Blueberries: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

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EXECUTIVE SUMMARY

The U.S. farm value of cultivated blueberry production was about $94 million in 1993. This does not include the value of "wild" or lowbush blueberry production, which is a major industry in Maine. Cultivated blueberry production is centered in Michigan and New Jersey, but substantial industries have developed in recent years in Georgia, North Carolina, Oregon and Washington. Fledgling industries are developing in other states such as Mississippi, Alabama, Arkansas, and Florida.

Blueberries are perennials that fall into three categories: highbush (grown mainly in the Eastern and Northern states); rabbiteye (native to the South), and lowbush (grown primarily in Maine). Blueberries reach peak production 6 to 10 years after establishment and, although the bushes can live 50 years, a 20- to 30-year life is typical.

Regardless of blueberry type, extension and industry contacts indicated that frost damage in the spring is the major peril facing growers. In the northernmost states, cold damage is a concern. Bird depredation is a major peril in the Pacific Northwest and Florida. Interestingly, perils faced by growers east of the Mississippi River appear to be largely related to weather, while Northwestern growers are plagued more by pests and diseases.

Because blueberries are shallow-rooted plants, they need 1 to 2 inches of rainfall per week during the growing season. Although much of the crop is irrigated, the extent of irrigation varies widely among states. In Mississippi and Florida, nearly all of the crop is currently estimated as under irrigation. In contrast, less than one-third of the North Carolina crop is irrigated.

Many perils have at least partial means of control. The primary method of protection against late frost damage is sprinkler irrigation. As a result, progressive growers are increasingly investing in this technology. Some states have recommended spray programs for insects and diseases. Netting and noise-making devices are suggested for control of birds.

The demand for insurance appears strongest in southern states in which blueberry acreage has increased considerably in the late 1980's. Based on discussions with extension specialists, demand appears to be strongest in Mississippi, Arkansas, and Florida. Demand also appears to exist among smaller growers in New Jersey. However, the demand among North Carolina growers, who were quite interested in insurance in the late 1980's, appears to have dwindled.

To protect against adverse selection, a sales closing date of no later than January 1 seems necessary in the northern growing areas. In Florida the closing date should probably be December 1 because temperatures during December can affect the earliness of bloom in the spring. These dates should protect FCIC from growers signing up later in the winter and early spring when the likelihood of losses from frost and cold damage become more apparent.

Moral hazard may appear in several ways if blueberry coverage is offered. Faced by low prices, some growers may let their berries become overripe and deteriorate on the bush. Others may reduce input use in order to collect an indemnity, while still maintaining the primary production asset--the blueberry bush--for potential harvest the next year. Moral hazard would be a particular problem if the return from the policy were expected to be higher than the producer's expected market return.

Given the uncontrollable perils faced by growers a blueberry policy would likely be of benefit to the industry. Methods of curbing adverse selection and moral hazard, as discussed in the report, would help protect FCIC's exposure to loss.

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INTRODUCTION

Blueberries are grown over a wide area of the United States, but USDA reported only nine states with value of cultivated blueberry production of $1 million or more during 1992. The U.S. farm value of cultivated blueberry production was $94.2 million in 1993 (47). This value does not include "wild" or lowbush blueberry production, which is a major industry in Maine. Maine produced 84 million pounds of lowbush blueberries in 1992, which exceeded the combined total production of the three largest cultivated blueberry states (46).

Maine, Michigan, and New Jersey are the traditional blueberry States. However, substantial industries have developed in recent years in Georgia, North Carolina, Oregon and Washington. Fledgling industries are developing in other states, such as Mississippi, Alabama, Arkansas, and Florida, but the total value of production in these areas is relatively small.

Blueberries are perennials that fall into three categories: highbush (grown mainly in the Eastern and Northern states); rabbiteye (native to the South), and lowbush (grown primarily in Maine). Highbush and rabbiteye blueberries are identifiable as to variety, and are cultivated in rows. In contrast, wild blueberries are not identifiable as to variety and grow up naturally as a transition vegetation between open field and the forest. Wild blueberries, however, are cultivated in that plants are pruned and the fields may be fertilized and irrigated to promote production and managed to control weeds, diseases, and insect pests.

Regardless of type, blueberries are long-lived bushes. Peak production usually occurs 6 to 10 years after establishment and, although blueberry bushes can live 50 years, a 20- to 30-year life is typical.

This report examines considerations that are important for the development of a blueberry insurance policy. It first examines the supply, demand, and price situation for blueberries, and then discusses industry characteristics. Cultivation and management practices are addressed, as are natural perils, loss prevention methods, harvesting, and marketing. The final section examines insurance issues.

SUPPLY, DEMAND, AND PRICES

Blueberry production in the United States has risen in the last 20 years with the biggest increase being wild blueberry output in Maine (table 1). Although wide year-to-year variations occurred, output in Michigan, New Jersey, and North Carolina also has risen as well as in the Pacific Northwest. Historical data are not available for most Southern States.

Table 1--Blueberries: Commercial acreage, yield per acre, production, and season-average grower price, by State, 1973 to date

State and year	Acreage harvested	Yield per acre	Utilized production	Utilization		Grower price			Value of utilized production
				Fresh	Processed	Fresh	Processed	All	
	Acres	Pounds	1,000 pounds			Cents/pound			1,000 dollars
Alabama									
1992	250	800	200	162	38	88.1	75.4	86.0	172
1993	90	300	27					96.3	26
Arkansas									
1992	700	2,570	1,800	1,600	200	107.0	50.0	101.0	1,812
1993	700	2,860	2,400	2,000	100	98.5	55.7	96.4	1,928
Florida									
1992	1,200	1,750	2,100	1,250	850	245.0	81.0	179.0	3,752
1993	1,000	1,000	1,000	500	500	220.0	40.0	130.0	1,300
Georgia									
1992	3,500	3,430	12,000	3,000	9,000	108.0	65.0	75.8	9,090
1993	3,700	4,490	5,500	1,500	4,000	102.0	27.0	47.5	2,610
Indiana									
1992	750	3,330	2,500	1,000	1,500	77.0	65.0	69.8	1,745
1993	830	3,370	2,800	1,400	1,400	70.0	26.6	48.3	1,352
Maine 1/									
1973	N.A.	N.A.	22,096	N.A.	22,096	N.A.	26.9	26.9	5,944
1974	N.A.	N.A.	18,566	N.A.	18,566	N.A.	18.5	18.5	3,435
1975	N.A.	N.A.	11,910	N.A.	11,910	N.A.	26.5	26.5	3,156
1976	N.A.	N.A.	24,908	N.A.	24,908	N.A.	31.0	31.0	7,721
1977	N.A.	N.A.	14,369	N.A.	14,369	N.A.	60.6	60.6	8,708
1978	14,800	1,220	18,053	N.A.	18,053	N.A.	51.0	51.0	9,231
1979	14,800	1,190	17,575	N.A.	17,575	N.A.	36.0	36.0	6,336
1980	14,800	1,430	21,190	N.A.	21,190	N.A.	38.0	38.0	8,056
1981	17,300	1,260	21,747	N.A.	21,747	N.A.	42.3	42.0	9,156
1982	N.A.	N.A.	35,925	N.A.	35,925	N.A.	52.0	52.0	18,681
1983	N.A.	N.A.	44,653	N.A.	44,653	N.A.	37.0	37.0	16,539
1984	N.A.	N.A.	24,684	N.A.	24,684	N.A.	25.0	25.0	6,170
1985	N.A.	N.A.	43,730	N.A.	43,730	N.A.	23.0	23.0	10,058
1986	N.A.	N.A.	40,169	N.A.	39,669	N.A.	30.0	30.0	12,452
1987	23,600	1,540	36,300	N.A.	35,300	N.A.	45.0	45.0	16,335
1988	N.A.	N.A.	52,344	N.A.	51,800	N.A.	45.0	45.0	23,555
1989	N.A.	N.A.	26,800	N.A.	26,500	N.A.	50.0	50.0	13,400
1990	N.A.	N.A.	72,400	N.A.	72,000	N.A.	35.0	35.0	28,500
1991	29,000	1,355	39,300	300	39,000	N.A.	45.0	45.0	17,685
1992	N.A.	N.A.	84,200	300	83,900	N.A.	43.0	43.0	36,206
Michigan 2/									
1973	N.A.	N.A.	38,560	4,943	N.A.	N.A.	34.0	N.A.	N.A.
1974	N.A.	N.A.	33,100	12,043	N.A.	N.A.	28.0	N.A.	N.A.
1975	N.A.	N.A.	29,415	8,840	N.A.	N.A.	28.0	N.A.	N.A.
1976	9,700	N.A.	31,325	8,130	N.A.	N.A.	41.6	N.A.	N.A.
1977	N.A.	N.A.	11,800	4,699	N.A.	N.A.	70.0	N.A.	N.A.
1978	9,000	3,000	27,000	12,500	14,500	64.4	67.4	66.0	17,820
1979	9,500	3,790	36,000	10,800	25,200	55.4	40.4	44.9	16,164
1980	9,400	4,360	41,000	14,500	26,500	56.5	31.0	40.0	16,408
1981	9,800	5,310	52,000	14,000	38,000	67.9	44.9	51.1	26,568
1982	N.A.	N.A.	41,400	14,200	27,200	N.A.	68.0	N.A.	N.A.
1983	12,000	4,095	49,148	13,425	35,723	N.A.	53.0	N.A.	N.A.
1984	N.A.	N.A.	46,666	20,484	26,182	N.A.	36.0	N.A.	N.A.
1985	N.A.	N.A.	50,200	19,100	31,100	N.A.	42.0	N.A.	N.A.
1986	15,000	3,800	57,000	16,800	40,200	N.A.	51.0	N.A.	N.A.
1987	N.A.	N.A.	56,100	15,500	40,600	N.A.	53.0	N.A.	N.A.
1988	N.A.	N.A.	43,384	11,500	31,900	N.A.	85.0	N.A.	N.A.
1989	16,000	3,756	60,100	18,300	41,800	N.A.	52.0	N.A.	N.A.
1990	N.A.	N.A.	56,500	21,500	35,000	N.A.	43.0	N.A.	N.A.
1991	N.A.	N.A.	54,800	15,000	39,800	N.A.	64.0	N.A.	N.A.
1992	13,000	2,620	34,000	10,000	24,000	115.0	65.0	79.7	27,100
1993	15,500	5,610	87,000	19,000	68,000	75.0	30.0	39.8	34,650

See footnotes at end of table. --Continued

Table 1--Blueberries: Commercial acreage, yield per acre, production, and season-average grower price, by State, 1973 to date

State and year	Acreage harvested	Yield per acre	Utilized production	Utilization		Grower price			Value of utilized production
				Fresh	Processed	Fresh	Processed	All	
	Acres	Pounds	1,000 pounds			Cents/pound			1,000 dollars
New Jersey									
1973	7,300	3,410	24,893	13,013	11,880	44.1	32.7	40.1	9,994
1974	7,500	3,520	26,400	16,610	9,790	40.0	27.3	35.3	9,317
1975	7,700	2,970	22,869	16,214	6,655	44.5	23.6	38.4	8,786
1976	7,600	3,465	26,334	16,599	9,735	49.1	39.0	45.4	11,947
1977	7,700	2,970	22,869	10,879	11,990	63.6	54.5	58.8	13,454
1978	7,800	2,860	22,308	11,418	10,890	75.0	63.6	69.4	15,482
1979	7,800	3,000	23,397	17,402	6,000	64.0	44.5	59.0	13,806
1980	8,100	3,210	25,993	19,998	6,000	69.0	34.5	61.0	15,870
1981	7,800	3,590	28,000	20,700	7,300	71.3	47.0	65.0	18,201
1982	7,500	4,000	30,000	22,000	8,000	76.0	59.0	71.2	21,360
1983	7,800	2,949	23,000	18,000	5,000	82.0	70.0	79.4	18,260
1984	7,900	3,797	30,000	24,140	4,860	69.0	35.0	62.0	17,980
1985	7,700	5,195	40,000	31,000	9,000	80.0	42.0	75.6	25,688
1986	7,900	5,063	40,000	28,000	12,000	84.4	49.0	77.4	23,216
1987	7,500	3,733	28,000	22,000	6,000	90.0	52.0	81.9	22,920
1988	7,700	3,377	26,000	18,000	8,000	110.0	82.0	101.4	26,360
1989	7,800	5,128	40,000	23,000	17,000	93.2	50.0	74.8	29,936
1990	7,900	2,970	23,500	19,000	4,500	90.0	52.0	82.7	19,440
1991	8,200	3,780	31,000	21,500	9,500	84.0	65.0	78.2	24,235
1992	7,600	3,030	23,000	13,000	10,000	104.0	83.0	94.9	21,820
1993	8,100	4,140	33,500	25,000	8,500	87.0	55.0	78.9	26,425
New York									
1992	320	2,090	670	670	N.A.	88.0	N.A.	88.0	590
1993	320	2,090	670	670	N.A.	88.0	N.A.	88.0	590
North Carolina									
1973	N.A.	N.A.	7,348	5,126	2,222	38.6	28.0	N.A.	N.A.
1974	N.A.	N.A.	5,698	4,400	1,210	41.8	29.5	N.A.	N.A.
1975	N.A.	N.A.	7,513	5,984	1,529	45.9	24.5	N.A.	N.A.
1976	4,200	N.A.	1,496	1,287	209	67.3	38.0	N.A.	N.A.
1977	N.A.	N.A.	5,610	4,010	1,600	58.2	41.8	N.A.	N.A.
1978	3,400	2,310	7,850	3,825	4,025	71.4	46.8	58.8	4,616
1979	3,300	2,330	7,700	5,130	2,570	71.2	44.0	62.1	4,783
1980	3,000	1,990	5,970	5,520	450	66.9	41.6	81.8	4,885
1981	3,200	2,230	7,150	5,880	1,270	84.6	37.0	76.1	5,444
1982	3,100	1,532	4,750	3,610	1,140	98.6	44.0	85.5	4,061
1983	4,000	1,645	5,100	4,230	870	92.0	49.2	84.7	4,320
1984	3,200	2,940	9,410	8,460	950	95.0	30.0	88.4	8,320
1985	3,200	530	1,700	1,678	22	125.0	28.0	123.8	2,105
1986	4,000	1,760	5,460	4,860	600	103.0	32.0	95.2	5,198
1987	3,400	3,370	11,460	7,370	4,090	122.2	37.5	80.3	9,199
1988	3,600	3,860	14,000	9,300	4,700	111.0	44.0	88.8	12,347
1989	4,350	2,940	10,000	8,000	2,000	93.5	38.0	82.4	7,997
1990	2,900	2,100	6,100	5,700	400	115.0	25.0	109.0	6,655
1991	2,900	3,970	11,500	8,100	3,400	103.0	32.0	82.0	9,431
1992	2,800	3,790	10,600	7,600	3,000	107.0	47.1	90.0	9,545
1993	2,900	5,170	15,000	11,000	4,000	109.0	34.1	89.0	13,354

See footnotes at end of table. --Continued

Table 1--Blueberries: Commercial acreage, yield per acre, production, and season-average grower price, by State, 1973 to date

State and year	Acreage harvested	Yield per acre	Utilized production	Utilization		Grower price			Value of utilized production
				Fresh	Processed	Fresh	Processed	All	
	Acres	Pounds	1,000 pounds			Cents/pound			1,000 dollars
Oregon									
1973	N.A.	N.A.	1,063	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1974	N.A.	N.A.	1,300	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1975	N.A.	N.A.	1,200	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1976	275	N.A.	1,600	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1977	N.A.	N.A.	1,500	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1978	450	5,000	2,250	750	1,500	64.0	67.0	66.0	1,485
1979	500	5,800	2,900	1,000	1,900	66.5	46.6	53.5	1,550
1980	550	5,450	3,000	1,400	1,600	67.2	29.3	47.0	1,410
1981	580	6,030	3,500	1,900	1,600	72.0	49.9	61.9	2,166
1982	620	5,650	3,500	2,000	1,500	67.5	69.0	68.1	2,385
1983	700	7,500	5,250	2,450	2,800	74.0	62.0	67.6	3,549
1984	750	6,000	4,500	2,300	2,200	67.0	35.0	51.4	2,311
1985	800	6,500	5,200	2,900	2,300	57.5	52.5	55.3	2,876
1986	900	6,730	6,057	N.A.	N.A.	N.A.	N.A.	66.7	4,040
1987	1,200	7,690	9,228	N.A.	N.A.	N.A.	N.A.	60.1	5,550
1988	1,300	7,860	10,218	N.A.	N.A.	N.A.	N.A.	75.5	7,707
1989	1,370	8,190	11,220	N.A.	N.A.	N.A.	N.A.	68.7	7,708
1990	1,450	7,900	11,455	N.A.	N.A.	N.A.	N.A.	60.6	6,942
1991	1,550	8,070	12,516	N.A.	N.A.	N.A.	N.A.	64.8	8,115
1992	1,800	8,610	15,500	4,500	11,000	108.0	65.0	77.5	12,010
1993	1,900	8,420	16,000	6,000	10,000	80.5	35.5	52.4	8,380
Washington									
1973	800	6,480	5,180	1,450	3,730	36.8	34.1	34.9	1,808
1974	800	5,100	4,080	1,710	2,370	41.3	28.4	33.8	1,379
1975	800	5,640	4,512	1,440	3,072	41.8	28.8	32.9	1,484
1976	800	5,000	4,000	1,090	2,910	45.5	40.6	41.9	1,676
1977	800	5,120	4,096	642	3,454	56.3	60.3	59.7	2,445
1978	800	6,030	4,824	928	3,896	68.4	63.1	64.1	3,092
1979	800	5,990	4,792	1,373	3,419	67.3	49.8	54.8	2,627
1980	800	6,380	5,100	1,765	3,335	61.6	51.0	54.7	2,788
1981	800	5,750	4,600	2,036	2,564	69.4	53.4	60.5	2,782
1982	900	6,800	6,120	1,620	4,500	72.4	69.1	70.0	4,283
1983	900	8,000	7,200	2,250	4,950	73.1	60.5	64.4	4,637
1984	800	6,000	4,800	1,700	3,100	64.0	42.0	49.8	2,390
1985	800	6,875	5,500	2,100	3,400	79.7	52.6	62.9	3,462
1986	800	3,625	2,900	1,100	1,800	81.5	62.5	69.7	2,022
1987	900	7,000	6,000	2,400	3,900	81.5	60.4	68.4	4,312
1988	1,000	6,500	6,900	1,800	4,700	83.4	73.0	75.9	4,932
1989	900	7,000	6,300	2,100	4,200	82.0	62.0	68.7	4,326
1990	850	7,400	6,290	1,300	4,990	75.0	55.0	59.1	3,720
1991	900	5,500	4,950	1,250	3,700	92.0	60.0	68.1	3,370
1992	1,200	6,800	8,160	1,960	6,200	92.0	64.0	70.7	5,771
1993	1,200	5,600	6,720	2,020	4,700	78.0	39.0	50.7	3,409

N.A.= Not available.

1/ Maine produces wild blueberries, other States cultivated. 2/ Includes small amount from Indiana, prior to 1992.

Sources: Oregon Agricultural Statistics, USDA and Oregon Agricultural Statistics Service, Oregon Dept. of Agriculture; Washington Agricultural Statistics, USDA and Washington Agricultural Statistics Service, Washington Dept. of Agriculture; Statistical Record, various years, North American Blueberry Council; Noncitrus Summary, various years, National Agricultural Statistics Service, USDA.

The rise in output is due partly to more area in blueberries. Harvested acreage in the 1990's is higher than in the 1970's, especially in Michigan, Oregon, and Washington.

Rising yields also account for part of the increase in output. USDA data on yields per acre indicate that average yields in Oregon have increased by nearly 50 percent in the 10 years between the 1978-80 average and the 1988-90 average. Yields in the major producing areas of Michigan and New Jersey have remained more stable. USDA has been collecting data on yields in the newer producing areas of the South for only 2 years. USDA does not collect data for several of the southern States, including Mississippi.

Yield variability accounts for most of the year-to-year variability in production. In New Jersey, for example, the state average yield ranged from less than 3,000 pounds an acre in 1990 to more than 5,000 during the mid-1980's. And, in North Carolina, the state average yield ranged from 530 pounds an acre in 1985 to 5,170 in 1993. Yield variability on individual farms would be substantially larger than the state averages.

While much of the growth in acreage in the late 1970's and early 1980's was in the traditional growing areas, in recent years, planted acreage has increased substantially in the South and the Pacific Northwest. In the deep South, blueberries ripen earlier than in other states, providing growers with a marketing opportunity early in the season when prices are at high levels. In the Pacific Northwest, some growers have found that blueberries offer the potential for higher returns than do other berry crops (31).

In the future, blueberry acreages are expected to continue expanding. Industry estimates project that North American (Canada and the United States) blueberry acreage may grow by another 10,500 acres, or by about 20 percent, by the end of the decade (31).

Blueberries are marketed through domestic and export channels. In 1992, about 30 percent of the total U.S. crop was exported, with the remaining 70 percent used domestically (26). About 20 percent of domestic use is for the fresh market.

Fresh berries are sold, typically in 1-pint containers, from road-side stands or in supermarkets. U-pick markets also exist in many states, being more important in states with smaller acreages.

Berries used for processing represent about 80 percent of domestic use. Processed uses include fruit fillings, bakery products, muffin mixes and canned uses, consumer frozen retail, baby food, yogurt bases, preserves, and juice drinks. The most important of these categories in terms of volume is the bakery category.

Fresh blueberry prices generally are at their peak at the beginning of the season (April through mid-May) when Florida is the only shipper (table 2). Prices usually drop sharply sometime during the second half of May when berries from North Carolina come on the market, and trend downward through

Table 2--Blueberry Prices: Fob, selected shipping-points, $/12 1-pint trays

	FL	NC	NJ	MI	AVG		FL	NC	NJ	MI	AVG
1987					1987	1990					1990
JAN						JAN					
FEB						FEB					
MAR						MAR					
APR						APR					
MAY						MAY	15.17	16.00			15.59
JUN	10.50	10.50		10.50		JUN	14.50	16.50	16.50		15.83
JUL		10.14	10.42	10.28		JUL			10.69	11.20	10.95
AUG			10.81	10.81		AUG				10.63	10.63
SEP						SEP				13.38	13.38
OCT						OCT					
NOV						NOV					
DEC						DEC					
1988					1988	1991					1991
JAN						JAN					
FEB						FEB					
MAR						MAR					
APR						APR					
MAY						MAY	18.25	15.30			16.78
JUN	13.01	14.00		13.51		JUN		12.00	12.84	12.45	12.43
JUL		13.00	13.06	13.03		JUL			9.94	10.50	10.22
AUG			14.05	14.05		AUG				14.53	14.53
SEP						SEP					
OCT						OCT					
NOV						NOV					
DEC						DEC					
1989					1989	1992					1992
JAN						JAN					
FEB						FEB					
MAR						MAR					
APR						APR	34.90				34.90
MAY						MAY	20.40	21.58			20.99
JUN	12.94	13.78		13.36		JUN	13.18	13.10	14.10		13.46
JUL	13.50	11.60	11.91	12.34		JUL			12.85	14.09	13.47
AUG		9.75	10.87	10.31		AUG			11.63	14.00	12.82
SEP			13.00	13.00		SEP				19.43	19.43
OCT						OCT					
NOV						NOV					
DEC						DEC					

Source: 45.

June and July, reaching a low point during August when Michigan reaches full-volume production.

Fresh market prices are determined primarily by the volume of berries available in the market. In contrast, processing prices depend on carryover stocks, as well as current supplies of berries for processing. Blueberries for fresh-market use usually sell for a premium over berries for processing. Growers have higher costs for harvesting and packing fresh market berries than those used for processing.

INDUSTRY CHARACTERISTICS

Several industry characteristics may affect the potential demand for crop insurance. Among these are: 1) the degree of specialization among enterprises on the farm, 2) the amount of income diversification among farm income and off-farm employment, and 3) the extent of the use of irrigation as a protection against drought and early spring frosts. The primary data source providing information on industry characteristics is the 1987 Census of Agriculture (see Appendices 1-4 for more detail).

The Census reported 3,911 farms with sales of cultivated blueberries in 1987. Most of those farms received relatively little income from blueberries, with about 75 percent reporting a total value of blueberry sales of less than $25,000 (43). In addition, 501 growers reported sales of wild blueberries, mostly in Maine.

Interviews with blueberry specialists in several states indicate that the largest producers tended to specialize in blueberries and are often located in Maine, New Jersey, and the Pacific Northwest (49, 30, 39). Quite a number of farms with blueberry sales in 1987 also had sales of other crops, especially fruit and vegetable crops. Several very large operations are vertically integrated and provide packing, grading, and processing services for smaller growers in the area. However, these operations appear to represent a relatively small portion of the growers in the industry as a whole.

Census data suggest that small blueberry producers often have off-farm sources of income. Farming was the occupation of the operator on 50 percent of all blueberry farms in 1987, but 59 percent of the reporting farms indicated that the operator worked off-farm during part of the year (43). In Michigan, for example, 386 of the 711 blueberry growers reported working off the farm at least 1 day.

Census data indicated quite a bit of irrigated blueberries in the major blueberry states in 1987. Interviews with University blueberry specialists in Mississippi, New Jersey, Florida, North Carolina, and Maine indicated that the larger commercial growers are moving even more to irrigation to boost yields and as a strategy to reduce the risk of crop loss due to early spring freezes (5, 30, 19, 21, 49). As a result, the 1992 Census of Agriculture is likely to show even a larger percent of irrigated blueberry acreage than in 1987.

In terms of ownership structure, individual or family ownership was the most frequent type of organizational arrangement among all blueberry farms in 1987, particularly among farms with sales of less than $100,000 (43). Partnership arrangements or a corporate arrangement (either family held or other) were more typical among the larger farms than among the smaller ones. Thirty-two of the farms growing blueberries and with sales of $500,000 or more in 1987 reported a corporate-type organizational structure.

CULTIVATION AND MANAGEMENT PRACTICES

Recommended cultivation and management practices provide information on the conditions and procedures necessary to maintain high yields. Care requirements also provide an indicator of the potential for moral hazard. Because the different types of blueberries require different climates and growing conditions, this section is organized by blueberry type--highbush, rabbiteye, and lowbush. Blueberry cultivars, by type, and cultivars grown in individual states are presented in tables 3 and 4.

Highbush Blueberries

"Highbush" blueberry is a term applied to several species naturally occurring in the eastern coast of North America from Nova Scotia and southern Quebec west to Wisconsin and south to extreme northern Florida and southeastern Alabama. Highbush blueberries range in height from 5 to 23 feet (9). Highbush blueberry cultivation is concentrated in southeastern North Carolina, New Jersey, and southwestern Michigan. Lesser acreages are located in Washington, Oregon, Massachusetts, New York, and Indiana. In recent years, southern highbush varieties (cultivars) have been developed that grow as far south as central Florida.

Temperature is a primary factor determining highbush-growing areas. Most varieties have winter chilling requirements in which plants need at least 900 to 1,000 hours below 45^{o}F. Southern highbush varieties in Florida and along the Gulf coast, however, may have chilling requirements as low as 200 to 300 hours below 45^{o}F. Minimum winter temperatures determine the northern limit of the highbush range. Temperatures below -15^{o}F to -20^{o}F damage flowerbuds and reduce yields (9, p.289). As a result, the northern boundary of the highbush production is Southern Maine and central Michigan.

Highbush plants grow best and bear the best-quality fruit when planted in full sunlight. They require a growing season of at least 160 days. Preferable soils are well-drained, sandy loams with a pH of 4.5-5.2, and at least 3 percent organic matter (8, p.286). Heavy clay soils should be avoided (8, p.135). If soils are not well-drained, canals, ditches, or tiling may be required. Since blueberries are shallow-rooted and require adequate soil aeration, poorly-drained soils may be mounded to provide raised rows.

Growers usually plant 2- or 3-year old nursery stock. Spring planting is advised to reduce losses to young plants due to heaving during the winter. The traditional row spacing, when machine harvesting was not as common, was

Table 3--Blueberry cultivars and percent of area in North America, 1992

Cultivar	% of Total	Cultivar	% of Total
HIGHBUSH	80.5%	RABBITEYE	18.0%
Bluecrop	32.9%	Tifblue	8.4%
Jersey	16.2%	Climax	4.3%
Weymouth	5.3%	Brightwell	1.5%
Croatan	5.1%	Premier	1.0%
Blueray	3.9%	Woodward	0.8%
Elliott	3.8%	Delite	0.5%
Rubel	2.9%	Powderblue	0.5%
Berkely	2.2%	Aliceblue	0.5%
Bluetta	1.8%	Beckyblue	0.5%
Patriot	1.1%	Homeblue	0.0%
Earliblue	1.0%		
Duke	0.9%	SOUTHERN HIGHBUSH	1.5%
Northland	0.7%	Sharpblue	1.1%
Collins	0.6%	O'Neal	0.3%
Murphy	0.5%		
Coville	0.5%		
New Murphy	0.4%		
1613A	0.3%		
Bluejay	0.2%		
Northblue	0.1%		
Spartan	0.0%		
Northcountry	0.0%		
Darrow	0.0%		
Northsky	0.0%		
St. Cloud	0.0%		

Source: 22.

4.5 to 9 feet. In recent years, the trend toward machine harvesting has resulted in rows that are commonly spaced at 10-foot intervals. Within the row, plants are generally spaced 4 feet apart (9, p. 290).

A complete chemical fertilizer is applied annually to highbush blueberries. Irrigation is generally recommended, as it helps guarantee the necessary water requirement of 1-2 inches per week. It also helps prevent problems resulting from fertilizer concentration.

Where irrigation is not used, mulching is typically necessary. Mulch conserves soil moisture, helps prevent weeds, maintains greater uniformity in soil moisture, and prevents heaving (8, p.138). An ideal mulch is one that decomposes slowly, such as sawdust. Pine needles can also be used. Mulches are typically used at a thickness of 4 to 6 inches. Herbicides are also an important method of weed control.

Table 4--Cultivated Blueberry Varieties by State

State	Variety (% of planted acres)	
Michigan	Jersey (40%)	Bluecrop (30%)
New Jersey	Bluecrop (50%)	Weymouth (30%)
Georgia	Tifblue (44%)	Climax (24%)
North Carolina	Croatan (60%)	Murphy (6%)
Florida	Sharpblue (25%)	Climax (20%)
Oregon	Bluecrop (30%)	Berkeley (25%)
New Hampshire	Bluecrop (20%)	Blueray (20%)
Texas	Tifblue (50%)	Climax (25%)
Arkansas	Bluecrop (70%)	Collins (12%)
New York	Bluecrop (40%)	Blueray (20%)
Washington	Bluecrop (25%)	Jersey (15%)
Mississippi	Tifblue (40%)	Premier (20%)
Massachusetts	Bluecrop (33%)	Berkeley (25%)
Indiana	Jersey (37%)	Bluecrop (23%)
Pennsylvania	Bluecrop	Patriot
Alabama	Tifblue (60%)	Climax (20%)
Louisiana	Tifblue (60%)	Climax (25%)

Source: 22.

Although highbush plants are self-pollinating, larger fruit and better fruit set are obtained with cross-pollination. As a result, rows of one cultivar are often alternated with rows of another cultivar that blooms at about the same time. The use of multiple cultivars also helps protect from frost damage (due to slightly varied bloom times), and helps spread out harvest. Growers often rely on bees to aid pollination. When wild bees are insufficient in number, growers introduce hives, generally at the rate of 1-2 per acre.

Mature highbush plants must be pruned each year to obtain the best-quality fruit, promote new shoot development, and enhance plant vigor. Generally, canes that are more than 4 years old are removed, and weak shoots on the younger canes are cut back to a strong lateral. Pruning is normally performed in the dormant months.

During the first 2 growing seasons in the field, pruning involves removing all flower buds to promote vegetative growth. A small crop is usually harvested during the third growing season (9, p.290). Plants generally reach maturity and achieve their maximum bearing potential between the seventh and tenth growing season.

Hybridization programs are underway to develop improved highbush cultivars. Major objectives of this work include greater winter hardiness, greater drought and disease resistance, and adaptation to mechanical harvesting (8). Objectives in the Southern states include the development of

cultivars that ripen earlier and that have greater resistance to bud mites and fungus diseases (8).

"Southern highbush" cultivars have been developed in recent years by hybridization of highbush cultivars and rabbiteye species native to the South. These cultivars have a lower chilling requirement than the northern highbush, and include 'Flordablue,' 'Sharpblue,' 'Avonblue,' and other varieties (9, p. 283). They have flavors and textures superior to those of the parent species. Although they bloom at about the time as rabbiteye cultivars, they ripen earlier, providing berries in late April and early May, before berries are available from other established production areas (8, p. 32).

Rabbiteye Blueberries

Rabbiteye blueberry cultivars can reach heights of 33 feet, but are pruned to manageable heights in commercial plantings. Rabbiteyes are distinguished by their tolerance of a wide range of soil pH levels and temperatures, their inherent drought resistance, and their short chilling requirement (9, p.274). Native to Georgia and northern Florida, the rabbiteye blueberry grows vigorously during hot summers and produces crops as far north as central Alabama, Mississippi, and coastal North Carolina.

Rabbiteye blueberry cultivars require only one-third to one-half as many chilling hours as highbush blueberry cultivars. In the Southeastern U.S., the number of required chilling hours below 45°F may be as low as 250 (9, p.319). Additional chilling beyond the required hours tends to raise the amount and rate of floral bud break and promote early bloom.

Rabbiteye blueberries grow well on various soils, but prefer light, well-drained soils with a pH between 4.2 and 5.5. They have a fibrous root system that penetrates more deeply than does the highbush root system, although it is still relatively shallow. Soil drainage is important, and the use of drainage ditches or raised beds may be necessary in poorly drained areas. Since most soils used for blueberries in the South are low in organic matter, peat moss is frequently added to improve soil structure and increase water holding capacity.

Rabbiteye blueberries can be planted at any time during the dormant season. Within the row, plants are usually spaced 5 to 8 feet apart, and from 12 to 14 feet apart between rows (9, p.321). Although rabbiteye plants are generally more drought tolerant than highbush cultivars, many areas in the South do not have a rainfall distribution that maximizes yields. Irrigation is recommended, and is often installed at planting time.

The rabbiteye has a similar fruiting habit to highbush blueberries, which produce fruit from buds on one-year-old wood. Buds are initiated during the late summer months, and bud development proceeds throughout the fall and winter. Due to the vigor of rabbiteye blueberries, plants pruned immediately after harvest (generally in mid-July) can produce new wood and initiate flower buds during the summer, thus producing fruit the following year (9, p.322)

In general, rabbiteye blueberries have some degree of self-incompatibility in pollination. As a result, it is recommended that growers plant two or more cultivars to aid in pollination. Cross-pollination results in an increase in berry size and seed content, and earlier ripening dates. Many growers alternate cultivars every two rows.

Since rabbiteye plants can produce a large crop and a large number of new shoots at the same time, little annual pruning is required. Pruning is used mainly to keep bushes from becoming too dense and tall.

The little information that exists on fertilization suggests that rabbiteye cultivars respond less than do highbush cultivars. For instance, studies from Georgia indicated that two rabbiteye cultivars did not respond to fertilization over a six-year period. Another study provided similar results, indicating that the cultivar 'Tifblue' did not respond to fertilizer during five years of growth. Higher fertilizer levels increased the amount of unmarketable fruit and pruned wood, and the time required for grading (9, p.321).

Desirable rabbiteye characteristics include their high yields, large fruit, early-bearing nature, and adaptation to machine harvesting. However, research indicates that the performance of a given cultivar can vary widely from one state or area to the next.

Lowbush Blueberries

Lowbush blueberries fill an ecological niche between the field and forest which is artificially maintained by periodic burning or mowing to control weeds and competing vegetation. Most lowbush blueberries are managed under a 2-year cycle. To maximize production, fields are pruned (burned or mowed) every two years. Pruning kills stems to about one-half inch above the soil, and can be done either in the fall or spring. If burning is used, either oil, propane, or straw is used as a fuel. Pruning is not done on stands of plants where growth has started (9, p.305).

The first year after pruning, shoots arise from the rhizomes or from lower portions of the plant that survived the pruning. Shoot growth begins in mid-May in southern Maine and continues until a black tip forms at the end of the shoot in early June (for year-old shoots) and early July (for new burn). This black tip signals a change from vegetative growth to one of flower bud formation. Flower buds continue to develop through late summer and early fall, provided that temperatures remain above 46°F.

Flowers and berries appear the second year after pruning. Flowering is generally in advance of vegetative growth or at about the same time. In southern Maine, flowering occurs in mid- to late May, while in Washington County, Maine, it is usually 1 to 10 days later.

Historically, fire was used as the main pruning method. However, repeated burning caused destruction of the organic pad and exposure of rhizomes. Mowing was found to produce equivalent yields without damaging the organic pad, and is less costly than using oil or straw. As a result, growers

have widely adopted the mowing method (49). Budgets indicate that burning can account for 75 percent of annual lowbush costs of production.

Pruning by burning does, however, provide some advantages. It removes competing growth of other species, and reduces the incidence of certain insects and diseases that occur in the leaf litter. Favorable weather can lead to outbreaks of such pests in mowed fields, necessitating periodic burning for control (49).

Lowbush plants are pollinated by insects, with pollination supplemented at times by bee hives brought in by growers. Since lowbush blueberries are highly self-sterile, it is necessary for the pollen of one cultivar to be pollinated by another genotype. This is not a management problem, however, because harvesting to date has been from native stands consisting of numerous species. Between four to six days of warm temperatures are required for fertilization to occur, and 70 to 90 days for berry development. Harvesting is usually during August and ends with the first frost in the fall.

Although irrigation has been found to increase yields, it is used by relatively few growers during the bearing year. Irrigation in the nonbearing years results in greater bud formation, which could lead to increased yields in the bearing year. The feasibility of irrigating non-bearing fields is being evaluated currently (49).

Lowbush plants do not consistently respond to fertilization. Generally, yield increases due to fertilization are reported in fields where weed control was not practiced. By removing weed competition for nutrients, many fields appear to be receiving adequate levels of nutrients by mineralization of soil organic matter. Leaf tissue analysis is recommended as a guide to the need for fertilization, rather than the historical practice of fertilizing every burn cycle (49).

NATURAL PERILS AND LOSS PREVENTION METHODS

This section provides information on the natural perils that are most likely to result in indemnities if a blueberry policy is offered. Because the perils affecting yields vary by type of blueberry, the discussion is divided into three parts--highbush, rabbiteye, and lowbush. The major perils by state are summarized in table 5.

Highbush Blueberries

In states east of the Mississippi River, weather factors are ranked as the most important perils affecting highbush blueberry yields. In contrast, blueberry specialists in the Pacific Northwest noted that pests and diseases were relatively more serious threats to blueberry production than weather-related perils.

Table 5--Major Natural Perils Faced by Highbush Growers

State	Ranking of Perils
Michigan	#1--Frost damage; #2--Cold damage; #3--Drought
New Jersey	#1--Frost damage; #2--Drought; #3--Cold damage; #4--Diseases
North Carolina	#1--Frost damage; #2--Drought; #3--Excess moisture at harvest; #4--Disease; #5--Insects
Oregon	#1--Birds; #2--Diseases; #3--Rain at pollination; #4--Frost damage

Sources: 41, 30, 21, 38.

Frost Damage--According to blueberry specialists, spring frost damage is the most important peril faced by highbush growers in Michigan, New Jersey, and North Carolina. For instance, a June frost in Michigan in 1992 severely affected that state's crop for the year (41). Other states report similar experiences.

The yield loss caused by spring frost depends on the stage of bud or flower development and the severity of the freeze. Research indicates that fully open highbush buds can be killed at 30°F. Buds that are less than fully open tolerate somewhat lower temperatures. However, below 24°F, severe damage can occur to closed highbush buds that are nearly open (9, p.285).

Frost that does not completely kill the flower or fruit often results in reduced quality. Damage to a flower part, such as the pistil or stamen, may result in a reduction in fruit set or the size of the berries. Frost damage may also reduce quality through scarring, as cold temperatures can cause a brown ring around the calyx of the berry that subsequently becomes the site of splitting given wet weather near harvest.

Early-blooming cultivars are the most prone to frost damage (8, p.50). This is because they have the greatest number of flowers at an advanced stage when frosts are more likely (8, p. 50). Research on highbush cultivars has found that the flower buds of 'Concord' and 'Rubel' suffered the least frost damage. In contrast, Southern highbush cultivars, which bear early in the

season, offer a greater potential for early frost damage than regular highbush cultivars. In North Carolina and Mississippi, less than 5 percent of the acres are planted to Southern highbush, although acreage is expected to expand (21, 5). Southern highbush cultivars appear relatively important in Florida.

Overhead sprinklers are the most effective method of frost protection, but are somewhat expensive to install and require a large volume of water. Overhead sprinkler protection is derived from the continuous application and freezing of water, which produces heat. If no wind is present, protection is provided to 23°F to 25°F.

Air mixing, which is achieved by creating heat and/or wind currents, also provides frost protection. This technique is effective only if a warmer layer exists 50-200 feet above the ground, and may be accomplished through the use of helicopters or by building fires throughout the planting. Although fires generate heat, the primary effect is through the mixing caused by heat-generated air currents (6).

In contrast to the eastern and southern states, highbush growers in the Pacific Northwest appear to have less of a problem with frost damage. Reports from that area indicate no significant frost damage or cold damage (see section on cold damage) in the past ten years (38, 7).

Cold Damage--Although highbush cultivars tolerate severe temperatures, winter injury is not uncommon in northern states such as Michigan and New Jersey. Cold damage does not appear to be an issue in North Carolina or other parts of the South, nor is it a problem in the Pacific Northwest.

Cold damage occurs when low winter temperatures kill dormant flower buds, reducing yield potential the following season. The highbush plant undergoes a lengthy hardening period, and begins dehardening when cold temperatures are still common. Highbush cultivars in New England were found to harden most quickly between September and October, and to reach maximum hardiness in late January (8, p.45). Dehardening began soon after late January. An industry source indicated that approximately the same dates were critical in Michigan.

As a general rule, highbush buds obtain their maximum cold hardiness during January, when they can tolerate temperatures as low as -15°F. Buds than have not fully hardened, or those that have begun to deharden during the post-rest period, may be damaged by less severe temperatures (9, p.285). Because of the hardening pattern, low temperatures in December and February may be more injurious than low temperatures in January. A Michigan industry source indicated that fluctuating temperatures, even in March and April, were a significant peril (41).

Research indicates that cold tolerance depends on cultivar, and that 'Northland,' 'Jersey,' 'Herbert,' and 'Bluecrop' are the most cold-hardy highbush cultivars (8, p. 49). The position of the bud on the twig is also important (8, p.49). Basal flowers are hardier than terminal flowers. As a result, cultivars with many flower buds per branch, such as 'Jersey,' provide growers with more protection against a complete crop loss.

Stem tissue is more cold tolerant than bud tissue, although the degree of hardening is again important (8, p.285). Hardened wood in January can withstand temperatures of -20°F. Prolonged periods below this temperature can result in root destruction, particularly in the absence of snow cover. If severely cold temperatures occur over several years, highbush canes can "acclimate," and become tolerant of successively lower temperatures. Generally, however, most highbush cultivars are not hardy north of southern Maine and central Michigan (9, p.285).

Drought--Blueberries are susceptible to drought because they are shallow-rooted plants. Highbush plants generally require a minimum of 1 inch of water every week during most of the growing season (37, 20, 6). This requirement increases to 1.5 inches per week during berry development, from fruit set to harvest (8). Newly-established plants have the most critical water needs.

Since many blueberries are grown on sandy soils, moisture must be carefully distributed to meet minimum weekly requirements (8, p.147). Extension literature in nearly all states strongly recommends irrigating commercial blueberry acres. Irrigation not only results in higher yields and larger berries, but also lowers susceptibility to diseases and insects, lowers the risk of fertilizer damage, and results in greater bud formation the following year.

Because irrigation is commonplace in many states, drought was mentioned as a peril only in Michigan, North Carolina, and parts of New Jersey, and generally was not a #1-ranked peril. The importance of irrigation in a particular area depends on soil type, the likelihood of rainfall spread out over the season, and other factors.

The Census of Agriculture provides information on the relative importance of irrigation to various states in 1987. Although the use of irrigation has likely increased since that time, it provides a rough indicator. According to the Census, about 50 percent of cultivated blueberry farms (46 percent of harvested acres) were irrigated in 1987, up from 33 percent of farms (35 percent of harvested acres) in 1982 (Appendix table 1).

Excess Moisture and Flooding--For highbush plants, neither of these perils were ranked highly by extension and industry contacts. One mention was by a Michigan source, who noted that flooding last summer caused reduced yields (41). Further, excess moisture, as noted by a North Carolina source, can keep growers out of the field and cause the berries to over-ripen (21).

Although contacts provided little information on this peril, research indicates that highbush plants may be more flood-sensitive than rabbiteye plants (8, p.58). Highbush plants can withstand extended periods of flooding during the dormant stage, but not during the growing season. Greenhouse studies have found that physiological processes decreased significantly in highbush plants after 4 days of flooding. The plants required at least 18 days to recover to their pre-flooding characteristics (8, p. 58).

Pollination seasons characterized by cold, rainy weather were also ranked as a peril to blueberry production. This peril results in the potential for partial crop loss, but does not usually cause a total crop failure.

Hail--Hail is a minor peril to most growers, although those who are affected can have their crops devastated. Extension specialists indicate that hail generally affects less than 5 percent of the blueberry crop in most states. This situation also was noted in rabbiteye and lowbush areas.

Diseases--Highbush blueberries can be affected by several fungal diseases, stem cankers, and viruses. Diseases rank relatively high as perils in the Pacific Northwest, but are somewhat less important in the eastern United States.

A particular problem in the Pacific Northwest, as well as other areas, is botrytis blight, a fungal disease of blossoms and twigs during prolonged rainy springs (39). Blossoms are the most susceptible tissue, and turn brown after a few days of high relative humidity when the disease is present. This disease is becoming increasingly resistant to chemicals in the Northwest.

Another serious fungal diseases is "mummy berry disease," which is characterized by dried-out (mummified) fruit at harvest. All commercial highbush cultivars are susceptible to the fruit-infection phase of this disease. Pepin and Toms estimated an average fruit loss of 8-10 percent due to mummy berry disease in a normal year; Pepin and Ormrod found it could be over 50 percent in areas where air circulation is poor and no control measures are in place (8, p.181). It is a particular problem in the Pacific Northwest.

Most highbush cultivars are susceptible to Phytophthora root rot, a fungal disease which is often associated with wet soil and poor drainage (8, p.191). It can cause spring growth to wilt and die back as a result of extensive root damage (8, p.191). This disease was first identified in New Jersey in the early 1960's. In the mid-1960's, a survey of 40 blueberry plantings in North Carolina indicated that 40 percent were infected with Phytophthora. It can also be a serious problem in Arkansas, the Pacific Northwest, and other areas (8, p.191).

Stem canker is a serious fungal disease that weakens and kills canes over several growing seasons. It is the major limiting factor to highbush blueberry production in North Carolina, and is a problem in the Pacific Northwest. The only practical means of control is the use of canker-resistant cultivars that have been developed for the region. A variety of other stem diseases exist, including Phomopsis canker, a serious disease of blueberries in southern Michigan and northern Indiana (8, p.189).

The principal viruses affecting highbush blueberries are blueberry stunt disease, red ringspot, mosaic, and shoestring. Generally, control is through destruction of virus-infected plants (9, p.294).

Fruit rots, which include anthracnose and gray mold rot, are common post-harvest diseases. Anthracnose decay results in an unsightly orange mold

on the berry, and has become an important economic disease, particularly in New Jersey, Michigan, and the Pacific Northwest. Symptoms may not be seen until after harvest. Gray mold rot produces a soft, watery decay followed by the development of grayish-white mycelium on the berry surface. Recent increases in the presence of fruit rots can be traced to the rise in "wet scar" damage caused by a shift from hand harvesting to mechanical harvesting in many areas (8, p.193.).

Insects--Insects affecting blueberry plants can be differentiated by the part of the plant that they attack. The major predator of highbush buds and blossoms in the East is the blueberry bud mite, which can be a problem in North Carolina due to its mild climate (9, p.293). Heavy infestations can kill buds and reduce yields. Insects can also be a problem in the Northwest (39). However, specialists did not generally rank insects as a serious peril.

The major fruit-destroying insect to plague highbush blueberries in the eastern U.S. is the blueberry maggot or mite. Presence of the larva often remains undetected until the blueberries are marketed, by which time maggoty berries become mushy (8). Other berry-eating insects include the plum circulio, which bores into the center of the fruit, leaving a prematurely-ripened berry that drops to the ground.

Of the foliage-eating insects that attack the highbush blueberry, the most serious is the sharpnosed leafhopper. Control measures are occasionally needed in New Jersey (9, p.293). Although this insect does little visible injury, it transmits a pathogen that causes stunt disease. Leafminers, leaf tiers, and leaf rollers have little economic impact on yields.

Insects can also attack stems, crowns, and roots of the blueberry plant. Scale insects feed on the plant's sap, and can result in reduced yields and shorten the life of the bush (8). It requires occasional control, particularly in New Jersey and the Pacific Northwest.

In the Pacific Northwest, aphids can be a particular problem. They weaken and stunt new shoot growth by removing plant sap (39). Chemical use is recommended early in the year, before populations have stunted the plants.

Birds and Mammals--Bird damage to highbush plants depends largely on the abundance of birds, the location of blueberry plants near vegetation attractive to birds, and a lack of alternative food. Isolated plantings near woodland are the most susceptible. Blueberry specialists in Florida and the Pacific Northwest noted that birds were a serious problem. They estimated that 10 percent of the crop is destroyed by birds each year in the Northwest and that individual growers can experience losses up to 60 percent or more due to bird depredation (38).

Overhead netting is the most effective method of protection. Some growers install 8-9 foot posts and overhead wires to support the netting (37). Netting is generally installed before the berries begin to ripen and is removed after harvest. In some cases, high-density plantings are being investigated to not only increase yields, but to also aid in efficient use of netting.

Visual and auditory devices are also used as protection from birds, but are less reliable than netting. Birds soon lose their fear of visual devices such as balloons and streamers. Noisemaking repellents (those that produce exploding noises or that give off bird distress calls) are somewhat more effective, but less so than netting (37). Noisemaking repellents in combination with personnel on a motorized vehicle in the field chasing birds at all times during daylight hours has proved effective in reducing losses in Florida.

Deer may find blueberry buds, fruit, and young shoots attractive. In areas of New Jersey, plantings must be fenced because of the large deer population (8, p.169). Mammal problems are also common in the Pacific Northwest where rabbits, gophers, and field mice can cause problems by eating the buds and young shoots (39). Chemical repellents are commonly used for protection.

Rabbiteye Blueberries

The major peril facing rabbiteye blueberry growers is late frost damage to the flowers and buds of the plant. Cold damage is not a problem, except in the northernmost rabbiteye-growing areas. Other potential perils vary in their incidence by area, although insect and disease problems overall appear less important (table 6).

Table 6--Major Natural Perils Faced by Rabbiteye Growers

State	Ranking of Perils
Mississippi	#1--Frost damage; #2--Excess moisture at harvest
North Carolina	#1--Frost damage; #2--Excess moisture at harvest; #3--Drought; #4--Diseases; #5--Insects
Florida	#1--Frost damage; #2--Birds; #3--Drought; #4--Hail; #5--High winds
Alabama	#1--Frost damage

Sources: 5, 21, 19, 12.

Frost Damage--Rabbiteye cultivars vary in their susceptibility to frost damage. However, frost damage was considered by extension specialists in all rabbiteye states surveyed to be by far the major peril affecting blueberry growers.

Early-blooming cultivars are the most prone to frost injury since they have the greatest number of flowers at an advanced stage when frosts are most likely. In the Mississippi freeze of 1980, 'Climax' and 'Briteblue' were the least injured because they were least advanced in development, while 'Woodard' and 'Delite' were severely damaged. The fully opened flowers of 'Southland' were much more tolerant of frost than a variety of other rabbiteye cultivars (8, p.50).

Cold Damage--Rabbiteye cultivars in the northernmost growing areas are more susceptible to cold damage than are highbush cultivars. In Arkansas, a study in the early 1970's indicated that a -27°C temperature severely decreased rabbiteye yields, but had no effect on highbush blueberry yields. Similar findings were reported in Maryland (8).

In controlled damage studies, severe damage was common in rabbiteye plants that had broken dormancy and were subjected to -4°F, while temperatures of 10°F killed all new growth and small stems, but did not damage larger canes. Very severe temperatures can damage even dormant plants (9, p.318).

Greater susceptibility to cold helps explain why rabbiteye blueberries are not native above a latitude of 40° in North America (8, p.49). In the more southern rabbiteye areas--including North Carolina and Mississippi--cold damage is not a problem.

Drought--Rabbiteye blueberries are shallow-rooted, yet can survive periods of drought. They are tolerant of summer heat and are productive in habitats that are too dry for highbush cultivars (9, p.323). Although rabbiteye bushes are grown in many areas that have adequate rainfall, the distribution of rainfall does not always maximize yields. As a result, irrigation is often recommended. Industry and extension specialists indicated that, as a result of irrigation, drought is not typically one of the most serious perils.

However, rabbiteye response to irrigation depends on the cultivar. In one research study, fruit yield from the 'Tifblue' cultivar averaged 4.4 pounds per plant under irrigation over a 3-year period, but only 0.8 without irrigation (9, p.324). In contrast, irrigation had little effect on the 'Woodard' cultivar, even during extremely dry periods.

The use of, and attitudes toward, irrigation vary considerably from state to state. In Florida, the blueberry extension specialist indicated that all commercial production was irrigated and that producers who did not irrigate were not interested in harvesting a crop. Nearly all of the Mississippi crop is estimated to be under irrigation currently. In contrast, only 28 percent of the North Carolina crop is estimated as under irrigation.

Attitudes toward the types of irrigation that are used also varies across states. In Mississippi, growers generally use drip irrigation because it is less costly than other types and uses water more efficiently. Some of the more progressive farmers have also purchased sprinkler irrigation, mostly within the past 3 years (5). These growers use drip to irrigate, and sprinklers when the threat of frost is imminent. In contrast, North Carolina growers who irrigate nearly all use sprinkler irrigation, both for drought and frost protection (21).

Excess Moisture and Flooding--Excess moisture is noted as a serious peril in several rabbiteye-growing areas. It is a particular problem at harvest, when the crop cannot be picked because of wet fields, and the berries become over-ripe. Also, over-ripe berries are prone to cracking and splitting. The problem of split berries can reduce the crop value from $1.10 per pound down to 30 cents (21). Rainy, cold weather at pollination was also ranked as a peril.

Flooding was not viewed as a serious peril by those contacted in individual states. However, rabbiteye blueberries are thought to be more tolerant of floods than are highbush blueberries. Flooding in the dormant stage is tolerated to a greater extent than during active growth. A 1984 study found that rabbiteyes grown in containers could withstand 58 days of flooding, but were nonetheless severely damaged (8).

Insects--Generally, rabbiteyes are more resistant to insect damage than are highbush cultivars. A 1977 study found a much greater infestation of the bud mite in highbush than in rabbiteye cultivars in the same location. As plantings of rabbiteyes increase, however, the need for insect control is expected to also rise. At present, spraying is not recommended unless infestations are observed by the grower (9, p.326). Blueberry specialists in Mississippi, Alabama, and North Carolina indicated that insects were not a major problem for their growers. The blueberry gall midge has proven to be a serious problem for rabbiteye blueberries in Florida.

Diseases--Rabbiteye blueberries generally are less disease-prone than are highbush plants. All leading rabbiteye cultivars are either immune or highly resistant to stem canker. Rabbiteyes are more immune to Phytophthora root rot than are highbush cultivars. Anthracnose is generally found only in isolated cases, and is not considered a serious problem. Disease were, however, listed as a major rabbiteye peril in North Carolina.

Birds--As discussed earlier, bird depredation is a major Florida peril. Specialists in Mississippi and North Carolina, in contrast, indicated that birds were only a minor nuisance (5, 21). Most growers report minor bird damage. The worst problems are often near major cities. Typically, between 2 to 3 percent of a state's crop in these areas is eaten by birds.

Lowbush Blueberries

The most serious peril facing lowbush growers is spring frost damage. Drought, poor pollination weather, and cold damage are of intermediate

importance. Insect and disease problems appear to be relatively unimportant (table 7).

Frost Damage--As for other types of blueberries, frost damage is the most severe peril facing lowbush growers. Unlike in most other states, frost damage in Maine can occur in either the spring or the fall, although spring frosts are generally more damaging. A Maine blueberry extension specialist noted that one grower has fall frost damage to his berries in August of nearly every year (49). As discussed in previous sections, damage can result in nearly total crop loss, or only partial losses. Damage in the fall occurs when cold temperatures freeze unharvested berries.

Cold Damage--Lowbush plants have been found to acclimate to falling temperatures more rapidly than highbush cultivars, and therefore, to survive much lower temperatures (8, p.47). However, cold damage is still ranked by extension specialists as a significant peril for Maine lowbush growers. Temperatures of -30° F or below can result in crop loss, although damage is not usually as severe as caused by frost damage.

Cold, Rainy Pollination Weather--Pollination seasons characterized by cold, rainy weather are also ranked as a peril to growers. This peril results in the potential for partial crop loss, but is not known to cause a total crop failure.

Drought--Irrigation of the Maine lowbush crop is estimated at less than 10 percent of acreage. As a result, drought can affect developing berries and reduce yields. However, drought causes severe crop loss only infrequently. Currently, only a few growers in Maine use irrigation, and then, only in the bearing year. The feasibility of irrigating non-bearing fields, in an effort to increase bud formation in the bearing year, is being evaluated.

Table 7--Major Natural Perils Faced by Lowbush Growers

State	Ranking of Perils
Maine	#1--Frost damage; #2--Drought; #3--Rain, cold at pollination; #4--Cold damage

Source: 49.

Note: Another source provided the following ranking: #1--Frost damage; #2--Cold damage; #3--Poor pollination weather; #4--Drought. Source: 36.

Diseases--Extension specialists indicated that diseases are not generally a serious peril for lowbush growers. However, two diseases are noted in lowbush blueberry management literature as of potential importance. One is mummy berry disease, which infects the buds, twigs, leaves, flowers and fruit of the plant. This fungus follows a two-year growth pattern, and causes fruit to shrivel and fall to the ground in the second year. This disease can be successfully controlled through chemicals (9, p.307), indicating why it is ranked relatively low in importance as a natural peril.

The second disease of potential importance is Botrytis blight, which occurs during bloom. It is a problem when extended wet periods occur during bloom or shortly after petal fall. The fungus attacks the blossoms and young fruit, causing them to turn brown. Fungicides during the bloom period control this disease.

Insects--Insect damage was not noted by extension specialists as a severe peril facing lowbush growers. Selective insecticides are generally applied only where a problem insect has been identified. Some insects that have at times been troublesome over the past 30 years include: blueberry maggots, black army cutworms, case beetles, flea beetles, red-striped fireworms, and tussock moths (9, p.308).

HARVESTING

Harvesting is an important issue for crop insurance purposes for two main reasons. First, the harvesting method used by the grower can have an effect not only on quality, but also on harvested yield. Second, harvesting costs for blueberries can be quite substantial. This situation has the potential to pose a moral hazard concern, particularly if prices are low at harvesttime.

The harvest season for cultivated U.S. blueberries depends on the variety and the climate of a particular production area. The harvest usually begins in mid-April in Florida, early May in North Carolina, early June in New Jersey, and early July in Oregon, Washington, and Michigan. The latest harvesting dates in the U.S. are found in Washington, Michigan, and Maine (table 8).

In a given location, the blueberry harvest generally runs from 3-5 weeks. Berries must be picked several times (that is, in several intervals) during the harvest period. The harvest interval, usually 5-10 days for a picking, has a major effect on quality. If temperatures are high, berries are not likely to be of acceptable quality after 7 days. As harvest progresses, the picking interval generally declines.

Blueberries are harvested mechanically or by hand labor. Growers at times prefer hand harvesting during the first two pickings of the season, since the mechanical unit tends to remove green berries that can be left on

Table 8--Typical blueberry Harvest Dates, by State

State	Start	Peak	End
Florida	4-15	5-1 to 6-10	6-15
North Carolina	5-10	5-25 to 7-1	7-10
Arkansas	6-1	6-10 to 7-15	7-25
Georgia	6-1	6-8 to 7-10	7-18
New Jersey	6-10	7-1 to 8-15	8-30
Oregon	7-5	8-5 to 9-5	9-10
Washington	7-5	8-5 to 9-5	10-5
Michigan	7-10	7-25 to 9-10	10-5
Maine	8-1	8-18 to 8-25	9-5

Source: 28.

the plant and ripen into marketable fruit. Mechanical picking is more efficient for later harvests due to savings in labor costs.

Berries that are hand picked are generally destined for the fresh market, while those that are mechanically harvested generally are processed. However, some mechanical harvesting is also used for fresh market berries. The first pickings of the season generally result in high quality berries that are most likely to be destined for the fresh market. The last pickings more often are used for processing.

Mechanical Harvesting--Machine harvested berries are generally of lower quality than those that are hand-picked. Machines harvest over-ripe, shriveled, soft, diseased, insect- and bird-damaged, green, or other fruit that would not be harvested by a good hand-picker (28). Bruising is also more of a problem with machine harvesting. Grading of machine-picked berries is a necessity.

Yields are also generally lower for machine-harvested berries than for those that are hand-picked. As seen below, berries can be lost from recoil of the bushes that results in berries falling to the ground. Generally, larger acreages are more likely to be machine harvested than smaller acreages.

Mechanical harvesting can be of several types. One type involves use of a hand-held, electrically-powered vibrator that is used with a catching frame. One problem with this method is that a large amount of debris is collected with the berries that must later be separated (28).

Over the past 10 years, significant advances have been made in designing self-propelled, over-the-row harvesters. The earliest type has a slapper-type picking mechanism where metal rods "slapped" the bushes from both sides. Dislodged fruit falls to the base of the machine where it is caught on sloped catch plates. Problems with this method include the potential for loss of a significant amount of fruit (perhaps 15-25 percent); bruising of the berries;

the collection of a significant amount of green or over-ripe berries; and branch breakage or scarring (28). Broken or scarred branches allow an entry point for diseases.

Over-the-row harvesters with a sway-type picking mechanism have provided an advancement. In this arrangement, a set of rods compress the bush and "sway" it from side to side to dislodge the berries. However, growers have found that the bushes tend to become compressed excessively within the tunnel. After the machine has passed a bush, the recoil of the stems results in a loss of both ripe and green berries behind the machine on to the ground (28).

The most recent and successful harvester technology is based on the use of a rotary head (28). On either side of the picking tunnel, a revolving drum with multiple nylon wands turns with the forward motion of the machine. This type of machine imparts the least fruit bruising and stem damage of all the different machine types available. As of early 1993, no estimate of harvest loss had been made on the newest rotary machines.

Despite these problems, the industry trend is toward increased mechanical harvesting. This trend is largely the result of expanded blueberry acreage in many areas and the lower cost associated with machine harvesting. Recent sources estimate the cost of machine harvesting and sorting fruit for processed markets at 18-25 cents per pound. In contrast, the cost for hand-harvesting and packing fruit for the fresh market amounts to about 50 cents per pound, including the costs of packing supplies and labor (see various budgets listed in "Sources").

Hand Harvesting--Hand picking is often done by migrant workers and local pickers. The average picker can harvest 5 or 6 12-pint flats per 8-hour day. However, highly skilled pickers can pick as many as 20 flats per day (28). Two to four pickers per acre are needed at the beginning and end of the seasons, while eight to ten per acre are needed at the harvest peak. Pickers are generally paid on the basis of the number of berries picked.

One method of harvesting involves picking directly into market containers. This method has the advantage of minimizing handling and better preserving the surface bloom (natural waxy covering) of the berry. Berries can also be harvested into buckets for grading and packing at a packingshed.

In Maine, pickers generally use hand-held rakes to remove berries from the bush. The rake, which consists of a box with a set of tongs or fingers, is pulled through the blueberry bushes, removing the berries and depositing them in the box. The berries are then place in a 5 gallon bucket for transport to a collection point in the field.

In addition to the cost of hiring labor, industry sources indicate other issues associated with hand picking. For instance, the turnover among hand pickers is extremely high, and some growers view the paperwork (payroll, taxes, etc.) involved in hiring workers as very burdensome (21).

Quality--While quality is generally higher for hand-picked berries than for those that are mechanically picked, other factors are also important. As

noted above, berries picked earliest in the season are the largest and highest quality. In addition, the "best" berries are picked in relatively dry seasons (21). In contrast, berries picked during rainy season are darker and the stem scars are wet and more vulnerable to deterioration. Diseases on the berries--particularly molds--are also more of a problem during wet seasons (21).

Sources indicate that it is uncommon that a harvest is of such low quality that it cannot be used for freezing. Lower quality berries--those that are over-ripe or that are damaged--are often used for juices or slurries, such as flavoring in yogurt (14).

Prices and Costs--Industry sources indicate that low processed-berry prices can have an influence on harvesting. One specialist noted that when processed prices are less than 30 cents a pound, a portion of the crop may be left in the field (21).

COSTS AND RETURNS

Initial costs of establishing blueberry plantings are relatively high and early returns are low because production does not result for several years after planting. Because costs vary according to the stage of development, multi-year enterprise budgets are usually estimated. As plantings mature, rising harvest costs outpace the annual preharvest costs, but gross revenue from blueberry sales also increases. Receipts from the third harvest can cover most cash operating costs, although start-up costs may not be recaptured for 10 years or more.

An important consideration for insurance is that the value of the blueberry crop "on the bush" is much less than its value at the first delivery point. Hand-harvesting costs typically amount to 75 percent of total production costs of fresh-market blueberries. In contrast, mechanical harvesting accounts for about 50 percent of the cost of producing processing berries. Because of high harvest costs, moral hazard may be a problem, particularly if the crop is of relatively low quality, prices are low, and labor costs are especially high. In such a situation, a grower may receive higher returns from crop insurance indemnities than from harvesting and selling in the market.

Non-use of protective measures--such as fencing and netting--may also pose a moral hazard concern. That is, if deer or birds are a problem, a grower may decide to opt for an indemnity payment rather than incur the costs associated with installing fences or netting.

Highbush Blueberries

Highbush blueberry establishment costs in Michigan, New Jersey, and North Carolina are estimated at $6,000 to $10,000 an acre. First-year costs range from $4,000 to $6,000 per acre, including land preparation, plants, and labor. Irrigation costs are additional, with drip irrigation systems costing less than $1,000 an acre and sprinkler irrigation up to $3,000 per acre. If

deer or birds are a problem, fencing and netting to protect blueberries each cost about $1,200 an acre (28).

Highbush blueberries in the East do not not reach full production for about 8 years. Before production begins, maintenance costs are usually less than $1,000 an acre, rising to $4,000 an acre as the bushes mature, and to $6,000 as mature bushes require added pruning, fertilizing, irrigation, and crop protectants.

Harvesting, packing, and marketing blueberries account for a large share of annual costs. Hand harvesting of berries typically costs $4,000 an acre, while mechanical harvesting costs about $2,000 an acre. A combination of hand- and machine-harvesting has an estimated cost of about $5,000 per acre of mature blueberries in North Carolina, which is 80 percent of total production costs (27).

In Oregon and Washington, costs of establishing highbush blueberries are nearly $10,000 an acre. Costs in the first 3 years range from $1,200 to nearly $4,000 per acre, including costs of land preparation, plants, weed control, and labor. Irrigation costs $1,500 an acre for an above-ground sprinkler system, which can also be used to cool plants in the summer (17).

Highbush blueberries in the Northwest do not reach full production for at least 6 years. Before full bearing potential is reached, maintenance costs are usually less than $1,000 an acre, rising quickly as bushes require more pruning, fertilizing, irrigation, and crop protectants. Six years of production may be required to achieve a positive net return over variable and fixed costs and 10 years to recover establishment costs.

High blueberry yields in Washington and Oregon drive harvesting costs above those of other states. Preharvest costs (variable and fixed) for an acre of mature blueberries in Oregon are about $2,300 and total costs are about $9,000. Harvest costs for mature plantings are nearly $7,000 an acre, 75 percent of total production costs.

Oregon's blueberry harvest costs are based on 70 percent of a 20,000-pound-per-acre crop mechanically harvested for processing and 30 percent of the crop hand harvested for the fresh market. Harvest rates are about the same as in other states: $0.50 a pound for hand-picking including packaging and a marketing fee, and $0.27 a pound for mechanical picking, loading, and shipping.

Rabbiteye Blueberries

Establishment costs for rabbiteye blueberries in the Southeast range from $2,500 to $3,000 an acre for land preparation, installation of drip irrigation equipment, planting cultivars, and maintaining the plantings in the first year. Development costs drop in the second and third years to less than $1,000 an acre. Flower buds are removed for the first two years to prevent fruiting and promote vegetative growth while blueberry bushes become established.

The first blueberry crop, typically in the third year, is usually small, but increases each year until full-bearing potential is reached after six years. For Alabama (48), Georgia, and Mississippi (1), a positive net cash flow (gross receipts covering variable costs) follow the second or third year of blueberry production. Gross receipts were not sufficient to meet all fixed costs, including the recapture of the early years' investment, as well as annual operating expenses, until the 4th or 5th year after planting.

As the plantings mature and yields per acre rise, costs of harvesting and packaging blueberries outpace the costs of growing. In Alabama and Mississippi, costs for hand-harvesting rose from less than $1,000 an acre the 3rd year after planting (first harvest) to $3,000-$5,000 an acre for mature plantings when total costs were about $4,000-$6,000 an acre. Hand-harvesting rates varied from $0.30 to $0.50 a pound, depending on whether containers, packaging, and grading were included.

Lowbush Blueberries

Maine's enterprise budgets for lowbush blueberries (50) do not include expenses for the initial establishment of the field, but do contain costs for re-establishing the above-ground portions of the plants every other year. Expenses during the harvest year, including pollination, pest control, and harvesting, total about $360 an acre. The addition of reestablishment expenses and miscellaneous, fixed costs bring total production costs to $570 per harvested acre.

Maine's lowbush blueberries are harvested only once a season, not 3 or more times as is common for the highbush and rabbiteye types. The berries are harvested with hand-held rakes and winnowed to remove green and overripe or damaged berries. Nearly all of the crop is sold for processing, at an average value of $0.46 a pound.

Mechanical harvesting costs in Maine are similar to other Eastern states, at $0.19 a pound. However, Maine's harvest costs were based on a much lower yield, 1,654 pounds per harvested acre, compared to a 5,000-pound yield on which Michigan harvest costs are based. Some growers in Maine receive substantially higher yields.

MARKETING

Marketing considerations are important for insurance because there is a potential for moral hazard if growers do not have profitable market outlets. Marketing outlets for blueberries are discussed below. Uncertainty as to availability of buyers does not appear to be an issue for blueberry growers.

Blueberries are marketed by blueberry cooperative associations, independent dealers, and vertically-integrated operations that grow, pack, and market their own crops. Cooperatives and independent dealers market berries to the fresh market or to processing plants. The importance of fresh, processed, and pick-your-own markets, by state, are shown in Table 9.

Table 9--Primary Blueberry Marketing Outlets, by State

State	Marketing Outlet		
	Processed (%)	Fresh (%)	U-Pick (%)
Alabama	15	75	10
Arkansas	10	80	10
Connecticut	3	27	70
Delaware	0	10	90
Florida	30	60	10
Georgia	62	33	5
Idaho	0	25	75
Illinois	0	60	40
Indiana	30	30	40
Iowa	0	0	100
Kansas	0	0	100
Kentucky	0	20	80
Louisiana	40	40	20
Maine	99	1	0
Maryland	0	10	90
Massachusetts	5	65	30
Michigan	60	35	5
Minnesota	5	10	85
Mississippi	60	30	10
Missouri	10	30	60
N. Hampshire	70	30	0
New Jersey	30	65	5
New York	5	50	45
N. Carolina	33	63	4
Ohio	10	35	55
Oklahoma	10	30	60
Oregon	55	40	5
Pennsylvania	0	40	60
S. Carolina	0	10	90
Tennessee	0	20	80
Texas	25	50	25
Vermont	0	25	75
Virginia	0	10	90
Washington	40	50	10
West Virginia	--	--	--
Wisconsin	0	5	95

Source: 24.

Cooperatives have been extremely effective in some regions because they allow growers to pool their output and meet the needs of large buyers. The cooperatives also provide low-cost inputs to producers, and make efficient use of promotion and advertising dollars. Two of the largest blueberry cooperative associations in the U.S. are the Michigan Blueberry Growers Association (MBG) and Tru-Blu Cooperative. MBG is located in Michigan, but also markets blueberries for growers in Indiana, Florida, Louisiana, Georgia, Mississippi, Arkansas, and North Carolina. Tru-Blu is based in New Lisbon, New Jersey and markets for New Jersey, North Carolina, and other states.

Cooperative associations generally accept berries from growers at receiving stations, or have refrigerated trucks that pick up the berries directly from the field. The point of sales transfer from the grower is at the receiving station or at the truck. The association pools the output from a number of growers for a given number of days and a grower's price is based on the average returns received for the pool, less marketing expenses charged by the grower association. Growers usually receive payments for fresh market berries each week. In contrast, growers may not receive full payment for berries used for processing for up to 1 year after harvest.

Some growers prefer to sell their crops through dealers rather than cooperative associations because they prefer the greater independence. In addition, independent dealers in some states get payments in full to producers more quickly than do the cooperative associations.

Forward contracting does not appear to be a factor in blueberry marketing outside of the Pacific Northwest and Maine. Outside of those areas, the industry sources and extension specialists contacted were not familiar with either quantity or price contracting prior to harvest. Neither were they familiar with buyers requesting delivery at, or by, a specific date.

The importance of various types of buyers can vary greatly from state to state, and each state has its own idiosyncracies in terms of the marketing process. Consequently, the following discussion is organized on a state by state basis. Within a given state, different blueberry types--such as highbush and rabbiteye--are typically marketed in the same fashion. Some buyers may, however, have a preference for a specific type or variety.

Michigan--The Michigan Blueberry Growers Association is the only cooperative association in Michigan that handles grower sales to processors and fresh market buyers. Many independent brokers also market fresh and processed blueberries. MBG markets about 50 percent of the Michigan crop. Independents dealers market the remainder. MBG members (about 45 percent of Michigan growers) and non-members (those who deal through the independents) are a mix of large and small growers (41).

Regardless of buyer, preliminary sorting of berries is done on the farm by the pickers. Growers who market through MBG deliver their berries to one of the cooperative's receiving stations in the state. Berries for the fresh market are cleaned to remove leaves and other debris, packaged, and inspected (41). MBG hires the inspectors (including USDA inspectors) who inspect the crop at the receiving station according to USDA standards. Berries are rarely

of such low quality that they are not accepted for processing in some form. The poorest berries are used for juice.

Blueberries destined for processing follow a different path than those intended for the fresh market. After picking, berries for processing pass over a blower, and then through a water separator, which is used to "float" green berries. The berries then are either bulk frozen or individually quick frozen. After packaging, inspectors select cartons randomly and check that standards are met (41).

Mississippi and Louisiana--MBG is the main marketing outlet for Mississippi and Louisiana blueberries, selling for the local Miss-Lou Association. Miss-Lou handles a large portion of the Mississippi crop, with about 80 percent of the state's growers estimated as members (5). Some small growers sell to the public (road-side stands) or through local outlets and are not members.

Growers who market through the association deliver blueberries to one of the seven Miss-Lou receiving stations, where the berries are sorted, inspected, graded, and cooled. They are then delivered to a central station where MBG takes possession and sells the crop under the pooling method described above. MBG markets both berries for the fresh market and for processing out of the Mississippi-Louisiana area.

Arkansas--About 60 percent of Arkansas growers belong to the Arkansas Blueberry Growers Association (29). The remaining growers market their crops through independent dealers. The largest blueberry farms in the state are in the range of 60-70 acres. MBG markets for the Arkansas growers association (29). As a result, the marketing channel is very similar to the Mississippi-Louisiana discussion above.

North Carolina--Marketing channels in North Carolina include three cooperative associations (MBG and Tru-Blu are the major players) and several independent dealers. About 60-70 percent of the crop is marketed through the cooperatives each year (21). From year to year, growers often switch from one cooperative to another, or to another dealer.

About 85 percent of North Carolina's blueberries are grown within a 40-mile radius centered in the southeast part of the state. Within that region, there are 6 receiving stations, owned either by a dealer or a cooperative. About 50 percent of the crop is delivered to a receiving station, with the sorting and grading process following the pattern noted above (21). The other 50 percent is picked up from the field by the association or dealer using a refrigerated truck. Berries that are picked up by truck can more easily retain high quality because they have field heat removed sooner than those delivered to receiving stations.

The cooperative associations operate receiving stations and have trucks in the area during the harvest season. The associations may leave the area, however, before all growers are through harvesting. In that case, the grower may need to deliver his crop to another buyer. The lack of a buyer was not reported as problem.

North Carolina, along with New Jersey, Oregon, and Washington, have promotional "check-off" programs that are used to fund blueberry research and promotional activities. The amount of the payment owed by growers is based on their production. For instance, in North Carolina, growers pay 3 cents per 12 pint flat for fresh blueberries, and 1-1/2 cents per 12 pint flat for processed blueberries (21).

New Jersey--The primary blueberry growing counties in New Jersey have quite different characteristics. In Atlantic county, growers are large and pack and market their own berries. There are about 10 large growers in the county, with 100-200 acres each. The largest has about 1,300 acres of blueberries and markets under his own brand name. Most growers in the county raise only blueberries, although some have cranberries. Nearly all of Atlantic county blueberries are irrigated (30).

In contrast, Burlington county has about 80 small growers, with about 10-20 acres per grower. They generally market their crop through Tru-Blu Cooperative Association. There is very little irrigation in Burlington county. In general, Burlington county growers are more diversified than is common in Atlantic county, with many having cranberries. According to an extension contact, Burlington growers typically provide less weed control and pruning than do Atlantic county growers (30). Burlington county yields are estimated at 100 flats per acre, while Atlantic county yields are estimated at 600 flats per acre (30).

Typically, New Jersey growers harvest twice by hand-picking within a season and sell those berries for the fresh market. The final pickings are done with a mechanical harvester, with that portion of the crop destined for freezing. About 75 to 80 percent of the crop is hand harvested in the state, and about 20 to 25 percent is mechanically harvested. About 70 percent of the New Jersey crop is marketed by the Atlantic Blueberry Company, Diamond Blueberry Company, and Tru-Blu Cooperative (30).

As noted above, New Jersey has a check-off program for blueberries. Funds are collected, based on a grower's production, and used for blueberry research and promotion. Al Murray, the New Jersey Dept. of Agriculture's liaison to the NJ Blueberry Advisory Council, indicated that council members are very interested in the potential for crop insurance (30). Data collected under the auspices of the check-off will likely be of use in rate-making.

Maine--About 99 percent of the Maine blueberry crop is used for processing, and is marketed to one of nine processing plants in the state. The largest processors also provide management services to growers, including spraying and burning services. Two of the nine processing plants also have canning facilities (49).

Several large growers account for 50 percent of Maine's blueberry acreage, with two growers in the 15,000-acre range. Several own processing plants. There are also estimated to be 300 small growers and three grower cooperatives, including the Wild Blueberry Association (49). This association is promoting exports of individually-quick-frozen (IQF) blueberries with assistance from USDA's Foreign Agriculture Service (49).

Berries for processing go from the field to a receiving station, where they are winnowed and placed in 25-pound field boxes. They are then taken to a processing plant, where they are again winnowed, washed, and graded. Each grower's berries are kept separate until after inspection at the plant. Berries that are rejected by the factory do not have an alternative use. After inspection, berries are frozen and placed in 40-pound boxes for freezing and storage.

Within this process, growers are paid on the basis of the weight or volume recorded at the receiving station. Grading at the plant is to improve the quality of the pack, but does not affect individual growers' prices. Too many green or over-ripe berries will lower the quality of the pack and can reduce the pool price. It is the overall quality of the processor pack that determines the price received by each grower (49).

There is one cooperative association operating in Maine that markets the portion of the crop that is used for the fresh market. Quality affects the pool price received by the cooperative. Processors may contract to buy all that a grower can deliver at a pre-established price, but may regulate deliveries by the number of field boxes supplied to the grower (49).

Oregon and Washington--There are no formal marketing organizations in Oregon and Washington. Small growers often sell their crops to large growers that are vertically integrated, with grading and packing lines, chillers, and freezing or canning equipment. These large growers are likely to produce many types of berries and grow, pack, and market their own berries and buy from four to five other growers (38).

Processing contracts may be used to ensure an outlet for growers, and a supply for processors. The price, however, is not likely to be predetermined under such transactions, and generally fluctuates with market conditions at the time of delivery. There is no price pooling, and growers mainly receive the current market price for their blueberries, whether selling to processors or for the fresh market.

INSURANCE ISSUES

Insurance issues can be divided into two categories. The first pertains to the demand for insurance, which appears to vary considerable in some areas. The second involves implementation issues surrounding policy development.

Demand for Insurance

The major insurance concern at this point in time involves grower interest in the development of an FCIC blueberry policy. Based on discussions with blueberry extension specialists and industry sources, grower interest appears to be strongest in the newer producing areas of the South and among smaller growers in New Jersey.

The state with the greatest interest appears to be Mississippi. An extension contact in that state, John Braswell, appeared very interested, and indicated that he had been involved with the several requests for insurance that were sent to FCIC in the late 1980's (5). An Arkansas extension specialist also stated that he believed growers would be interested in insurance, as did a Florida specialist. A New Jersey Department of Agriculture employee who worked with blueberry growers also thought that interest would exist in that state, most likely among the smaller growers.

John Braswell also stated that the North American Blueberry Council analyzed the benefits and costs of a blueberry policy in 1990. Myrtle Ruch was the contact person at the council, and Braswell believed that she assembled a significant amount of information on the topic. He was not sure why the push for blueberry insurance had lost momentum. Ms. Ruch has not been in the office for several weeks and could not be contacted for this study. Her number is 609-399-1559.

North Carolina growers, who expressed a strong interest in insurance in the late 1980's, appear to be less interested currently. Mike Mainland, an extension specialist in the state who was involved with previous insurance requests, indicated that growers reached a point where they did not expect to see a policy materialize given the extended period of time over which requests were made with no response. As a result, progressive growers have begun investing in overhead sprinklers to protect against frost damage, the major peril in the state. [Note: Mike Mainland is listed in requests to FCIC as "Charles Maitland."]

Indeed, some growers may be opposed to insurance because they feel that it would protect growers who posed a moral hazard. That is, they believe that insurance would protect growers who would harvest a crop only if conditions favored a crop in that year, and who did not generally provide adequate inputs and management. Such growers are believed to generally market a lower-quality crop, tainting the image of all growers in the state. Some larger commercial producers may just as soon see such growers leave the blueberry industry, rather than having crop insurance to provide them with protection.

The demand for blueberry insurance appears to be lower in Michigan, Maine, and the Pacific Northwest than in the southern states. However, all discussions were with industry personnel or extension specialists, and reflect their viewpoints. Certainly, growers reflect a varied group that may provide quite different information and perspectives.

Implementation Issues

Implementation issues include the availability of adequate individual yield data, as well as moral hazard and adverse selection concerns.

Availability of Individual Yield Data--The availability of individual yield data is questionable, particularly for a large number of growers. The two main sources of individual yield data are marketing cooperatives and, in states with promotional check-offs, the administering agency (typically, the

state's Department of Agriculture). Some growers may have adequate production records in the form of sales receipts.

One of the largest blueberry marketing cooperatives in the U.S., Michigan Blueberry Growers Association (MBG), is also the cooperative that markets a large portion of the fruit from the Southeast, the area of highest potential demand for blueberry insurance. A former president of MBG, along with others, stated that all cooperatives have production and/or yield series for individual growers. Initial contacts with MBG indicated that they would not release data because they did not want to violate grower confidentiality (41). The president of the Mississippi Blueberry Growers Association is currently in contact with MBG to encourage the release of this information (5).

Data collected by the check-off program, in states where applicable, may also be a source of individual production and/or yield data. The New Jersey Department of Agriculture, which administers New Jersey's check-off, indicated that they had individual grower production records for four years. They would begin to collect acreage data in 1994, but did not have such data for earlier years. Because of the lesser apparent interest in North Carolina, Washington, and Oregon, these states were not contacted in this regard.

If individual grower yields are not available, county yields may not be a good proxy. This is because of wide variability in yields among producers within local areas due to soil differences and differences in management intensity. A blueberry specialists in Florida indicated that expected average yields could vary among growers from 1,000 to 8,000 pound an acre.

Price Election Determination--Several factors complicate the setting of price elections for blueberries. First, processed blueberry prices are nearly always lower than fresh blueberry prices, and the differential between the two can vary significantly from year to year. Second, many growers harvest their first pickings for the fresh market, with later pickings (within weeks of the first) often destined for processed markets. Third, a grower may find that a portion of his crop does not meet fresh market standards, and is only saleable for the processed market.

These considerations indicate that setting separate elections for fresh and processed berries would be difficult because of the uncertainty at the time of signup about whether berries will be marketed for fresh market or for processing. An election that combines fresh and processed price projections also creates difficulty in that a grower may find it more profitable to collect an indemnity based on combined prices than to harvest a crop only for the lower processed market price.

USDA does not project prices for either fresh or processed blueberries, but does report average market prices by month throughout the marketing season for some states.

APH Determination and Plant Maturity--Blueberry plants generally reach maturity--and maximum bearing potential--at the seventh year through the tenth year after planting. The first and second years result in no harvested

berries. Small crops are harvested in the third through sixth years. The timing of maturity depends on the cultivar and the location of the planting.

Because of this bearing pattern, an APH-type of concept, in which past years are averaged to obtain an expected yield, can only be used after about the seventh through the tenth year after planting. An alternative would be to offer insurance in the pre-maturity years, but at different rates and coverages than offered for mature plantings.

Adverse Selection--The primary cause of loss in nearly all growing areas was late frost damage to the buds, flowers, or young fruit. Winter damage can also occur in the northernmost growing areas. Because of these concerns, several individuals contacted for this report suggested a final sign-up date of no later than January 1, particularly in northern areas. In areas where cold damage is a particular problem, such as in Michigan, a sign-up date of December 1 may be desirable. This is because damage to the plant during the early winter can kill flower buds and reduce yields in the subsequent season. In Florida, a cold December can cause early flower bud development thereby increasing the likelihood of frost damage during the spring bloom, also suggesting a December 1 final signup date.

Moral Hazard--Market prices would likely have an effect on moral hazard. In low-price years, producers would likely have an incentive to allow their crop to over-ripen, or to not treat diseases and other problems. This would be a particular problem if the return from the policy were expected to be higher than the producer's expected market return. However, a producer's APH history would suffer in such cases.

In addition, the Florida extension specialist interviewed for this report indicated that FCIC might wish to consider a category of "uninsurable losses" (19). For instance, he believed that Florida growers who did not irrigate or who did not protect from bird depredation were severe moral hazard risks. As discussed above, however, losses that could potentially be considered "uninsurable" could vary significantly from area to area.

Despite the potential for moral hazard, the development of a blueberry policy appears to be of significant interest to growers in several areas. Given the uncontrollable perils faced by growers, a blueberry policy would likely be of benefit to the industry. Methods of curbing adverse selection and moral hazard, as discussed in the report, would help protect FCIC's exposure to loss.

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Appendix table 1--States Reporting Blueberry Production: Agricultural Census, 1982 and 1987

State and major counties	1987					1982				
	Number of Farms	Harvested Acres	Harvested 1000 Pounds	Irrigated Farms	Irrigated Acres	Number of Farms	Harvested Acres	Harvested 1000 Pounds	Irrigated Farms	Irrigated Acres
SOUTHEAST										
Alabama	83	232	438	52	159	31	99	189	7	33
Escambia	11	(N)	192	4	(N)	8	68	111	2	(N)
Coosa	4	(N)	22	3	(N)	(N)	(N)	(N)	(N)	(N)
Talladega	4	7	17	1	(N)	(N)	(N)	(N)	(N)	(N)
Other	64	225	207	44	159	23	31	78	5	33
Arkansas	127	530	1,256	115	496	58	230	490	49	208
Benton	30	226	731	29	222	11	107	246	10	93
Washington	21	70	131	21	70	15	31	67	13	30
Franklin	7	61	108	6	(N)	5	(N)	75	5	(N)
Other	69	173	286	59	204	27	92	102	21	85
Florida	161	1,172	1,199	115	1,014	82	307	476	57	244
Alachua	43	504	434	34	450	21	95	258	16	74
Marion	16	59	79	15	(N)	9	48	71	7	44
Suwannee	7	28	78	7	28	(N)	(N)	(N)	(N)	(N)
Putnam	7	67	71	1	(N)	6	78	38	5	64
Other	88	514	536	58	536	46	86	110	29	62
Louisiana	62	172	197.864	49	155	18	25	35.166	11	21
Mississippi	109	323	(N)	54	206	72	137	(N)	29	85
Pearl River	19	81	(N)	10	68	6	7	(N)	5	6
Madison	3	21	(N)	3	12	(N)	(N)	(N)	(N)	(N)
Other	87	221	(N)	41	126	66	130	(N)	24	79
North Carolina	185	3,032	7,219	91	700	134	2,985	4,502	30	369
Bladen	31	1,659	3,501	9	(N)	28	1,264	1,516	1	(N)
Pender	9	507	1,142	(N)	(N)	9	(N)	1,126	1	(N)
Craven	3	160	744	3	(N)	4	(N)	560	4	204
Duplin	3	(D)	634	1	(N)	7	283	711	(N)	(N)
Other	139	706	1,198	78	700	86	1,438	590	24	165

(N): Indicates "not available" or "not published" to avoid disclosure of individual operations.

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	Number of Farms	Harvested Acres	Harvested 1000 Pounds	Irrigated Farms	Irrigated Acres	Number of Farms	Harvested Acres	Harvested 1000 Pounds	Irrigated Farms	Irrigated Acres
NORTHEAST										
Maine (cltvtd)	110	2,426	2,464	14	132	83	1,306	1,487	7	42
Washington	35	1,796	1,862	1	(N)	31	808	987	2	(N)
Hancock	28	342	356	4	(N)	19	266	279	(N)	(N)
Oxford	4	72	69	(N)	(N)	3	3	2	(N)	(N)
Other	43	216	177	9	132	30	229	219	5	42
Maine (wild)	433	21,186	31,988	9	334	474	17,773	29,562	10	1,177
Washington	201	13,695	23,106	6	(N)	230	11,168	20,043	6	(N)
Hancock	125	3,870	5,028	1	(N)	118	3,088	6,072	1	(N)
Knox	33	1,846	1,964	(N)	(N)	44	1,212	947	1	(N)
Waldo	26	505	477	(N)	(N)	27	688	848	(N)	(N)
Other	48	1,270	1,412	2	334	55	1,617	1,651	2	1,177
Michigan	711	13,712	48,045	257	5,692	681	11,079	36,357	143	3,086
Ottawa	132	4464	16,934	73	2,172	136	3,527	12,348	47	1,401
Van Buren	220	4422	15,460	55	1,696	204	3,591	11,962	30	766
Allegan	112	2133	7,285	36	865	99	1,679	6,000	13	335
Berrien	98	1069	3,472	23	209	110	880	2,716	12	100
Muskegon	38	797	3,020	14	(N)	35	700	1,726	7	217
Genessee	6	67	234	4	54	6	58	217	3	33
Kent	8	(N)	218	5	39	3	19	58	2	(N)
Other	97	760	1,422	47	657	88	625	1,330	29	234
New Jersey	251	7,768	24,146	93	4,071	234	7,399	30,521	68	3,661
Atlantic	66	3,979	15,161	45	2,466	84	4,195	19,480	43	3,017
Burlington	133	2,710	5,263	28	706	107	2,552	7,012	13	314
Other	52	1,079	3,722	20	899	43	652	4,029	12	330
NORTHWEST										
Oregon	352	1310	7,141	299	1,170	243	622	2,911	213	560
Washington	56	324	2,937	51	309	33	113	540	32	112
Marion	56	319	1,703	53	248	43	182	729	40	167
Clackamas	77	173	630	59	152	40	(N)	212	32	54
Lane	37	62	375	33	58	35	47	348	33	45
Benton	9	79	302	8	78	12	53	207	12	53
Columbia	11	105	289	7	95	8	44	218	6	(N)
Other	106	248	906	88	230	72	183	657	58	129
Washington	146	967	5,827	85	612	131	767	4,894	65	509
Whatcom	26	(N)	2,681	22	(N)	14	(N)	1,738	13	(N)
Clark	30	133	818	20	120	19	(N)	278	12	(N)
Thurston	9	116	674	5	(N)	8	101	547	5	77
Pierce	22	94	501	12	47	28	123	871	16	56
Other	59	624	1,153	26	445	62	543	1,460	19	376
United States	4,412	59,216	142,038	1,919	17,692	3,409	47,696	119,957	975	11,437
Wild	501	21,969	32,616	22	420	544	18,777	30,282	15	1,204
Cultivated	3,911	37,247	109,422	1,897	17,272	2,865	28,919	89,675	960	10,233

(N): Indicates "not available" or "not published" to avoid disclosure of individual operations.