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

Prepared by the Economic Research Service, USDA

for the Office of Risk Management,
Consolidated Farm Service Agency

October 3, 1995

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Executive Summary

Cucumbers are grown for either the fresh or processing markets. Production methods differ slightly depending on the market, as do the varieties grown. Cucumbers for the fresh market are often referred to as "slicers." The varieties grown for processing are called "pickles," or sometimes, "curvys."

Cucumbers are grown across the United States, although a few states dominate production. Florida dominates the fresh market. However, during the summer, when Florida's production is low, states such as Virginia, New York, and New Jersey are the large producers. Michigan and North Carolina dominate processing cucumber output. Texas, Wisconsin, and South Carolina are also major producers of processing cucumbers.

An average 2.1 billion pounds of cucumbers were produced annually in the U.S. between 1992 and 1994. About 56 percent of the cucumbers produced in the U.S. were for processing use over that period. An average 1.2 billion pounds were produced annually for processing, while about 922 million pounds were for fresh-market use.

Consumer preference and per-capita use of pickling cucumbers far outpaced fresh cucumber use throughout the early 1970's. Preferences began to change, however, in the mid- to late-1970's, and per capita consumption of pickles declined while consumption of fresh varieties began increasing. By 1992, consumption of fresh cucumbers exceeded that of pickles for the first time.

Because of production practices, yields are generally lower for processing cucumbers than for fresh-market cucumbers. Processing cucumbers are usually grown on bare ground with little or no irrigation. In contrast, growers are willing to spend more on inputs for fresh production because of the higher associated product prices. Therefore, fresh varieties are often grown on plastic mulch in irrigated fields. In addition, fresh cucumber fields are picked more often during a harvest, which results in higher yields.

Slicers are sold in a similar manner to other fresh vegetables, with farmers using brokers or state farmers' markets to sell to wholesale outlets. Larger growers may sell directly to retail outlets. Pickles are sold on a contract basis with major pickle processors, such as Vlasic and Heinz. Contracts are usually based on size and quantity. If production exceeds the pre-specified tonnage, processors often will buy the excess, provided that an oversupply of pickling cucumbers does not exist. Otherwise, any excess is not picked.

The cost of harvesting a fresh-market cucumber crop is an important factor in determining whether or not to continue picking once market prices have begun to drop. Once market values fall below a certain level, picking is often terminated or a newer field is harvested, where the crop is more abundant and the cucumbers are of higher quality. In Michigan, for example, it is estimated that if prices fall below $6.00 per bushel, growers will not be able to cover their costs and will abandon the remainder of the fresh-market crop. Most growers of slicer cucumbers either have their own packinghouses or use conveyor lines. Smaller growers, and many northern Florida growers, however, transport cucumbers in picking containers to packinghouses on larger farms or

to a central packinghouse. Once the cucumbers are brought to the packinghouse they are graded, sorted by size, waxed, and packed. Grading standards for slicers are set by USDA and the industry. Slicers are graded either select or super select.

Pickling cucumbers are trucked in bulk to processors, who grade and size the cucumbers. The packing industry sets the standards for pickling cucumbers. The price that processors pay growers for their cucumbers is based on the size of the fruit, with smaller cucumbers commanding a higher price.

Major production perils affecting cucumber production include excessive cold, drought, high winds, cool summers, and poor pollination. In particular, frost can be a serious problem for slicer cucumber production in all parts of the country. Cucumbers are very sensitive to the cold and a frost can easily kill the plant. In the Midwest, most growers wait to plant their cucumbers until after the threat of frost is past. However, growers of slicer cucumbers trying to get an early start on production may plant early, increasing their risk of loss due to frost. Growers of pickling cucumbers typically plant later in the season, as harvesting an early crop to obtain high prices is not an issue for them.

Our assessment is that cucumbers may be a good candidate for crop insurance, especially in the major producing states. Many growers in these states also produce other crops that are presently covered by crop insurance, including tomatoes, peppers, and field crops. Growers who already have crop insurance coverage for other crops may be more likely to insure cucumbers than growers who are unfamiliar with the program.

Cucumbers are also grown in area where weather-related perils have lead to large losses and disaster assistance payments. Florida, for example, is susceptible to storms. Unpredictable frosts and excessive moisture in the spring can affect plantings in the Midwest. Drought is a common peril reducing yields in the Northeast and Midwest.

While various extension agents indicated that cucumber growers would be interested in crop insurance, several also stated that smaller growers, in particular, may not be willing to invest in the added expense of crop insurance. Cucumbers are often a second crop, or are rotated in the field with other crops. As a result, some growers may be willing to absorb the loss from a failed cucumber crop, and hope to make up the loss with the next crop that follows.

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Introduction

Cucumbers are grown for either the fresh or processing markets. Production methods differ slightly depending on the market, as do the varieties grown. Cucumbers for the fresh market are often referred to as "slicers." The varieties grown for processing are called "pickles," or sometimes, "curvys."

Slicers are more likely to be grown on plastic and with irrigation than are pickles. The slicer varieties have a thicker skin than do pickle varieties, and should be dark green in color. Long slicer cucumbers are graded higher and have a higher value than short slicers. In contrast, pickling varieties are best when the skin is a light green color. The smaller the cucumber, the higher the grade and value of pickling varieties.

Slicers are sold in a similar manner to other fresh vegetables, with farmers using brokers or state farmers' markets to sell to wholesale outlets. Larger growers may sell directly to retail outlets. Pickles are sold on a contract basis with major pickle processors. Contracts are usually based on size and quantity.

Cucumbers are grown across the United States, although a few states dominate production. Florida dominates the fresh market. However, during the summer, when Florida's production is low, states such as Virginia, New York, and New Jersey are the large producers. Michigan and North Carolina dominate processing cucumber output. Texas, Wisconsin, and South Carolina are also major producers of processing cucumbers.

The Cucumber Market

Supply

An average 2.1 billion pounds of cucumbers were produced annually in the U.S. between 1992 and 1994 (Table 1). About 56 percent of the cucumbers produced in the U.S. were for processing use over that period. An average 1.2 billion pounds were produced annually for processing, while about 922 million pounds were for fresh-market use.

Fresh cucumber production increased 93 percent from 1970-75 to 1989-94 (Table 2). Pickling cucumber production grew at a slower rate than fresh (slicer) production, increasing only 3 percent during the same time period (Table 3). Because of the rapid growth of fresh cucumber production relative to that of the pickling varieties, the share of total production attributable to fresh output increased from 25 to 30 percent in the 1970's to about 40 percent in the late 1980's and early 1990's.

Florida, Michigan, California, North Carolina, and Georgia, respectively, are the major cucumber-producing states (Table 1). Florida, California, and

Table 1--Cucumber production by state, average 1992-94

State	Market	Acres	Yield per acre	Production
		--Acres--	---1,000 lbs.---	
California	Fresh	5,033	25	123,333
	Processing	3,867	24	85,753
	Total	8,900	--	209,086
Colorado	Processing	1,067	17	16,660
Florida	Fresh	13,600	28	378,800
	Processing	2,500	18	43,000
	Total	16,100	--	421,800
Georgia	Fresh	11,000	12	129,150
Indiana	Processing	2,200	12	26,680
Maryland	Fresh	1,500	11	15,933
Michigan	Fresh	5,233	16	84,067
	Processing	22,500	11	247,600
	Total	27,733	--	331,667
New Jersey	Fresh	2,300	20	46,000
New York	Fresh	3,500	14	48,533
North Carolina	Fresh	5,733	4	22,567
	Processing	22,033	8	171,787
	Total	27,766	--	194,354
Ohio	Processing	3,367	22	73,093
South Carolina	Fresh	1,833	39	15,267
	Processing	7,650	7	55,180
	Total	9,483	--	70,447
Texas	Fresh	2,133	12	26,400
	Processing	9,800	10	91,633
	Total	11,933	--	118,033
Virginia	Fresh	5,767	12	71,500
Wisconsin	Processing	6,100	16	99,733
U.S. Total	Fresh	54,260	17	921,967
	Processing	109,235	11	1,184,273
	Total	163,495	---	2,106,240

--= Not available.
Source: NASS, *Vegetables: 1994 Summary*. January, 1995.

Table 2--U.S. fresh cucumbers: Supply, utilization, and price, 1970-95

Year	Supply			Utilization		Per capita use	Season average price 3/	
	Production 1/	Imports 2/	Total	Exports 2/	Total		Current dollars	Constant 1987 dollars
	Million pounds					Pounds	$/cwt	
1970	447.8	143.3	591.1	13.2	577.9	2.8	6.42	18.29
1971	432.6	157.4	590.0	11.6	578.4	2.8	7.57	20.46
1972	470.2	169.5	639.7	16.9	622.8	3.0	8.14	20.93
1973	420.6	177.6	598.2	16.5	581.7	2.7	9.34	22.62
1974	467.6	182.2	649.8	17.5	632.3	3.0	10.40	23.16
1975	496.9	131.1	628.0	22.2	605.8	2.8	10.50	21.34
1976	510.9	213.9	724.8	52.6	672.2	3.1	9.67	18.49
1977	564.7	251.0	815.7	45.9	769.8	3.5	10.00	17.89
1978	593.1	305.0	898.1	50.7	847.4	3.8	12.10	20.07
1979	592.1	320.0	912.1	49.3	862.8	3.8	14.70	22.41
1980	614.3	316.2	930.5	51.0	879.5	3.9	13.70	19.11
1981	603.7	374.6	978.3	58.5	919.8	4.0	15.20	19.26
1982	722.2	304.6	1,026.8	54.9	971.9	4.2	--	--
1983	728.6	390.6	1,119.2	56.2	1,063.0	4.5	--	--
1984	766.1	388.3	1,154.4	54.7	1,099.7	4.7	--	--
1985	723.2	380.5	1,103.7	55.9	1,047.8	4.4	--	--
1986	745.7	429.1	1,174.8	61.8	1,113.0	4.6	--	--
1987	813.3	476.0	1,289.3	59.1	1,230.1	5.1	--	--

1988	834.9	428.6	1,263.5	81.4	1,182.1	4.8	--
--							
1989	805.2	452.8	1,258.0	74.8	1,183.2	4.8	--
--							
1990	857.6	394.6	1,252.2	83.0	1,169.2	4.7	--
--							
1991	854.1	382.9	1,237.0	81.6	1,155.4	4.6	--
--							
1992	915.6	432.5	1,348.1	82.1	1,265.9	5.0	19.10
15.80							
1993	943.7	502.3	1,446.0	79.4	1,366.6	5.3	18.00
14.57							
1994	906.6	549.1	1,455.7	77.9	1,377.8	5.3	15.80
12.51							
1995 f	922.0	545.4	1,467.4	79.8	1,387.6	5.3	--
--							

-- = Not available. f = ERS forecast.

1/ Source: National Agricultural Statistics Service, USDA through 1981. Data for 1982-91 were estimated by ERS. 2/ Source: Bureau of the Census, U.S. Dept. of Commerce. From 1978-89, U.S. exports were adjusted using Canadian import data. 3/ Deflated by the GDP implicit price deflator, 1987=100.

Table 3--U.S. cucumbers for pickling: Supply, utilization, and price, farm weight, 1970-95

Year	Supply				Utilization				Season average price 4/	
	Production 1/	Imports 2/	Beginning stocks 3/ 3/	Total	Exports 2	Ending stocks 3/	Total	Per capita use	Current dollars	Constant 1987 dollars
	Million pounds							Pounds	$/ton	
1970	1,177.6	3.6	402.0	1,583.2	0.9	421.1	1,161.2	5.7	94.10	268.09
1971	1,126.2	4.2	421.1	1,551.5	0.8	401.7	1,149.0	5.5	93.20	251.89
1972	1,142.3	5.0	401.7	1,549.0	3.4	410.1	1,135.5	5.4	94.00	241.65
1973	1,197.6	5.2	410.1	1,612.9	4.7	409.4	1,198.9	5.7	99.30	240.44
1974	1,194.0	6.0	409.4	1,609.4	3.4	378.4	1,227.6	5.7	131.00	291.76
1975	1,348.5	4.5	378.4	1,731.4	3.4	406.5	1,321.5	6.1	129.00	262.20
1976	1,267.6	5.8	406.5	1,679.9	4.3	339.6	1,336.0	6.1	126.00	240.92
1977	1,247.7	6.8	339.6	1,594.1	5.8	316.3	1,272.0	5.8	126.00	225.40
1978	1,370.9	9.7	316.3	1,696.9	6.6	343.9	1,346.4	6.0	130.00	215.59
1979	1,337.9	8.0	343.9	1,689.8	6.3	367.3	1,316.2	5.8	145.00	221.04
1980	1,218.3	7.0	367.3	1,592.7	6.8	356.8	1,229.1	5.4	166.00	231.52
1981	1,150.8	5.0	356.8	1,512.6	7.2	276.5	1,228.8	5.3	175.00	221.80
1982	1,179.3	7.1	276.5	1,462.9	6.7	270.4	1,185.8	5.1	--	--
1983	1,207.9	6.7	--	1,214.6	6.6	--	1,208.0	5.2	--	--
1984	1,236.5	7.2	--	1,243.7	8.2	--	1,235.5	5.2	168.00	184.62
1985	1,388.9	9.8	--	1,398.7	9.4	--	1,389.3	5.8	178.00	188.56
1986	1,279.1	11.0	787.0	2,077.2	17.5	778.0	1,281.7	5.3	177.00	182.66
1987	1,270.9	9.6	778.0	2,058.5	25.8	688.8	1,344.0	5.5	180.00	180.00
1988	1,303.2	10.3	688.8	2,002.2	22.7	686.1	1,293.4	5.3	200.00	192.49
1989	1,285.4	11.2	686.1	1,982.7	16.1	682.8	1,283.8	5.2	204.00	188.02
1990	1,307.0	11.4	682.8	2,001.2	19.6	732.4	1,249.2	5.0	209.00	184.47
1991	1,246.1	10.6	732.4	1,989.0	20.4	686.9	1,281.6	5.1	210.00	178.57
1992	1,116.1	12.1	686.9	1,815.2	20.5	627.0	1,167.7	4.6	211.00	174.52
1993	1,174.0	16.7	627.0	1,817.6	19.4	671.9	1,126.3	4.4	215.00	174.09
1994	1,262.7	24.7	671.9	1,959.4	22.9	729.8	1,206.7	4.6	220.00	174.19
1995 f	1,190.0	18.0	729.8	1,937.8	21.0	687.3	1,229.4	4.7	--	--

-- = Not available. f = ERS forecast.

1/ Source: National Agricultural Statistics Service, USDA (1970-81, 1984-90). ERS estimates 1982-83. 2/ Source: Bureau of the Census, U.S. Dept. of Commerce. All product weight data was converted to a fresh weight basis using a factor of 0.744. Data are on a calendar year. Imports for 1970-76 were estimated as 15 percent of a misc. pickled vegetable category. 3/ Brine stocks on Oct 1 from 1970-82 as reported by the Pickle Packers International, Inc. Stocks in tanks, barrels, & fresh pack on Oct 1 as reported by USDA, NASS, converted to a fresh weight basis (factor=0.744). Stocks not

available 1983-85. 4/ Deflated by the GDP implicit price deflator (1987=100).

Georgia produce mostly fresh-market cucumbers, while Michigan and North Carolina produce mostly processing cucumbers.

Because of production practices, yields are generally lower for processing cucumbers than for fresh-market cucumbers. Processing cucumbers are usually grown on bare ground with little or no irrigation (varying by state). In contrast, growers are willing to spend more on inputs for fresh production because of the higher associated product prices. Therefore, fresh cucumber varieties are often grown on plastic mulch in irrigated fields. In addition, fresh cucumber fields are picked more often during a harvest than are the processing varieties, which results in higher yields.

While Florida, Georgia, and California accounted for 68 percent of U.S. fresh-market cucumber production over the 1992-94 period, state output is very seasonal. In the spring, most of the fresh-market cucumbers originate in Florida, South Carolina, and Texas. In the summer months, they come from New York, New Jersey, and Virginia, and in the fall months, from Virginia and Texas. Florida and South Carolina once again dominate the market in the fall through winter months (Table 4).

Michigan and North Carolina dominate pickling cucumber production. During the 1992-94 period, these two states' production accounted for 35 percent of U.S. total pickling output. The majority of pickling cucumber output is produced under contract.

Imports are an important source of fresh cucumbers, especially during the winter months. Imports have increased from about one-quarter of total supplies in the early 1970's to about one-third of the total in the 1990's (Table 2). Mexico is the major source of fresh cucumber imports. Very few pickling cucumbers are imported.

Demand

Consumer preference and per-capita use of pickling cucumbers far outpaced fresh cucumber use throughout the early 1970's (Figure 1). Preferences began to change, however, in the mid- to late-1970's, and per capita consumption of pickles declined while consumption of fresh varieties began increasing. By 1992, consumption of fresh cucumbers exceeded that of pickles for the first time.

Since the pickling process adds sodium to the cucumber, greater consumer awareness of nutrition may have contributed to this reversal in preferences. The trend may be short lived, however. Pickles are beginning to show signs of revived demand, while fresh-market cucumber consumption may be leveling off.

Exports of slicer cucumbers have been growing since the 1970's. In the early 1970's, about 3 percent of total slicer supplies were exported. By the early 1990's, exports increased to about 6 percent. Most U.S. cucumber exports are shipped to Canada.

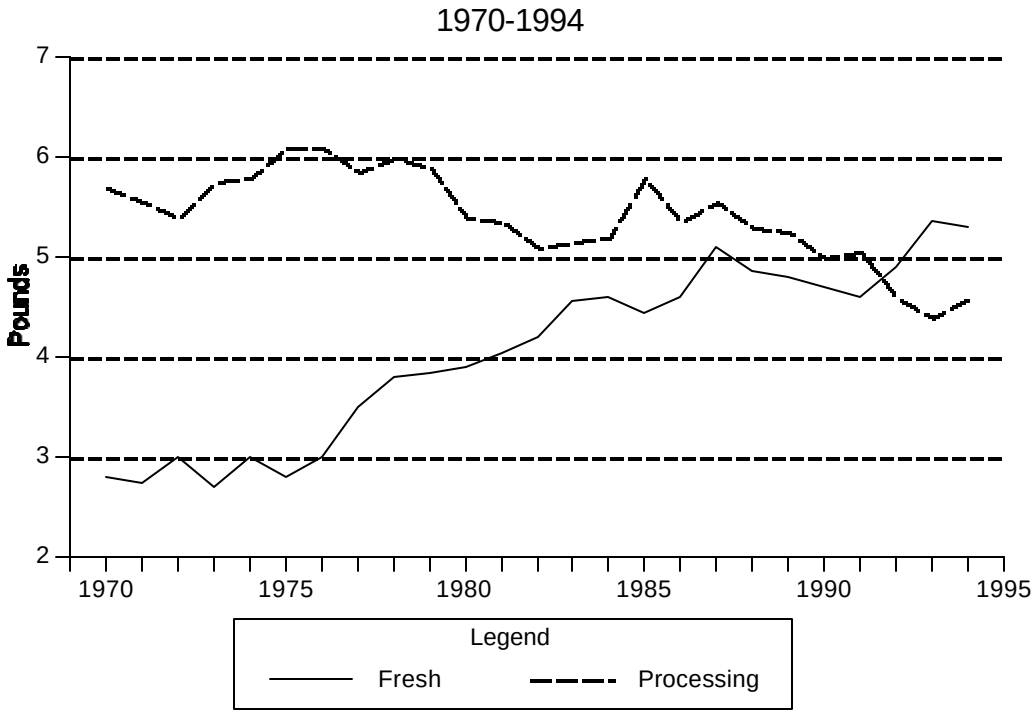
Table 4--Slicer cucumber supply by season and state, 1994

State	Area harvested by season 1/			Usual harvest period
	Spring	Summer	Fall	
	----Acres----			
Florida	8,600		3,400	Apr-June Oct-Dec
New Jersey		2,300		June-Aug
New York		3,300		July-Sep
South Carolina	1,000		1,000	May-Aug Oct-Dec
Texas	1,000		1,200	Apr-June Aug-Nov
Virginia		2,500	3,400	July-Sep Sep-Oct
Total	10,600	8,100	9,000	

1/ No cucumbers are harvested during the winter months.

Source: NASS, *1994 Vegetable Summary*.

Figure 1: Per Capita consumption



Although exports of pickling cucumbers have been minor, they have increased considerably over time. In the 1970's, exports were about 0.2 percent of total supplies, increasing to about 1 percent in the early 1990's. In the 1990's, pickling cucumber exports have been steady at about 20 million pounds.

Prices

The prices received by growers for fresh market and pickling cucumbers, in real terms, have fallen over the last 25 years. As shown in Tables 2 and 3, season average prices for slicer and pickling cucumbers, in constant 1987 dollars, declined about 32 percent between 1970-75 and 1992-94.

Cultivation and Management Practices

Slicer and pickling cucumbers differ in various aspects of their cultivation and management. Because of the higher value of slicer cucumbers, growers are willing to spend more money on inputs such as black plastic mulch, which is not used in producing pickling varieties. The varieties planted differ between the two crops, with slicer cucumber plants producing a longer, darker green fruit than the pickling varieties. Slicers tend to be planted closer together within a row. Most growers do not produce both slicer and pickling cucumbers, and in many of the major cucumber-producing states, one crop tends to dominate in production.

Climate

Cucumber seeds are best planted when soil temperatures are between 55^{o} F to 60^{o} F. If temperature are lower than 55^{o} F, seeds do not germinate. Air temperatures ranging from 70^{o} F to 85^{o} F are optimal for development of the cucumber plant. At temperatures above 85^{o} F, however, plants can become stressed, affecting fruit quality. In the case of heat-related water stress, insufficient water flows through the fruit causing the blossom end to become pinched, or "nubbed" (Neibauer). Heat stress can be alleviated with irrigation, if it is available.

Soil Requirements

Cucumbers can be grown satisfactorily on most soil types. Most cucumbers, however, are planted on sandy, loam soils which allow for good drainage. Sandy soils can produce early crops and the fruit are easy to clean. Sandy soils also allow fields to be worked the same day after a morning rain (Neibauer).

Varieties

Cucumber varieties (or cultivars) have been developed for several attributes, including those associated with market destination, disease and insect resistance, harvesting technique, and climate.

Most cultivars are generally classified as open-pollinated types or hybrids.[1] Open-pollinated cultivars are true-breeding, and have separate staminate (male) and pistillate (female) flowers on the same plant. Such a plant is called "monoecious." Hybrid cultivars are not true-breeding. A new hybrid seed must be produced for each crop by crossing unrelated parents. Hybrids may be monoecious or "gynoecious," in which the flowers are only female.

While cucumber cultivars can be either monoecious or gynoecious, only the female flowers produce fruit. The seed of a monoecious cultivar is mixed with the seed of a gynoecious cultivar to provide the male flowers for pollen production. The monoecious cultivar is chosen so that the flowering dates and fruit quality are similar to those of the gynoecious hybrid (G. Hochmuth).

Gynoecious cultivars usually produce earlier yields than monoecious varieties. However, the quality of the early yield can be reduced because the gynoecious plants set several fruits while the plants are small. In addition, the female flowers may bloom before enough male flowers bloom, causing poor pollination. These situations can lead to reduced quality associated with the early harvest (G. Hochmuth).

Cultivars for both the fresh and pickling markets can be either monoecious or gynoecious. The cultivars for each of these markets, however, vary by size, color, spine, and vine habit. Pickling cucumbers are smaller and blockier than fresh-market cucumbers and have a smaller diameter-to-length ratio. Pickling cucumbers should have a green color with a white spine, while fresh-market cucumbers should have a uniform dark green color (G. Hochmuth).

The major cultivars for the fresh market are Centurion, Dasher II, Early Triumph, Floracuke, Raider, Sprint 440, and Poinsett 76-S. Pickling cucumber cultivars include Addis, Calypso, and Carolina (G. Hochmuth).

Planting

Slicer cucumbers typically are planted from seed, although transplants occasionally may be set in the field. They can be planted either under black plastic, which can help produce an early harvest, or in the bare ground. When plastic is used, seeds are planted so that there are 4 to 5 feet between rows, and 6 to 30 inches within a row, depending on the location (G. Hochmuth, Neibauer). On bare ground, the seeds are planted with 4 feet between rows and 2 feet within the row (Neibauer).

Pickling cucumbers are usually planted on bare ground because harvesting an early crop is less important than for certain other vegetables. When hand harvesting is to be used, seeds are planted with about 3 feet between rows,

[1] Parthenocarpy cultivars also exist. They are grown in greenhouses, produce fruit without pollination, and do not develop seeds. If grown in the field, however, these cultivars would be pollinated and would develop seeds (G. Hochmuth).

and 2 to 18 inches within the row (Hochmuth, Neibauer). If the field is to be machine-harvested, row widths of 4 feet generally are used.

Mulching

Black plastic mulch is used by most growers for the production of slicer cucumbers. Mulch helps promote germination and results in earlier fruiting of the plant. By using mulch, many growers can plant from seed and still obtain fruit early in the season (Neibauer).

Pickle cucumber production does not require the use of mulch, with most pickle varieties grown on bare ground. Pickles are sold under contract and do not need to meet a specific market window in order to obtain a high price. As a result, the timing of production is less important than for slicer cucumbers, and pickle cucumber producers do not typically believe that the added cost of the black mulch is warranted.

Fertilization

Important nutrients in cucumber production are phosphorous, potassium, and nitrogen. The quantity of each nutrient applied at planting-time depends on the fertility of the soil (G. Hochmuth).

In non-mulched fields, phosphates should be placed in the root zone, since phosphate movement in the soil is minimal. About one-half of the nitrogen and potassium requirement should be applied at planting-time. The remainder should be banded in split applications during the early part of the growing season (G. Hochmuth).

In plastic mulched fields, fertilization depends to a large extent on the type of irrigation system in use. With an overhead system, fertilizers should be incorporated into the beds before mulch is applied. With seepage irrigation, phosphates and micronutrients should be incorporated into the beds along with 10 to 15 percent of the nitrogen and potassium. The remainder of the nitrogen and potassium should be placed in narrow bands in grooves on the surface of the finished beds prior to mulching.

With drip irrigation, fertilizers can be applied during irrigation, through a liquid injection wheel, or by placing the nitrogen and potassium in or on the beds before mulching (G. Hochmuth).

Irrigation

Adequate soil moisture is necessary throughout all phases of crop development. Critical periods include seed germination, and during flowering and fruiting. Irrigation is also useful to help reduce plant stress during hot, dry periods (G. Hochmuth, Neibauer).

Pollination

Most cucumber cultivars require pollination for fruit set and development, with honey bees being the most effective pollinators. Approximately 1 to 2 hives per acre are usually placed along the edge of the field when the plants begin to bloom. The colonies should remain in place until about 7 days before the completion of the harvest.

Fields that are planted with gynoecious cucumber cultivars must be mixed with a sufficient number of pollinator cultivars to ensure adequate pollination. Parthenocarpic cultivars must be grown in a greenhouse environment, which excludes bees and pollen from the environment (G. Hochmuth).

Harvesting

Fresh-market cucumbers are ready for harvesting when they are about 6 to 10 inches long and 1.5 to 2.5 inches in diameter. The cucumber should be dark to medium green, without any signs of yellowing. On average, 58 to 65 days are required from seeding to maturity, depending on the cultivar and the growing conditions (G. Hochmuth). The timing of harvest varies by location and state (Table 4).

Pickling cucumbers are ready for harvesting when the ratio of length-to-diameter ranges from 2.9 to 3.1. The cucumbers should be medium green, slightly lighter than fresh cucumbers, without any signs of yellowing. On average, it takes 55 to 65 days from seeding to maturity, depending on the cultivar and growing conditions (G. Hochmuth).

Fresh-market cucumbers are harvested by hand. Because the individual fruits do not develop and mature consistently, the timing of maturity is not uniform within a field. As a result, fresh-market cucumbers typically are picked between 6 to 8 times over a 3-week period (Zandstra). In some situations, fresh-market cucumbers can be picked up to 12 to 15 times in a season.

The number of pickings depends on when the seeds are planted and the supply and demand situation in the market. Price is an important factor in picking. Once prices for cucumbers fall below a certain level, it become uneconomical for growers to continue harvesting (Neibauer, Shuler).

Pickling cucumbers are either hand or machine harvested. Hand harvesting is common in areas where migrant labor is readily available. When harvested by hand, the field is typically picked 5 to 6 times (Neibauer). Pickling cucumbers must be harvested at 3- or 4-day intervals to prevent oversizing (G. Hochmuth). If a machine is used for harvesting, however, the field is only picked once.

Once picked, the cucumbers are placed into plastic pails or baskets that hold about one-half bushel. The filled containers are dumped into gondolas, truck beds with an inclined bottom, or pallet boxes for transport from the field to the packinghouse or processor.

Packing and Shipping of Fresh and Pickling Cucumbers

Most growers of slicer cucumbers either have their own packinghouses or use conveyor lines (Neibauer, Shuler). Smaller growers, and many northern Florida growers, however, transport cucumbers in picking containers to packinghouses on larger farms or to a centrally-located packinghouse (R. Hochmuth). Once the cucumbers are brought to the packinghouse they are graded, sorted by size, waxed, and packed. Grading standards for slicers are set by USDA and the industry. Slicers are graded either select or super select (Neibauer).

Pickling cucumbers are trucked in bulk to processors, who grade and size the cucumbers. The packing industry sets the standards for pickling cucumbers. The price that processors pay growers for their cucumbers is based on the size of the fruit, with smaller cucumbers commanding a higher price (Neibauer).

Marketing

In the fresh-market cucumber industry, growers typically work with one or two brokers who make contacts with buyers. Brokers either buy at the farm-level, or from growers who bring their cucumbers to state farmers markets, such as the Pompano State Farmers market in Florida (Shuler). Most slicers are sold to grocery chains. Large growers may serve as their own brokers, with a sales staff establishing the operation with large retailers (Shuler). Few slicers are sold locally through road-side stands (Neibauer).

The majority of pickling cucumbers are grown under contract with major pickle-processing companies, such as Vlasic and Heinz (Table 5). Contracts are usually established early in the season. Processors have field personnel who go into production areas, talk with growers, and sign contracts for a certain quantity to be delivered in tons. The price for that tonnage is established at the time the contract is signed (Neibauer). If production exceeds the pre-specified tonnage, processors often will buy the excess, provided that an oversupply of pickling cucumbers does not exist in that year. Otherwise, any excess of pickling cucumbers is not picked (Zandstra).

Costs of Production

The cost of harvesting a fresh-market cucumber crop is an important factor in determining whether or not to continue picking once market prices have begun to drop. Harvesting costs are a major part of average variable costs because the harvest is hand picked. In Florida, harvest costs were estimated to be 67 percent of total variable costs in 1993/94 (Table 6, Appendix tables).

Once market values fall below a certain level, picking is often terminated or a newer field is harvested, where the crop is more abundant and the cucumbers are of higher quality (Neibauer, Shuler, R. Hochmuth, Reiners, Schultheis). In Michigan, for example, it is estimated that if prices fall below $6.00 per bushel, growers will not be able to cover their costs and will abandon the remainder of the fresh-market crop (Neibauer).

Table 5--Cucumbers for pickles: Area planted and under contract by state, 1994 and 1995

State	1994		1995	
	Area planted	Area under contract 1/	Area planted	Area under contract 1/
	----Acres---			
California	5,000	4,800	NA	5,500
Colorado	900	900	840	840
Florida	2,100	850	NA	2,600
Indiana	2,400	2,400	2,400	2,400
Michigan	24,500	21,000	22,000	22,000
North Carolina	25,500	19,100	12,400	12,400
Ohio	3,200	3,100	3,000	3,000
South Carolina	8,300	8,300	7,000	7,000
Texas	13,900	11,000	NA	11,500
Wisconsin	6,200	5,800	6,200	6,200
Other States 2/	28,410	20,500	26,640	26,640
Total	120,410	97,750	100,080	100,080

NA = Data were not published to avoid disclosure of individual operations.
1/ Includes acreage from major brokers.
2/ Alabama, Arizona, Arkansas, Delaware, Georgia, Illinois, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, New York, Oregon, Virginia, and Washington.

Source: NASS, *Vegetables*. Released July 14, 1995.

Table 6--Costs of producing cucumbers

State	Market variety	Unit	Harvesting cost	Average variable cost	Harvest as percent of average cost
Florida 1993/94	fresh	$/bu	4.66	6.99	67
Michigan 1/ 1992	pickle	$/ acre	35.50	488.57	7

1/ Machine harvested.

Sources: Smith and Taylor, *Production Cost for Selected Vegetables in Florida, 1993-94*, Univ. of Florida, and Shapley and Dudek, *Cost of Producing Machine Harvested Pickling Cucumbers*, Michigan State University.

Cost of production is not a significant factor in harvesting the majority of the pickle cucumber crop. Most of the crop is contracted at a predetermined price, and growers will continue to harvest until they reach the quantity for which they contracted. The oversupply, as well as oversized cucumbers, however, may not be harvested if prices are low or if processors are uninterested in purchasing them.

Production Perils

Weather conditions affect cucumbers differently at various production stages. If damage occurs to young plants, fields can often be replanted. However, many growers plant other vegetable crops after their cucumber crop, and replanting may not be feasible if it interferes with the next crop. Weather damage occurring after the plant has produced fruit is typically the most severe, and may result in an unmarketable crop, depending on the extent of the damage and market conditions.

Excessive Rain

Excessive rains can destroy a cucumber plant, particularly when the plant is grown in clay soil. In such situations, the plants' roots may rot, killing the plant (Zandstra). Excessive moisture under other conditions, while not killing the plant, may cause the fruit to become deformed. The moisture may stress the plant, causing the fruit to form nubs, a condition in which the fruit becomes pinched at the blossom end (Neibauer). These fruit have a lower value or may be unmarketable. Excessive rains also encourage many diseases (Shuler).

Excessive Heat

Temperatures in excess of 85^{o} F for long periods can stress cucumber plants (Neibauer). Excessive heat can cause the blossoms to wither and fall off the plant, or may create poor fruit set (Zandstra). Many growers, however, have irrigation, which can help alleviate the effects of excessive heat.

Excessive Winds

Most cucumbers are grown on sandy soils. Heavy winds can create sand storms, destroying the leaves of new plants or uprooting them (Zandstra). Wind can also be a problem if cold winds occur after the fruit has begun to develop. The winds injure the leaves that protect the fruit, and may cause pitting marks on the cucumber. This scarring, however, may not appear until the cucumber is mature (Shuler). If the scarring is severe, the cucumber may be unmarketable.

Frost

Frost can be a serious problem for slicer cucumber production in all parts of the country. Cucumbers are very sensitive to the cold and a frost can easily kill the plant. In the Midwest, most growers wait to plant their cucumbers until after the threat of frost is past (Neibauer). However, growers trying

to get an early start on production may plant early, increasing the risk of losing their crop to frost.

Also, unexpected late spring and early fall frosts can destroy cucumber crops in both the North and South (R. Hochmuth, Reiners). Spring frosts affect plants early in the season, and growers may have sufficient time to replant. Fall frosts, however, may damage the fruit and make the crop unmarketable.

Growers of pickling cucumbers do not have to meet market windows in order to obtain desirable prices. As a result, pickling cucumber producers typically wait longer to plant, until the threat of early spring frosts is past. Most of the pickle harvest is completed before the threat of fall frosts (Zandstra).

Drought

Droughts or excessive dryness may result in low yields or poor fruit formation (Zandstra). Poor fruit formation reduces the price of slicer cucumbers, and may make pickle cucumbers unacceptable to processors. In most cases, the effects of drought can be alleviated with irrigation. In some areas, however, such as in Michigan, the water supply may be insufficient and water sources can be pumped dry. In such situations, drought can totally destroy a cucumber field (Neibauer).

Hail

Hail that affects young plants may result in shredding of the leaves and stems. Later in the season, hail can pit the fruit, creating entryways for diseases and making the crop unmarketable (Zandstra). In severe cases, a heavy hailstorm can shred the entire plant, including the fruit, reducing the yield to zero (Neibauer).

Cool Summers

Temperatures need to reach about 85^{o} F for cucumber plants to produce their highest yields. In the northern states, some summers do not have enough consecutive days in the 85^{o} F range, reducing fruit formation and yields (Reiners).

Poor Pollination

Several factors can cause poor pollination. One factor is cloudiness, which reduces the activity of bees. If cloudiness persists when the plants are in bloom, pollination can be affected and yields may be reduced.

A second factor is the availability of bees for pollination. The wild bee population has been reduced by aphids, making growers more reliant on bee keepers to provide enough bees for adequate pollination. Availability of bees can also be a problem if another crop is in bloom which has blossoms more attractive to the bees, such as alfalfa. Even domesticated bees may leave the cucumber field if a more attractive crop is blooming nearby.

Poor pollination not only reduces yields, but may cause nubs (a pinched appearance) on the cucumbers that form. Nubs due to insufficient pollination appear on the stem end of the fruit.

Insects

Several insects may damage cucumber plants. Controlling insects is important because many insects transmit diseases. In addition, pickling contracts often require complete insect control.

Aphids

Aphids are small, soft-bodied insects. They usually feed on the undersides of young leaves and on the vine tips by sucking sap from cells. While feeding, they may inject toxins, which cause the leaves to become twisted and cupped. Aphid infestations produce a sticky secretion known as honeydew. The honeydew makes the fruit unattractive and can provide a medium for the growth of black sooty mold. Aphids also may transmit viruses. Insecticides can be used to control aphid infestations (G. Hochmuth).

Armyworms

Armyworms are larvae that are distinguishable by the white or light-colored inverted "Y" on the front of the head. The worms feed during the day, mostly in the leaf whorls or other compact plant parts. Insecticides can be used to control armyworms (G. Hochmuth).

Cucumber Beetles

Adult striped or spotted cucumber beetles are small, light yellow beetles that feed on the plants' foliage and flowers. Their larvae feed on the roots or tunnel into the root system. Insecticides are used for control (G. Hochmuth).

Cutworms

Cutworms are stout, slick-appearing, dark larvae that feed on plant foliage or cut the plant stems at night. They can be found during the day close to the plant in the soil. Baits, applied in the afternoon, are the best control (G. Hochmuth).

Flea Beetles

These small beetles have enlarged hind legs which permit them to jump great distances. They are either bronze, brown, or black in color. The adult beetles feed on leaves, causing a shot-holing effect. Insecticides can be used to control beetle populations (G. Hochmuth).

Leafminers

The adult leafminer is a small, black fly which lays eggs in the leaf tissue of the cucumber plant, resulting in spotting or a white, stippled appearance.

The larvae appear as small, yellow maggots, which feed just under the surface of the leaf tissue, leaving a winding trail. Because of the protected feeding habits of the larvae, control is difficult. Insecticides must be alternated since leafminers readily develop resistance (G. Hochmuth).

Mites

Several species of mites attack cucumber plants, but the red spider mite is the most common. In periods of hot, dry weather, the leaves of infested plants may become light colored or blotched, and they eventually dry up and die. Mites feed on plant sap, which is drawn through the insects' lancing mouth parts. They spin webs and leave behind numerous molted skins on the leaves. Insecticides are effective at controlling mite populations (G. Hochmuth, Reiners).

Mole Crickets

Mole crickets are nocturnal insects rarely observed during the day. They damage the cucumber plant by tunneling under and around the root systems. Occasionally, they may feed on the roots. Baits can be used for control (G. Hochmuth).

Pickleworms

The eggs of pickleworm moth larvae are laid on the young portions of the cucumber plant or fruit. The pickleworms are the young larvae which feed on the stems, flowers, or foliage of the cucumber plant. The older, whitish-to-green caterpillars bore into the fruit and feed on the fruit's interior. During feeding, masses of green, gummy, sawdust-like excrement is pushed out of the entry hole.

Four to five generations of the pickleworm can be produced in a season. The damage from the larvae causes the fruit to rot, and can lead to rejection of whole loads of cucumbers by processors. Control of pickleworms is difficult since the larvae must be killed before it bores into the fruit. Timing of insecticide application is critical (G. Hochmuth).

Stink Bugs

There are several types of stink bugs, all of which are characterized by an offensive odor produced when they are disturbed. Stink bugs remove plant sap and inject toxins through the use of their piercing, sucking mouth parts, weakening the plant (G. Hochmuth).

Sweet Potato White Flies

Sweet potato white flies carry viruses that may destroy the cucumber plant. The flies are most prevalent in the fall after they have had the spring and summer to reproduce. Because they die off in the winter, fly populations are at their lowest levels in the spring (R. Hochmuth).

Thrips

Thrips are small, slender insects that usually inhabit plant blossoms. They damage the plant by rasping the surface, and then by feeding on the sap that is exuded. Thrips can cause petal or leaf distortion (G. Hochmuth).

Wireworms

Wireworms are the slender, shiny, yellowish-brown larvae of click beetles. They are one of the most damaging soil insects. The larvae are long-lived in the soil and the damage they cause can be quite sudden. Crop rotation is recommended to control the insect. Preplant chemical control, however, is most commonly used to control damage (G. Hochmuth).

Nematodes

The two most common nematodes affecting cucumber plants are the root-knot and the sting nematode. These nematodes cause stunting, wilting, and chlorosis (yellowing or blanching) of the plant. Above-ground symptoms alone, however, are not sufficient in diagnosing their presence.

The roots of the plant infested with root-knot nematodes have galls which will interfere with normal water and nutrient uptake by the plants. In contrast, sting nematodes feed on the sap of small roots, leaving only brushes of coarse roots.

Fields should be tested for nematodes prior to planting with cucumbers. Soils known to be infested should be avoided or treated with approved nematicides or fumigants (G. Hochmuth).

Diseases

Several diseases commonly affect cucumber crops. The disease organism may be present at any stage of growth, from the seedling stage through harvesting and shipping. Use of disease-resistant varieties helps reduce yield losses. Diseases become a problem, however, when the plants are stressed from drought, excessive moisture, and heat. Disease problems also tend to be worse during the late summer and fall months when insects that carry diseases are most abundant.

Alternaria Leaf Blight

Leaf blight (*Alternaria cucumerina*) is a bacterial disease. It produces small, circular tan spots on the oldest leaf surfaces. As the spots enlarge, they form concentric rings. Crop rotation and fungicidal sprays can help control this disease (G. Hochmuth).

Angular Leaf Spot

Angular leaf spot is a bacterial disease caused by *Pseudomonas syringae* pv *lachrymans.* The bacteria causes angular, water-soaked lesions on the leaves

that dry and leave angular holes. Spots on the fruit are generally smaller than the leaf lesions, and are nearly circular and slightly sunken. Often, affected cucumbers are difficult to cull during grading. The fruit's internal flesh turns brown below the skin lesion and the discoloration may extend the length of the fruit.

The disease is most serious during wet springs. Disease-free seed, resistant cultivars, and chemical sprays help control the bacteria, which can survive in crop debris. Also, plants should not be handled when wet (G. Hochmuth).

Anthracnose

Anthracnose is caused by the fungus *Collectotrichum lagenarium (Glomerella cingulata)*. The fungus appears on the foliage as small, yellow or red-brown water-soaked spots, which enlarge and turn brown. Dead tissues dry and the affected parts may drop from the plant.

On the fruit, the circular, sunken, water-soaked lesions become dark green or brown. During wet weather, pink sore masses may appear in the center of the lesions. The disease develops rapidly during wet periods when temperatures are between 70° F to 80° F. The fungus also attacks watermelons, cantaloupes, and several weed species. Resistant cultivars and fungicides help control anthracnose. If possible, wet plants should not be handled (G. Hochmuth).

Belly Rot

Belly rot is caused by the common soil fungus *Rhizoctonia solani.* The disease is most likely to occur when temperatures are above 82° F and the humidity is high. First indications of belly rot include a yellow-brown superficial discoloration, which develops into a sunken, irregular lesion or pit on the underside of the fruit. Large, water-soaked decay areas develop on mature fruit.

To control belly rot, fields should be rotated out of cucumbers for at least 2 years and all previous crop residues should be plowed under. Use of full-bed plastic mulch reduces the occurrence of the disease (G. Hochmuth).

Cottony Leak

Cottony leak is caused by the *Pythium aphanidermatum* fungus. This disease primarily causes fruit rot, but can also cause seedling damping-off or vine cankers. The fungus can attack any part of the fruit, causing dark green, water-soaked lesions. Once infected, the fruit becomes soft and mushy, and covered with white, cottony mold. The disease can be serious before and during transit of the cucumbers. Cottony leak is best controlled if the cucumbers are planted in well-drained beds, and the fruit are harvested into clean containers. Harvesting from infected areas should be avoided (G. Hochmuth).

Damping-Off

Damping-off is a fungal disease caused by various *Pythium* species and by *Rhizoctonia solani*. The disease may prevent seeds from emerging from the soil and may cause young seedlings to fall over, exhibiting a discolored stem that is constricted at the soil line. To control damping-off, seeds should only be planted when soil conditions favor rapid seedling emergence. Fungicide-treated seeds should be used, and these seeds should be planted as shallow in the soil as possible (G. Hochmuth).

Downy Mildew

Downy mildew is caused by the fungus *Pseudoperonospora cubensis.* The disease first appears on the upper leaf surfaces, creating angular, yellow spots. During damp weather, gray mold may also appear on the undersurfaces of the leaves. General leaf yellowing develops and the affected leaves turn brown and die.

Downy mildew is controlled through the use of resistant cultivars and by the application of fungicides. Once detected in the field, plants must be treated immediately because downy mildew spreads quickly. Wet plants should not be handled to also facilitate control (G. Hochmuth).

Fusarium Wilt

Fusarium wilt is caused by the fungus *Fusarium oxysporum* f.sp. *cucumerinum.* The fungus infects cucumbers at any stage of growth. It can cause damping-off in the seedling stage, or wilting of vines in older plants. When infection is present, the vascular tissue of the lower stem shows a brown discoloration when cut open, and a pink mold may be evident on the exterior. Once Fusarium wilt is evident, fields should be rotated for a minimum of 5 years to such crops such as crucifers, legumes, or solanaceous crops. If rotation is not possible, soil fumigation may help control Fusarium wilt (G. Hochmuth).

Gummy Stem Blight

This disease is caused by the fungus *Phyllosticta citrullina (Mycosphaerella citrullina)*. It can be seed-borne, and is able to survive in crop and weed debris. It usually begins at the crown, where it causes lesions that are brown, turning white with age. These lesions often exude sap. Leaf lesions are round or irregular, and brown with a faint zonation. Control of gummy stem blight requires the use of fungicide-treated seeds and fungicidal sprays at the first signs of the disease (G. Hochmuth).

Powdery Mildew

Powdery mildew is a fungal disease caused by the species of *Oidium (Erysiphe cichoracearum).* It first appears as round, white spots on older leaves. The spots enlarge, appearing on the upper leaf surfaces. Severe infections cause the leaves to turn yellow and die, leaving the cucumber fruit exposed to the

sun. Resistant or tolerant cultivars, as well as fungicides, help control powdery mildew (G. Hochmuth).

Scab

The fungus *Cladosporium cucumerinum* causes scab, which appears as small brown spots with yellow margins on the leaves of the cucumber plant. On the fruit, it causes sunken, gray spots, which ooze a sticky material. Spots may grow together, causing large, scab-like lesions. Olive-green spores may appear in the spots during humid periods.

Scab is most severe during cool weather. It can be seed borne and may survive in old crop refuse. It can also be spread by spores in wind, splashing water, clothing, and tools. Scab can be controlled with the use of 3-year rotations, scab-resistant cultivars, and fungicides (G. Hochmuth).

Target Spot

Target spot is a fungal disease caused by *Corynespora cassiicola*. Symptoms initially appear on the leaf as yellow flecks with a definite outline. The spots become circular, with light brown centers surrounded by dark brown margins.

Target spot and angular leaf spot are similar in appearance. The lesions that appear when target spot is present are 1/8- to 3/8-inch in diameter, but may grow together to form large dead areas. Controlling the disease includes avoiding field work when plants are wet, and using fungicides (G. Hochmuth).

Watermelon Mosaic Virus 1 and 2

Watermelon mosaic viruses are transmitted by aphids, and may infect various cucurbit crops including muskmelon, watermelon, cucumbers, and squash. The viruses cause infected leaves to become stunted and to show various degrees of mosaic distortion. The fruit may be mottled and distorted. Controlling these viruses requires destroying weeds around cucumber fields, and isolating cucumber fields from other cucurbit plantings (G. Hochmuth).

State Analyses

The state analyses cover four representative states: Florida, Michigan, North Carolina, and New York. Florida and Michigan are selected because they are the two largest cucumber-producing states, and are representative of fresh-market and pickling production, respectively. North Carolina is selected as it is a major pickling cucumber producer in the South. Because North Carolina produces mostly pickling varieties, production patterns vary from those in Florida. New York is selected as a representative state because of its large fresh-market output, which occurs at a time when cucumbers are not grown in Florida.

Florida

Florida is the number-one U.S. producer of fresh-market cucumbers, with an average of 13,600 acres over the 1992-94 period. Palm Beach County has the largest acreage devoted to cucumber production in the state. Other major producing counties include Manatee, Hendry, and Collier (Shuler, Census). The value of slicer production in the state totalled about $47 million in 1994 (NASS).

Florida also produces pickling cucumbers, although they accounted for only 15 percent (about 2,500 acres) of the state's total cucumber area over the 1992-94 period (NASS). Pickling cucumbers are grown mostly in central Florida, in Seminole, Lake Volusia, Sumter, Hillsborough counties, and in Dade County (R. Hochmuth). The value of Florida's processing cucumbers totalled about $11 million in 1994 (NASS).

Planting

Florida's fresh-market cucumbers are planted in both the spring and fall, with the spring planting the largest. Palm Beach County growers plant continuously from August through May. In the northern counties, planting begins in mid-to-late March for the spring harvest, and in August for the fall harvest (R. Hochmuth). The winter crop is small relative to the spring and fall crops. Most growers do not plant in June and July, when the cucumber harvest in other states is abundant (Shuler).

In southern Florida, cucumbers are planted on black plastic using either sub-surface or overhead irrigation. The average size farm that produces cucumbers is between 200 and 5,000 acres. Cucumbers are usually a second crop for most southern Florida growers, after they have harvested their tomato, pepper, and eggplant crops (Shuler).

In the northern counties, about half the farmers grow cucumbers on black plastic, and the other half grow on bare ground. Those with black plastic use drip irrigation, while other growers use overhead irrigation. The average size farm growing cucumbers in northern Florida is about 200 acres.

Only about one-quarter of the acreage on northern Florida cucumber farms is typically used for raising fresh vegetables (including cucumbers, peppers, squash, tomatoes, watermelons and collard greens). The remainder of these operations are typically devoted to raising cattle, as well as to pastureland, pines, and field crops such as tobacco (R. Hochmuth).

Harvesting

Florida's slicer cucumbers are all hand harvested. The largest portion of southern Florida's crop is harvested in late May (Shuler). In the northern counties, harvest is from May to June, and again in late September through October.

The number of times a cucumber field is picked depends on market conditions. In general, however, fields in southern Florida counties may be picked 8 to 10 times if the crop is planted in early spring. For late spring plantings, a field will only be picked about 3 to 4 times, before prices fall too low to make picking economical.

As prices decline, so do the number of times the crop is picked. Once the price drops below a critical point, harvesting stops completely. During the spring, when planting is a continuous process, harvesting of fields that have already been picked several times that season may be abandoned in favor of newer, more productive fields (Shuler).

In northern Florida, spring-planted cucumber fields may be harvested from 6 to 8 times. Fall-planted fields are usually harvested about 5 times (R. Hochmuth).

Marketing

In southern Florida, most large growers have their own packingsheds. Smaller growers have conveyor lines and temporary sheds, that are often used for other vegetables, as well as for cucumbers. Cucumbers are graded, waxed, and packaged at these packing facilities.

Some large growers have their own sales staff that sell directly to retail grocery chains around the country. Other growers take their crop to the Pompano State Farmers Market, where brokers market cucumbers to wholesalers and retail chains (Shuler).

In the northern counties, cucumbers are taken from the field to central, cooperatively-owned locations where they are graded, waxed, and packaged. Brokers work out of these locations, selling cucumbers to wholesalers and retail chains (R. Hochmuth).

Production Perils

Production perils differ somewhat between southern and northern Florida. In southern Florida, the major perils are weather-related, and include heavy rains and windstorms. Heavy rains cause root or fruit rot, and increase the presence of diseases. Heavy winds may tear or shred the leaves. Young fruit may become scarred, although the scarring may not show up until the fruit has reached maturity, making it unmarketable.

Poor pollination due to cloudiness or windiness can also reduce production. The market is also seen as a major peril to production, especially around the time that production in southern Florida coincides with production from other states (Shuler).

In northern Florida, weather affects the spring and fall crops differently. In the spring, an early frost may kill off young plants, requiring replanting. If frosts occur later, the fruit may be destroyed, as cucumbers are very

sensitive to cold damage. Hail also can destroy the crop, especially if it occurs in May, near the time of the spring harvest (R. Hochmuth).

Heavy winds, especially in association with rain and hail, can also destroy a crop. Winds early in the season can cause sandblast, which occurs when sand and soil are blown against the plant. Excessive rain can cause root rot, bloating, and increase the presence of disease organisms.

In the fall, risks of storms increase. Hurricanes become a problem during the fall harvest months of August through October. Later fall plantings can be killed by early fall frosts. While frost is not common in October, it has occurred (R. Hochmuth).

Spring plantings are less affected by diseases than plantings in the fall. In the spring, insect populations are lower, and disease is spread less easily. By fall, these insect populations, especially aphids and sweetpotato white flies, have had time to build up, increasing the spread of disease (R. Hochmuth).

Demand for Crop Insurance

Florida's cucumber growers received about $5.3 million in disaster assistance payments over the 1988-93 period. Almost half of these payments were made in 1993 for the 1992-93 growing season. During that year, growers were affected by the "storm of the century," which damaged the plants' foliage, as well as frosts and cool temperatures that slowed fruit development. The cool weather moved southern Florida's harvest in that year so that it coincided with the harvest in northern Florida (Florida Agricultural Statistics Service, Shuler). Crop insurance for cucumbers may be well received in Florida. Growers would likely see it as a good risk management tool. Many already have insurance for other vegetables and field crops (Shuler, R. Hochmuth). Some growers may see crop insurance as giving them an edge, permitting them to take added risks, including planting cucumbers in the winter months in southern Florida, when the weather is more variable (Shuler).

Michigan

Michigan is the largest producer of pickling cucumbers in the United States, accounting for 21 percent of the U.S. total over the 1992-1994 period. In 1994, Michigan harvested 24,500 acres of pickling cucumbers, producing about 264 million pounds (NASS). Pickling cucumbers are grown throughout the state. Michigan is also an important producer of slicer cucumbers, accounting for about 10 percent of U.S. output over the 1992-94 period (NASS). Slicer cucumbers were harvested on 5,400 acres in 1994, producing about 92 million pounds. Slicer production is concentrated in Allegan, Cass, Van Buren, and Berrien counties in southwestern Michigan (Michigan Department of Agriculture).

Planting

Slicer cucumbers are planted beginning in early May (Neibauer). As a result, Michigan can produce an early crop of cucumbers for the fresh market, with harvesting beginning in late June.

Pickling varieties are planted between May 20 and the beginning of June, with planting continuing through the end of July. Harvest begins in early July and extends through September and October (Zandstra).

The average size farm that grows cucumbers in Michigan is about 300 acres, with between 30 to 100 acres devoted to cucumbers. Most growers of slicer cucumbers also plant tomatoes or other fresh vegetable crops. Growers of pickling cucumbers typically produce other fresh vegetable crops, fruits, or grain crops. Very few Michigan cucumber growers produce both slicer and pickling cucumbers (Neibauer).

Michigan's cucumbers are grown mostly on sandy loam soil from seed. Only about 10 percent of the slicer producers use transplants. Seeds are cheaper and produce almost as early as the transplants if grown under black plastic mulch (Zandstra).

Most slicer cucumber producers use plastic mulch to promote early growth. All pickling cucumbers are grown on bare ground since earliness of the crop is not important, and most growers do not wish to incur the expense of the plastic (Neibauer). Most producers use irrigation, with overhead irrigation the most commonly-used system (Neibauer).

Harvesting

Cucumber harvesting begins around the middle of July. Slicer cucumber fields are hand harvested, with fields picked about 12 to 15 times in a season.

Pickling cucumbers grown in southwestern Michigan are also hand harvested, as labor is already available to harvest other vegetables and fruits. In other parts of the state, most pickling cucumbers are machine harvested. Pickling cucumbers are picked 5 to 6 times if they are hand harvested. If machine harvesting is used, picking occurs only once.

When hand harvesting is used, crews pick the cucumbers and place them into buckets. The full buckets are then emptied into bulk boxes. For slicers, the cucumbers are then trucked to packinghouses or sheds, most often located on the farm. In the packinghouse, the cucumbers are graded, sorted, waxed, and packaged (Neibauer). Growers work with one or two brokers, who make contacts with buyers. Most slicer cucumbers are sold to large grocery chains.

Pickles are trucked in bulk boxes directly to processors. Most of Michigan's pickling cucumbers are sold to Vlasic or Heinz. Michigan also has one private processor. Processors grade the pickles, with the smaller pickling cucumbers receiving the highest prices (Neibauer).

Production Perils

The major perils to cucumber production in Michigan are excessive moisture, heat, dryness, wind, cloudiness at pollination time, diseases, and hail (Zandstra, Neibauer).

To combat excessive heat and drought, most of Michigan's cucumber fields are irrigated. Most irrigation systems, however, rely on ponds which may become depleted if water demands are heavy. To control for problems caused by excessive moisture, most cucumbers are grown on sandy soils.

Most cucumber varieties are bred for disease resistance. However, diseases can still create problems for cucumber production, especially during prolonged wet periods, and during drought, when the plants become stressed and are less able to maintain their resistance. Diseases that may reduce cucumber yields in Michigan include root rot, fruit rot, angular leaf spot, Phytophthora, scab, and anthracnose. Since diseases are often spread by insects, pesticides are helpful in disease control.

Frosts are not usually a problem in Michigan. Most pickle planting is done after the threat of frost is past. Some slicer growers, however, attempt to harvest an early crop and lose plants to frost. Frosts usually occur early enough in the production cycle that growers can reseed their fields.

Demand for Crop Insurance

Michigan received the second largest volume of disaster assistance payments of any state during the 1988-93 period, totalling almost $10 million. Cucumber growers received payments primarily for losses caused by drought, excessive heat, cold, and moisture (Gavrun).

Even though the state's cucumber growers received large disaster assistance payments, extension contacts did not foresee a heavy demand for cucumber crop insurance. They believe that most perils are at least partially controllable. Some growers, however, already have insurance for crops that are currently eligible, and may be interested in coverage for cucumbers (Neibauer).

New York

New York is a major summer producer of fresh-market cucumbers, harvesting 3,300 acres in 1994, and accounting for about 41 percent of U.S. summer-harvested cucumber area (NASS). Counties with the largest harvested cucumber acreage include Monroe, Orleans, and Ontario in western New York, and Suffolk County on Long Island (Census).

The average size farm growing cucumbers in New York ranges from 200 to 400 acres. New York growers also often produce other fresh vegetables, such as sweet corn, tomatoes, and bell peppers (Reiners).

Cucumber planting begins in mid-May and continues through mid- to late-July. A small number of growers use transplants in early-to mid-May to obtain an

early crop. Most other growers direct seed in bare ground. Only a small percentage of growers use black plastic.

On Long Island, production is on sandy soil. In the upstate counties, clay loam is the most common soil type. Between 50 and 75 percent of the growers irrigate their fields, most often with overhead sprinklers (Reiners).

Harvesting begins in late June and continues until the first frost. Almost all of the crop is hand harvested. Fields can be picked up to 10 or more times in a season. Picking stops when prices fall to a critically low level, or the first frost, whichever occurs first.

Growers have shed structures where they grade and pack cucumbers. Most growers use brokers to sell their produce to grocery chains, although some growers sell directly to retailers. A small volume of cucumbers is sold through farmers' markets and roadside stands (Reiners).

Production Perils

The major weather conditions contributing to cucumber yield losses in New York include hail, cloudiness, drought, and cool summers.

New York's cucumber production is affected by various insects, with the most common including cucumber beetles, striped and spotted aphids, squash bugs, and spider mites. These insects feed on the plant, and in some cases, the fruit. Most insects and mites are controllable with insecticides.

Diseases affecting New York cucumbers include powdery mildew, downy mildew, alternaria, angular leaf spot, anthracnose, belly rot, damping-off, gummy-stem blight, Phytophthora blight, and cucumber scab. Fungicides and resistant varieties can be used for control. Bacterial diseases, such as bacterial wilt, are controlled primarily through the control of insect populations.

Viruses are also a problem. They may stunt the plant, produce a poor yield, and result in misshapened or discolored fruit. Resistant varieties and the use of insecticides to control aphids help reduce the effects of viruses.

Weeds are a problem in New York, particularly since plastic mulch is not commonly used by growers. Herbicides help control most grassy weeds. During very dry conditions, however, herbicides become less effective and weeds can take over fields, reducing yields (Reiners).

Demand for Crop Insurance

New York cucumber growers received about $2.6 million in disaster assistance payments during the 1988-93 period. Payments were made mainly due to drought, unseasonable coolness, and excessively cloudy, rainy weather (Reiners).

New York State's cucumber crop is susceptible to many insects, diseases, weeds, and weather problems, and growers may view crop insurance as a good management tool (Reiners). Growers may be especially interested after this

past summer's hot, dry weather, which caused cucumber losses in numerous counties (Reiners).

North Carolina

North Carolina was the second-largest producer of pickling cucumbers in 1994, producing about 200 million pounds on 25,000 acres. The state, however, has among the lowest yields per acre of all the major pickling cucumber growers (NASS). North Carolina also grew about 6,000 acres of slicer cucumbers in 1994. The major pickle-producing counties are Duplin, Sampson, and Henderson, while counties producing both pickle and slicer cucumbers include Wayne, Greene, Wilson, and Nash (Schultheis, Census).

The average size farm producing cucumbers in North Carolina is about 200 to 300 acres. The state has one of the largest pickling cucumber growers in the country, with 4,000 acres devoted solely to pickle production (Schultheis). Cucumber growers also often produce other vegetables, such as peppers and sweet potatoes, and field crops such as soybeans, corn, wheat, tobacco, and cotton. Slicer cucumbers are often a second crop after peppers.

Planting begins in mid- to late-April and extends through early May. In the southern, coastal areas planting may begin in early April. Northern counties do not begin to plant until about April 15.

Pickling cucumbers are grown on bare ground. In contrast, slicer varieties are often grown on plastic after another vegetable crop has been harvested. Most cucumber production is on sandy loam soil. Only about 30 percent of North Carolina's cucumber acres is irrigated. Irrigation is found mostly in areas where plasticulture is used.

<u>Harvesting and Marketing</u>

Cucumber harvesting begins in North Carolina in June and extends through early July. Fields are generally picked from 4 to 10 times, with about 3 pickings a week for up to 2 ½ weeks. Almost all of the crop is hand picked. Mechanical harvesting is not very common in North Carolina.

Pickling cucumbers are grown under contract with the major processors, both in North Carolina and in other states. The major processors in North Carolina are Mt. Olive Pickle Company and Dean Foods (which is part of Charles F. Cates). Growers also ship pickling cucumbers out of state to Vlasic and other processors.

Processing companies have buying stations throughout the state. Growers transport their pickles to these stations where they are weighed, sized, and graded. Contract prices are based on pickling cucumber size and the weight of the total shipment. Almost all pickling cucumber acreage is under contract. Some pickles, however, are sold to the fresh market, similar to the situation for slicer varieties.

Slicer cucumbers are sold through various outlets. Some are sold at auction at the State Farm Market. Some growers sell their cucumbers through contracts with supermarkets chains, while others are sold at small farmers' markets.

Production Perils

North Carolina cucumber production is susceptible to drought, especially since only a portion of the state's acreage is irrigated. During long periods of dry weather, plants may wither and die. In addition, the ratio of male to female blooms increases during prolonged dry periods. Since only the female blooms produce fruit, yields decline in such circumstances.

Other weather-related perils are important. Prolonged periods of temperatures higher than 90° F weaken the plant, reducing yields. Cold temperatures are especially detrimental to cucumber production because the plants are very sensitive to cold. Wet weather, especially during pollination, can decrease bee activity and reduce the number of blooms pollinated (Schultheis).

Hail has also caused crop losses in North Carolina. When it occurs early in the season, yields may be reduced, as the plants' leaves may be ripped apart. When hail occurs after fruit set, the hail can cause pitting, which may make the fruit unmarketable.

Flooding can increase the incidence of diseases and weeds, reducing yields. With minimal use of plastic mulch, weeds are a problem, especially if they are abundant during the first three weeks after planting. Once the plant is beyond the early stages of growth, weeds are less detrimental to the plant's productivity (Schultheis).

Demand for Crop Insurance

North Carolina received the fifth-largest volume of disaster payments in the U.S. during the 1988-93 period, totalling about $4.1 million. Payments were made mainly due to drought, flooding, and excessive rain.

Cucumber production in North Carolina is a lower-input enterprise than in most other major producing states. For this reason, some growers, particularly the smaller growers, may not be interested in the added costs of crop insurance. However, many growers plant crops that are presently covered by insurance, and may be interested in buying insurance for cucumbers as well.

Ad Hoc Disaster Assistance for Cucumbers

Ad hoc disaster payments were made available to cucumber growers for losses due to natural causes in each of the years 1988 to 1993. Since commercially-grown cucumbers were not eligible for crop insurance in those years, cucumber producers were required to realize a yield loss of at least 40 percent in order to collect an ad hoc disaster payment.

Data on ad hoc disaster payments provide an indication of potential high-loss areas. The states and counties with large ad hoc payments from 1988 to 1993

are most likely to face a relatively high risk of loss under a potential FCIC policy for cucumbers, and would likely have relatively high demand for crop insurance for cucumbers.

Disaster assistance payments for cucumber losses totalled almost $55 million over the 1988-93 period. The states receiving the largest disaster assistance payments over this period, in order of their ranking, were Texas, Michigan, Georgia, Florida, and North Carolina (Table 7). Major causes of loss include drought, excessive heat combined with excessive dryness, hail, high winds, and excessive rain at planting-time (Mroczek, McCormick).

Disaster payments during the 1988-93 period were scattered across the United States (Figure 2). More than 950 counties received ad hoc disaster assistance payments for cucumber losses in at least one of the six years. The top-ranked counties in terms of disaster payments were: Kleberg County, Texas ($3.6 million over the six years); Van Buren County, Michigan ($2.7 million); Hidalgo County, Texas ($2.4 million); Mitchell County, Georgia ($1.9 million); and Berrien County, Michigan ($1.6 million).

Ad hoc disaster data can be used to indicate which cucumber-producing areas received large payments relative to their acreage. Texas and Michigan accounted for a large share of total ad hoc disaster assistance payments, with each state receiving about 18-19 percent of the U.S. total. At the same time, production in these states only accounted for 6-10 percent of the total value of production. Part of the lower value of these state's production relative to other states is that they produce mostly pickling cucumbers, which have a lower value.

In contrast, Florida accounted for a relatively small share of payments relative to its share of output. The state received 10 percent of the U.S. ad hoc payments made for cucumber losses over the 1988-93 period, and accounted for 28 percent of the U.S. value of cucumber production.

Cucumber Insurance Implementation Issues

Adverse Selection and Underwriting Issues

Actuarial difficulties may arise in insuring cucumbers if a producer increases his or her risk-taking in terms of planting a crop in a season which is not optimal for cucumber production in the area. For example, Florida cucumber output during the winter months is typically small because the winter climate is more variable than in other seasons. With crop insurance, growers may increasingly try to plant cucumbers during the winter months, if appropriate underwriting and premium rate adjustments are not in place.

Setting Reference Prices

A reference price for cucumbers should represent the in-field value of the crop, because growers would not incur the expenses of harvesting and marketing the portion of the yield that is lost. Variable harvesting and marketing expenses account for about two-thirds of total production costs for slicer

Table 7--Disaster assistance payments to cucumber growers 1988-93, top ten recipients

State	Payments, 1988-93	Percent of total payments	State share of total value of production, 1992-93 1/
	--$1,000--	--Percent--	
Texas	10,416	19	6
Michigan	9,798	18	10
Georgia	6,210	11	3
Florida	5,280	10	28
North Carolina	4,124	8	7
South Carolina	3,837	7	2
New York	2,598	5	3
New Jersey	1,929	4	3
Ohio	1,555	3	3
Arkansas	1,235	2	--
Total	54,803	100	100

1/ Production data for fresh-market cucumbers were not collected in 1988-91.

Sources: NASS, *Vegetables-1994 Summary*; NASS, *Vegetables--Final Estimates 1987-92*; and USDA, CFSA.

Figure 2 not available in this format.

cucumbers that are hand harvested. Essentially all slicer cucumbers are hand harvested, and a large portion of pickling cucumber output is hand harvested. The harvesting costs for pickling cucumbers that are machine-harvested are minimal.

Because growers do not incur harvesting and marketing expenses on unharvested production, they could face situations where indemnity payments based on a market-value price would exceed net returns had they harvested and marketed the crop. Such situations would provide undue incentive for moral hazard, particularly for fresh-market growers during periods of low market prices. Pickling cucumber growers would have less incentive for moral hazard since the prices they receive are generally guaranteed under contract.

There are two approaches for deriving an in-field reference price. One is to deduct the estimated harvesting costs from an estimated market price. (The estimated market price for pickling cucumbers could be based on an average of contract prices.) The second is to estimate the cost of production (exclusive of harvesting and marketing expenses), using it as a proxy for the in-field price. In all cases, the market price refers to the grower price and not the retail price.

Market Prices and APH Distortions

For fresh-market cucumbers, yields are typically measured in terms of the quantity of cucumbers harvested and marketed, rather than in terms of the quantity produced and potentially available for harvest. Growers usually pick a field from four to ten times before abandoning the planting. During periods of low cucumber prices, however, growers may pick fewer times.

Consequently, for a given field, the reported yield is higher if market prices are relatively high when the cucumbers mature than would be the case if market prices were extremely low. Because of this relationship between market prices and harvested yields for fresh-market cucumbers, a grower's actual production history, in terms of available records, may not necessarily indicate yield potential and farming ability.

Market prices and economic abandonment are also factors in pickling cucumber production. Most pickling cucumber production takes place under contract. Contracts are based on quantity (in weight) as well as size of the cucumber. During high-yield years, a grower's production may exceed the amount under contract. This portion of the crop may be abandoned if the processor will not buy the excess, and the grower cannot find another outlet. In this instance, the contract volume (and implicit yield history) may not accurately represent the actual production history of a farm.

Estimating "Appraised Production"

One approach to estimating appraised production for cucumbers (harvestable, but unharvested yield) is to count and weigh the marketable cucumbers in a sample of plots and expand the plot yields (in terms of weight) to a per-acre basis. For plantings in which the cucumbers are immature, yields per plot can

be estimated by counting the potentially harvestable fruit in the plot and multiplying by an average or typical weight per cucumber.

Important differences between fresh market and pickling cucumbers in weight per cucumber and the number of plants per acre should be taken into account in calculating appraised production. In particular, larger sizes are desirable for fresh-market cucumbers, while smaller sizes are the most desirable for pickling varieties. Thus, the "weight per plot" is greater for fresh-market cucumbers than for pickling cucumbers.

Further, the number of plants per acre should also be factored into the calculation. Cucumbers plant for the fresh market tend to be planted closer together in fields than those used for processing.

Market Prices and Moral Hazard

Moral hazard is a potential problem in insuring fresh-market (slicer) cucumber production. This is because the situation sometimes arises where, due to low market prices, an indemnity payment would be larger than the net return from harvesting and marketing the crop. Moral hazard could arise in such circumstances if the grower contributed to causing a loss by neglecting prudent management practices.

Another potential moral hazard concern for slicer cucumbers involves the timeliness of planting. Profitability sometimes depends on having cucumbers for sale early in the season before prices decline. Planting dates largely determine when cucumbers will be ready for harvest. Some growers are faced, consequently, with a trade-off between planting earlier and risking losing their young plants to frost, and planting later, and risking losing market value at harvest-time due to low prices. With an insurance policy in place, some growers may rely on a potential crop insurance indemnity, and take greater risks at planting than they would without the insurance coverage.

Moral hazard may be less of a problem with pickling cucumber insurance. Market prices are not an issue for these growers at harvest, because almost all pickling cucumber acreage is contracted with a processing company in advance, with growers guaranteed a price based on the size and weight of the output. Production in excess of the contract, however, may be abandoned if processors are not willing to purchase over the contracted amount. In most cases, however, processors will purchase a grower's excess supply (Zandstra).

Availability of Individual Yield Data

Individual-grower yield data does not appear to be available. Processors may have such data for pickling cucumber growers. However, such data are likely to be confidential. Florida and Michigan have state agricultural statistical services that collect yield data. This information is also likely to be confidential at the individual-grower level.

Demand for Insurance

Our assessment is that cucumbers may be a good candidate for crop insurance, especially in the major producing states. Many growers in these states also produce other crops that are presently covered by crop insurance, including tomatoes, peppers, and field crops. Growers who already have crop insurance coverage for other crops may be more likely to insure cucumbers than growers who are unfamiliar with the program.

Cucumber production is susceptible to various disease perils. While breeding has helped reduce the risks of disease losses, this peril can still be a major factor reducing overall production levels. Diseases are a problem, especially during years plagued by excessive moisture, excessive heat, or drought.

Cucumbers are also grown in area where weather-related perils have lead to large losses and disaster assistance payments. Florida, for example, is susceptible to storms. Unpredictable frosts and excessive moisture in the spring can affect plantings in the Midwest. Drought is a common peril reducing yields in the Northeast and Midwest.

While various extension agents indicated that cucumber growers would be interested in crop insurance, several also stated that smaller growers, in particular, may not be willing to invest in the added expense of crop insurance. Cucumbers are often a second crop, or are rotated in the field with other crops. As a result, some growers may be willing to absorb the loss from a failed cucumber crop, and hope to make up the loss with the next crop that follows.

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