927	2,607,186	51.5	5.4	3.9
Nevada	227,977	227,977	860,428	100.0	1.0	1.3
New Mexico	194,614	184,572	794,617	94.8	0.9	1.2
Utah	501,278	449,286	1,758,044	89.6	2.2	2.6
Wyoming	484,510	358,977	1,123,866	74.1	42.1	1.7
--Total	4,394.826	3,338,967	13,487,818	76.0	19.3	20.1
Northeast						
Connecticut	23,064	57	55,829	0.2	0.1	0.1
Delaware	4,991	155	15,316	3.1	0.0	0.0
Maine	34,582	19	57,802	0.1	0.2	0.1
Maryland	79,611	563	246,657	0.7	0.3	0.4
Massachusetts	30,490	185	79,053	0.6	0.1	0.1
New Hampshire	17,612	- -	33,869	- -	0.1	0.1
New Jersey	37,810	433	101,979	1.1	0.2	0.2
New York	813,084	2,324	2,044,356	0.3	3.6	3.0
Pennsylvania	795,326	447	2,188,135	0.1	3.5	3.3
Rhode Island	3,023	- -	7,492	- -	0.0	0.0
Vermont	87,673	307	201,719	0.4	0.4	0.3
--Total	1,927,266	4,490	5,032,207	0.2	8.5	7.5
Northern Plains						
Kansas	874,197	210,285	3,053,842	24.1	3.8	4.6
Nebraska	1,270,921	316,023	4,025,983	24.9	5.6	6.0
North Dakota	1,058,536	23,400	1,598,591	2.2	4.6	2.4
South Dakota	1,921,040	77,391	3,865,379	4.0	8.4	5.8
--Total	5,124,694	627,099	12,543,795	12.2	22.5	18.7
Pacific						
California	939,097	908,120	5,879,133	96.7	4.1	8.8
Oregon	400,881	340,119	1,426,579	84.8	1.8	2.1
Washington	437,600	293,090	1,870,629	67.0	1.9	2.8
--Total	1,777,578	1,541,329	9,176,341	86.7	7.81	3.7
Southeast						
Alabama	24,654	182	88,342	0.7	0.1	0.1
Florida	35,344	1,897	83,640	5.4	0.2	0.1

Georgia	21,201	978	68,818	4.6	0.1	0.1
--Total	81,199	3,057	240,800	3.8	0.4	0.4
Southern Plains						
Oklahoma	323,603	39,786	1,048,225	12.3	1.4	1.6
Texas	167,244	67,719	700,982	40.5	0.7	1.0
--Total	490,847	107,505	1,749,207	21.9	2.2	2.6
Alaska	- -	- -	- -	- -	- -	- -
Hawaii	- -	- -	- -	- -	- -	- -
--Total	22,792,626	5,672,678	67,063,849	24.9	100.0	100.0

- - = data not reported..

Source: Census of Agriculture, Dept. of Commerce.

Appendix Table 3--Small Grain Hay Acres Harves, Acres Irrigated, and Tons Produced, by Farm Production Region and State, 1992

Region/State	Acres Harvested	Acres Irrigated	Tons	Percent Irrigated	Percent of U.S. Acreage	Percent of U.S. Production
Appalachian						
Kentucky	87,814	165	143,539	0.2	2.9	2.5
North Carolina	44,527	171	82,818	0.4	1.5	1.5
Tennessee	95,522	496	152,757	0.5	3.1	2.7
Virigina	50,239	302	105,001	0.6	1.6	1.9
West Virginia	5,744	88	10,790	1.5	0.2	0.2
--Total	283,946	1,222	494,905	0.4	9.3	8.8
CornBelt						
Illinois	39,857	89	78,842	0.2	1.3	1.4
Indiana	26,500	--	54,190	--	0.9	1.0
Iowa	95,274	96	180,139	0.1	3.1	3.2
Missouri	83,531	619	156,007	0.7	2.7	2.8
Ohio	31,717	78	63,621	0.2	1.0	1.1
--Total	276,879	882	532,799	0.3	9.1	9.4
Delta						
Arkansas	20,640	294	37,753	1.4	0.7	0.7
Louisiana	23,998	613	50,939	2.6	0.8	0.9
Mississippi	47,881	52	88,414	0.1	1.6	1.6
--Total	92,519	969	177,106	1.0	3.0	3.1
Lake States						
Michigan	23,264	--	40,326	--	0.8	0.7
Minnesota	68,581	385	135,844	0.6	2.3	2.4
Wisconsin	174,968	897	352,078	0.5	5.7	6.2
--Total	266,813	1,282	528,248	0.5	8.8	9.4
Mountain						
Arizona	10,627	9,944	25,500	93.6	0.3	0.5
Colorado	81,258	34,781	146,814	42.8	2.7	2.6
Idaho	46,649	34,536	102,882	74.0	1.5	1.8
Montana	141,462	38,729	234,042	27.4	4.6	4.1
Nevada	11,037	11,037	27,462	100.0	0.4	0.5
New Mexico	24,413	15,925	53,119	65.2	0.8	0.9
Utah	29,193	27,473	71,503	94.1	1.0	1.3
Wyoming	38,980	20,156	65,325	51.7	1.3	1.2
--Total	383,619	192,581	726,647	50.2	12.6	12.9
Northeast						
Connecticut	1,668	--	3,410	--	0.1	0.1
Delware	1,310	--	3,016	--	0.0	0.1
Maine	1,993	--	3,317	--	0.1	0.1
Maryland	8,246	--	18,523	--	0.3	0.3
Massachusetts	864	32	1,593	3.7	0.0	0.0
New Hampshire	513	--	1,011	--	0.0	0.0
New Jersey	6,942	--	12,405	--	0.2	0.2
New York	27,773	160	48,715	0.6	0.9	0.9
Pennsylvania	39,860	184	74,753	0.5	1.3	1.3
Rhode Island	125	--	125	--	0.0	0.0
Vermont	3,734	--	7,073	--	0.1	0.1
--Total	93,008	376	173,941	0.4	3.1	3.1
Northern Plains						
Kansas	113,346	9,896	207,690	8.7	3.7	3.7
Nebraska	74,934	10,370	137,725	13.8	2.5	2.4
North Dakota	245,180	1,424	384,695	0.6	8.1	6.8
South Dakota	213,833	5,090	336,590	2.4	7.0	6.0
--Total	647,293	26,780	1,066,700	4.1	21.3	18.9
Pacific						
California	267,501	120,363	696,807	45.0	8.8	12.3
Oregon	45,950	26,369	99,041	57.4	1.5	1.8
Washington	27,255	11,094	54,215	40.7	0.9	1.0
--Total	340,706	157,826	850,063	46.3	11.2	15.0
Southeast						
Alabama	25,605	326	47,093	1.3	0.8	0.8
Florida	7,940	1,550	13,439	19.5	0.3	0.2
Georgia	23,040	1,031	44,747	4.5	0.8	0.8
South Carolina	26,892	81	--	0.3	0.9	0.0
--Total	83,477	2,988	105,279	3.6	2.7	1.9
Southern Plains						
Oklahoma	255,549	5,877	403,291	2.3	8.4	7.1
Texas	320,601	33,345	539,813	10.4	10.5	9.6
--Total	576,150	39,222	943,104	6.8	18.9	16.7
Alaska	742	--	--	--	--	
Hawaii	--	--	--	--	--	
--Total	3,045,172	424,729	5,649,013	13.9	100.0	100.0

--=data not reported. Source: Census of Agriculture, Dept of Commerce.

Appendix Table 4--Other Tame Hay: Acres Harvested, Acres Irrigated and Tons Produced, by Farm Production Region and State, 1992

Region/State	Acres Harvested	Acres Irrigated	Tons	Percent Irrigated	Percent of U.S. Acreage	Percent of U.S. Production
Appalachian						
Kentucky	1,306,116	1,736	2,506,771	0.1	6.6	6.7
North Carolina	351,608	4,003	681,645	1.1	1.8	1.8
Tennessee	1,093,736	1,930	2,016,995	0.2	5.5	5.4
Virginia	695,952	2,125	1,316,586	0.3	3.5	3.5
West Virginia	288,208	332	463,709	0.1	1.5	1.2
--Total	3,735,620	10,126	6,985,706	0.3	18.9	18.6
Corn Belt						
Illinois	205,353	266	403,958	0.1	1.0	1.1
Indiana	196,208	316	400,930	0.2	1.0	1.1
Iowa	165,338	109	327,747	0.1	0.8	0.9
Missouri	2,248,566	2,939	3,746,486	0.1	11.4	10.0
Ohio	352,987	321	698,172	0.1	1.8	1.9
--Total	3,168,452	3,951	5,577,293	0.1	16.1	14.8
Delta						
Arkansas	789,763	7,187	1,546,440	0.9	4.0	4.1
Louisiana	274,283	3,385	649,512	1.2	1.4	1.7
Mississippi	426,633	1,098	922,804	0.3	2.2	2.5
--Total	1,490,679	11,670	3,118,756	0.8	7.6	8.3
Lake States						
Michigan	131,112	340	180,580	0.3	0.7	0.5
Minnesota	333,734	1,713	514,011	0.5	1.7	1.4
Wisconsin	320,093	781	595,150	0.2	1.6	1.6
--Total	784,939	2,834	1,289,741	0.4	4.0	3.4
Mountain						
Arizona	21,579	20,455	68,431	94.8	0.1	0.2
Colorado	308,756	208,829	481,354	67.6	1.6	1.3
Idaho	82,943	32,246	129,068	38.9	0.4	0.3
Montana	278,288	102,573	376,388	36.9	1.4	1.0
Nevada	35,632	35,632	51,097	100.0	0.2	0.1
New Mexico	28,548	18,831	45,191	66.0	0.1	0.1
Utah	39,874	36,189	79,429	90.8	0.2	0.2
Wyoming	166,481	137,851	207,695	82.8	0.8	0.6
--Total	962,101	592,606	1,438,653	61.6	4.9	3.8
Northeast						
Connecticut	37,352	- -	75,088	- -	0.2	0.2
Delaware	3,245	- -	7,208	- -	0.0	0.0
Maine	117,143	73	177,301	0.1	0.6	0.5
Maryland	100,367	216	208,077	0.2	0.5	0.6
Massachusetts	52,552	116	99,530	0.2	0.3	0.3
New Hampshire	41,243	- -	70,818	- -	0.2	0.2
New Jersey	58,504	369	99,620	0.6	0.3	0.3
New York	649,305	704	1,173,703	0.1	3.3	3.1
Pennsylvania	613,542	536	1,160,551	0.1	3.1	3.1
Rhode Island	3,441	- -	6,690	- -	0.0	0.0
Vermont	166,144	226	307,379	0.1	0.8	0.8
--Total	1,842,838	2,240	3,385,965	0.1	9.3	9.0
Northern Plains						
Kansas	804,778	12,571	1,636,674	1.6	4.1	4.4
Nebraska	282,687	23,424	518,114	8.3	1.4	1.4
North Dakota	434,501	1,821	514,822	0.4	2.2	1.4
South Dakota	437,163	2,686	630,004	0.6	2.2	1.7
--Total	1,959,129	40,502	3,299,614	2.1	9.9	8.8
Pacific						
California	136,399	119,357	441,831	87.5	0.7	1.2
Oregon	239,013	92,721	449,172	38.8	1.2	1.2
Washington	142,626	48,775	337,869	34.2	0.7	0.9
--Total	518,038	260,853	1,228,872	50.4	2.6	3.3
Southeast						
Alabama	549,831	3,123	1,155,989	0.6	2.8	3.1
Florida	189,618	13,212	489,547	7.0	1.0	1.3

Georgia	421,784	9,388	1,027,734	2.2	2.1	2.7
South Carolina	185,188	767	365,527	0.4	0.9	1.0
--Total	1,346,421	26,490	3,038,797	2.0	6.8	8.1
Southern Plains						
Oklahoma	1,069,655	18,337	1,926,190	1.7	5.4	5.1
Texas	2,832,033	86,609	6,297,371	3.1	14.4	16.7
--Total	3,901,688	104,946	8,223,561	2.7	19.8	21.9
Alaska	- -	- -	- -	- -	- -	
Hawaii	- -	104	- -	- -	- -	
--Total	19,727,365	1,057,297	37,611,717	5.4	100.0	100.0

- = data not reported.
Source: Census of Agriculture, Dept. of Commerce.

Appendix Table 5--Wild Hay: Acres Harvested, Acres Irrigated and Tons Produced, by Farm Production Region and State, 1992

Region/State	Acres Harvested	Acres Irrigated	Tons	Percent Irrigated	Percent of U.S. Acreage	Percent of U.S. Production
Appalachian						
Kentucky	94,729	335	136,099	0.4	1.4	1.6
North Carolina	18,417	239	21,290	1.3	0.3	0.3
Tennessee	91,571	202	126,192	0.2	1.4	1.5
Virginia	74,738	50	107,685	0.1	1.1	1.3
West Virginia	44,891	169	49,203	0.4	0.7	0.6
--Total	324,346	995	440,469	0.3	4.8	5.2
Corn Belt						
Illinois	19,692	167	30,338	0.8	0.3	0.4
Indiana	26,448	--	35,055	--	0.4	0.4
Iowa	14,171	--	25,236	--	0.2	0.3
Missouri	302,808	1,003	408,674	0.3	4.5	4.8
Ohio	44,002	100	58,588	0.2	0.6	0.7
--Total	407,121	1,270	557,891	0.3	6.0	6.6
Delta						
Arkansas	237,652	706	365,662	0.3	3.5	4.3
Louisiana	69,819	1,560	122,948	2.2	1.0	1.5
Mississippi	125,498	140	206,564	0.1	1.9	2.4
--Total	432,969	2,406	695,174	0.6	6.4	8.2
Lake States						
Michigan	22,257	--	23,428	--	0.3	0.3
Minnesota	167,147	421	221,317	0.3	2.5	2.6
Wisconsin	48,531	291	69,015	0.6	0.7	0.8
--Total	237,935	712	313,760	0.3	3.5	3.7
Mountain						
Arizona	2,142	1,655	5,458	77.3	0.0	0.1
Colorado	228,966	186,743	285,525	81.6	3.4	3.4
Idaho	56,470	37,586	70,228	66.6	0.8	0.8
Montana	306,171	176,568	394,422	57.7	4.5	4.7
Nevada	93,960	93,960	106,496	100.0	1.4	1.3
New Mexico	7,192	5,025	7,675	69.9	0.1	0.1
Utah	69,131	61,551	116,055	89.0	1.0	1.4
Wyoming	307,182	271,414	332,920	88.4	4.5	3.9
--Total	1,071,214	834,502	1,318,779	77.9	15.8	15.6
Northeast						
Connecticut	6,192	--	9,825	--	0.1	0.1
Delaware	164	--	292	--	0.0	0.0
Maine	21,166	--	24,293	--	0.3	0.3
Maryland	6,106	--	8,349	--	0.1	0.1
Massachusetts	7,900	--	10,809	--	0.1	0.1
New Hampshire	6,174	--	6,839	--	0.1	0.1
New Jersey	6,939	14	9,203	0.2	0.1	0.1
New York	76,835	213	108,328	0.3	1.1	1.3
Pennsylvania	50,122	137	65,120	0.3	0.7	0.8
Rhode Island	599	--	591	--	0.0	0.0
Vermont	15,001	--	19,822	--	0.2	0.2
--Total	197,198	364	263,471	0.2	2.9	3.1
Northern Plains						
Kansas	635,605	545	879,977	0.1	9.4	10.4
Nebraska	1,175,216	24,142	1,216,874	2.1	17.3	14.4
North Dakota	673,890	2,872	710,878	0.4	9.9	8.4
South Dakota	677,190	2,050	728,401	0.3	10.0	8.6
--Total	3,161,901	29,609	3,536,130	0.9	46.7	41.7
Pacific						
California	47,219	26,655	65,719	56.4	0.7	0.8
Oregon	148,397	105,803	205,855	71.3	2.2	2.4
Washington	42,900	2,803	61,548	6.5	0.6	0.7
--Total	238,516	135,261	333,122	56.7	3.5	3.9
Southeast						
Alabama	62,558	228	96,036	0.4	0.9	1.1
Florida	18,536	1,035	28,745	5.6	0.3	0.3
Georgia	22,163	525	38,774	2.4	0.3	0.5
South Carolina	12,225	67	16,452	0.5	0.2	0.2
--Total	115,482	1,855	180,007	1.6	1.7	2.1
Southern Plains						
Oklahoma	416,987	1,898	558,562	0.5	6.2	6.6
Texas	169,005	3,916	274,033	2.3	2.5	3.2
--Total	585,992	5,814	832,595	1.0	8.7	9.8

Alaska	1,060	--	1,624	--	--	--
Hawaii	--	--	--	--	--	--
--Total	6,773,734	1,013,060	8,473,022	15.0	100.0	100.0

-- = data not reported.
Source: Census of Agriculture, Dept. of Commerce

APPENDIX 5

Other Pests and Diseases

Alfalfa Snout Beetle

The alfalfa snout beetle attacks the roots and leaves of alfalfa, and damage may be severe enough to kill the plant. The adult beetle is nearly half an inch long, and has been found thus far only in New York. The beetles' spread has been limited because they do not fly. The larvae are large, white, and grub-like in appearance. It can also infest clover, rhubarb, and some wheats (Shields).

Clover Leaf Weevil

The larvae of this insect look very much like alfalfa weevil larvae except that they are larger (1/2 inch long) and have brown heads, not black. They may be found feeding on alfalfa at night, very early in the spring. They are very susceptible to fungus disease, and diseased, dying or dead larvae are commonly found curled around the stems. Usually their numbers are reduced by the disease before extensive damage occurs.

Meadow Spittlebug

Meadow spittlebug damage is most likely on legumes seeded in small-grain stubble. The adult spittlebug is .25 to .38 inch long and resembles a frog; its head is short and blunt with large eyes. Adults vary in color and marking, ranging from light grey to dark brown, with spots, strips, or bands on the wing covers. Adults walk with their front four legs and drag their back legs. The nymphal stage is found within the frothy spittle mass which they secrete. They are about .03 inch long and orange. As they develop, they become greenish yellow and then green.

Spittlebugs lay eggs in the stipules of the alfalfa leaves during the summer and fall. Upon hatching in the spring, the nymph produces a white spittle mass, usually in the axil of the stem and leaf petiole. The adults and nymphs feed by sucking plant juices. Damage is mainly in the first growth during the spring. Insect feeding brings about a shortening of the internodes above the spittle mass, causing a rosette type of terminal growth.

It is usually not profitable to apply pesticide controls unless there are one or more spittle masses per stem by mid-May.

Alfalfa Blotch Leafminer

The adult leafminer fly is about .13 inch long and resembles a common housefly. It emerges in late May from overwintering pupae on the ground. The larvae (maggots) are pale yellow and have short, thick, soft bodies. Adult females emerge in the spring, cut shallow holes through the lower leaf surface, and deposit eggs under the leaf epidermis. A female lays one to three eggs per leaflet. After the eggs hatch, the larvae tunnel (mine) within the leaf, feeding on leaf tissue. The larval stage lasts approximately two weeks. During this time, their mining causes conspicuous white blotches on the leaflets, which are typically comma-shaped. Blotches and punctures can cause deterioration of foliage quality, loss of photosynthetic area, and defoliation.

The second cutting is usually most severely infested. Control may be justifiable if 30 percent or more of the leaflets have a mine present. In the Northeast, a second generation emerges about a week after pupation in mid-July, followed by a third generation in late August.

Variegated Cutworm

Cutworms prefer non-grass crops and can cause extensive damage to alfalfa during warm, wet seasons. When fully grown, cutworms are about 2 inches long and range in color from almost black to light greenish-yellow or tan. It has a distinctive row of light yellow diamond-shaped spots aligned down the middle of the back. The worms feed mainly at night and hide under clods or in soil debris during the day. Several species, in addition to the variegated, occasionally damage alfalfa.

Differential Grasshopper

The differential grasshopper is only one of several species which attack alfalfa. Grasshoppers become most numerous in uncultivated areas. Consequently, the heaviest infestations are usually found in field margins, fence rows, pastures, grass waterways, etc. Their population increases in seasons which are hot and dry. New seedings of alfalfa are favorite foods of grasshoppers.

Plant Bugs

There are several plant bugs found in alfalfa fields. Their feeding activity reduces both quality and quantity of the hay produced. They suck juices from the foliage and, if populations are sufficiently large, may cause wilting of plant tips.

Fall Armyworm

The fall armyworm occurs throughout the warmer regions of the world, attacking more than 60 species of plants. It shows a preference for plants of the grass family but also attacks broad leaf plants such as alfalfa and clovers. When abundant, the fall armyworm caterpillars eat all the food at hand, completely stripping foliage. After stripping one fields they crawl in great armies into adjoining fields.

They winter over in southern Florida and along the Gulf Coast. In the spring, swarms of adult moths are produced and fly northward, sometimes covering hundreds of miles before they alight to lay their eggs. About 1,000 eggs are laid by each female, usually on green plants, and covered with hairs from the moth's body. The larvae feed for about 2 weeks before pupating. Within another 2 weeks a new swarm of moths emerges and fly a long distance before laying eggs. In the South there may be 5 or more generations per year.

Generally, the first fall armyworms arrive in states north of Florida in June. In favorable seasons a number of parasitic enemies keep the population down to moderate numbers. However, when hordes of these worms move in to a crop, pesticide controls may be needed.

Root Knot Nematodes

There are at least four species of root knot nematodes that attack alfalfa. They feed on root tissue, causing small oval galls and excessive branching of the roots. Heavy infestations reduce the stand, diminish plant vigor, and allow disease organisms, such as bacterial wilt and fusarium wilt, to enter the

plants through the lesions they cause. Although root knot nematodes attack alfalfa over a wide area of the United States, they are particularly troublesome in Nevada, Utah, and California. The most practical method for combating root knot nematodes is to use resistant varieties (O'Bannon and Peaden).

Stem Nematodes

Stem nematodes derive their name from their tendency to feed on stems rather than roots. They infect the crown and young buds and stem bases of alfalfa and some clovers (Palm). Infected buds thicken and are deformed, and usually do not elongate into stems. As spring advances, they turn dark and rot off, appearing as a crown rot. Infections are associated with cool temperatures and high moisture, such as flood irrigation or flooded fields. Control consists of avoiding planting where flooding is likely to occur. Some alfalfa varieties show resistance to the stem nematode.

Common Leaf Spot

Common leaf spot is a fungal disease of alfalfa, and is most active in cool, moist weather. It attacks the lower leaves first and moves up to the higher leaves if weather remains favorable for fungus growth. The leaves die and fall to the ground and are the inoculum for future infections. The disease occurs wherever alfalfa is grown.

Small, circular, brown to black spots appear on the leaflets. As the spots become older, a small, raised disc, usually lighter in color, appears in the center of the spot. The infected leaves turn yellow and drop as the disease progresses.

Leptosphraerulina Leaf Spot or Pepper Spot

"Lepto" leaf spot attack true clover mainly, but alfalfa is also susceptible. It is characterized by small brown spots on leaflets, surrounded by a halo, which enlarge and acquire a tan center with an irregular brown border. The infected leaves die and cling to the stem for a time.

Only young leaves become infected and the greatest damage occurs on the young growth after clipping. In older growth, only the young upper leaves become infected and have typical symptoms, and these seldom die. Infections are associated with moist, weather conditions.

Stemphylium Leaf Spot

Stemphylium leaf spot, a fungal disease, attacks both alfalfa and the clovers. It appears as slightly sunken and dark brown areas with a lighter center. Young lesions are surrounded with a yellow halo. Older spots may be concentric ringed, resembling a target. In the western U.S., especially in California, the fungus produces elongated lesions, irregular in outline, with tan centers and brown borders. The disease is favored by cool, moist weather.

Spring Black Stem

Spring black stem causes dark brown to black spots with irregular borders on alfalfa leaves. The spots enlarge and merge until much of the leaflet is covered. The leaves turn yellow and drop. Stem lesions are dark green at first, later turning black. Stem lesions may enlarge and merge until most or all

of the lower portion of the stem becomes black. Young shoots are often girdled or killed. The disease occurs during cool, moist weather. Control consists of destroying infected crop residues by plowing or burning.

Summer Black Stem and Leaf Spot

Summer black stem occurs in association with spring black stem, but may be later. Large, usually circular, light gray to black spots appear on alfalfa leaves during the summer and early fall. Young spots on the leaves are often surrounded by a halo. Considerable leaf drop results from severe infections. Brown to black lesions appear on the stem. These lesions enlarge and often cover large portions of the stems. The disease, most prevalent in the central and southeastern United States, is favored by warm, moist weather.

Alfalfa Mosaic Virus

Alfalfa mosaic is a viral disease which may cause yellow streaks between the leaf veins or light green to yellow mottling of alfalfa leaflets. The mottling is often accompanied by malformation of the leaflets. The disease usually does not result in large direct losses in forage production, but plants may be weakened and become more susceptible to other infections (Palm).

Mosaic virus is transmitted by aphids and machinery. Control consists of preventing aphid infestations.

References

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APPENDIX TABLES

1--Acres Harvested, Acres Irrigated and Tons of Hay Produced, All Hay, by Farm Production Region and State, 1992

2--Acres Harvested, Acres Irrigated and Tons of Hay Produced, Alfalfa and Alfalfa Mixtures, by Farm Production Region and State, 1992

3---Acres Harvested, Acres Irrigated and Tons of Hay Produced, Small Grain Hay, by Farm Production Region and State, 1992

4---Acres Harvested, Acres Irrigated and Tons of Hay Produced, Other Tame Hay, by Farm Production Region and State, 1992

5---Acres Harvested, Acres Irrigated and Tons of Hay Produced, Wild Hay, by Farm Production Region and State, 1992