

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

Prepared by the Economic Research Service, USDA

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Executive Summary

Cabbage (*Brassica oleracea* var. *capitata*) is regarded as the most important member of the *Cruciferae* or mustard family, and has remained one of the world's leading vegetable crops. In 1992, the United States was the world's sixth-largest producer of cabbage, accounting for nearly 4 percent of total production, following the former USSR, China, the Republic of Korea, Japan, and India, respectively.

Although botanically classified as a biennial crop, cabbage is grown mostly as an annual crop throughout the United States. It is the most easily grown of the cole crops (which include broccoli, brussels sprouts, and cauliflower) because it can be planted under a wide variety of conditions. As a native of the temperate zone, however, it thrives best in cool, moist climates.

Cabbage is grown throughout the United States. The five leading states in fresh-market production are New York, Texas, California, Florida, and Georgia, accounting for 75 percent of total production. These five states produced 19,193,000 cwt of fresh-market cabbage in 1994, with a total value of \$183.2 million (77 percent of the U.S. total value). In terms of value of output, the top three states, in order of their ranking, are California, New York, and Texas.

Cabbage is generally classified as head cabbage and Chinese cabbage. Head cabbage represents over 90 percent of commercial U.S. cabbage production. Depending on the variety, head cabbage produces round, oval, or flat heads that vary widely in size and weight. Chinese cabbage heads, on the other hand, are oval and flat, more loosely formed, and lighter in weight.

Some head cabbage varieties are sold for fresh use, while others are primarily processed into sauerkraut (kraut). Also, some head cabbage varieties are called storage cabbage because they can keep for up to five to six months. A small proportion of head cabbage is classified as red cabbage, which is sold as fresh heads or shredded and packed with other leafy greens as a salad mix. Chinese cabbage is sold mainly fresh for use in stir fries and other dishes.

Most commercial cabbage in the South (particularly Texas and Florida) and in California is planted in the fall and winter for winter and spring shipment. Plants for the early crop in the North are transplanted to the field as soon as hard freezes are over, while late cabbage is set out in the latter half of June and in July.

Hybrid and open-pollinated varieties are available. Hybrid varieties are generally more expensive, but most growers prefer them over open-pollinated varieties. Hybrid varieties tend to have higher yields, improved seedling vigor, better color, and a longer shelf life. They also mature earlier and more uniformly. Uniform maturity reduces the number of harvests required during a season, with a majority of the heads cut during the first harvest.

Because of the cabbage plant's extensive and shallow root system, a successful cabbage crop requires abundant moisture throughout development. Cabbage plants normally require about 20-30 inches of water during the season.

Frequent, light irrigation, particularly for summer-seeded crops, may be necessary to maintain favorable conditions for development. Heavy irrigation is required from head formation until harvest-time.

Nationally, drought is a major threat to cabbage production. As of the 1992 Census, only 37 percent of the farms growing cabbage had irrigation. These farms accounted for 56 percent of cabbage harvested area. Among the major cabbage-producing states, New York and Wisconsin had less than 50 percent of both their farms and harvested acreage under irrigation.

Different cabbage varieties require varying lengths of time to reach maturity. Generally, most transplanted cabbage varieties mature in 70 to 120 days, while direct seeded cabbage matures in 90 to 140 days. Cabbage is usually harvested when 50 to 60 percent of the heads are firm. A cabbage field is generally harvested 2-4 times in a season. With most hybrids, 60 to 70 percent of the heads are cut during the first harvest, as they mature fairly uniformly.

Fresh-market cabbage is sold mostly to brokers, supermarket warehouses, or central markets in large cities. Some cabbage is also sold directly to retail food chains, including fast food restaurants. Some large buyers seek the services of local agents or brokers to facilitate trading activities. The top three cabbage markets are Los Angeles, Chicago, and Boston.

Cabbage growers, particularly in the southern, northeastern, and North Central states, are often confronted by crop losses due to weather, pests, and diseases. Excessive rain and drought are the major production perils in these areas. Many pest and disease problems, although usually controllable through proper crop management, are promoted by very wet or very dry conditions. Cabbage growers in California confront far fewer natural perils.

Ad hoc disaster assistance payments totalled \$26.1 million over the 1988-93 period. These payments can be used to indicate which cabbage-producing areas received large payments relative to their acreage. New York, Texas, and Georgia were major cabbage-producing states whose shares of total disaster payments were somewhat larger than their estimated shares of U.S. harvested cabbage acreage between 1988 and 1993. In contrast, California and Florida accounted for a small share of payments relative to their respective acreage.

The demand for cabbage insurance will probably be strong, particularly among growers in the southern, northeastern, and North Central regions. These areas have collected about the same proportion of total U.S. disaster assistance payments for cabbage between 1988 and 1993. Several contacts indicated that growers in these areas would likely be interested in a cabbage policy due to the reduced likelihood of individually-based ad hoc disaster assistance.

Cabbage producers from the western United States, particularly in California, will probably have less of an interest in crop insurance. Disaster payments for cabbage losses in California accounted for a relatively small proportion (less than 1 percent) of the nation's total payments for cabbage, even though California accounted for about 12 percent of U.S. average harvested acreage between 1988 and 1993.

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

Introduction

Cabbage (*Brassica oleracea* var. *capitata*) is commercially cultivated for its large, leafy head that is rich in vitamin C. It is regarded as the most important member of the *Cruciferae* or mustard family, and has remained one of the world's leading vegetable crops. In 1992, the United States was the world's sixth-largest producer of cabbage, accounting for nearly 4 percent of total production, following the former USSR, China, the Republic of Korea, Japan, and India, respectively (FAO).

Although botanically classified as a biennial crop, cabbage is grown mostly as an annual crop throughout the United States. It is the most easily grown of the cole crops (which include broccoli, brussels sprouts, and cauliflower) because it can be planted under a wide variety of conditions. As a native of the temperate zone, however, it thrives best in cool, moist climates.

Although cabbage production is scattered across the United States, about 75 percent of production was located in New York, Texas, California, Florida, and Georgia in 1994 (USDA, NASS). Cabbage is grown as a spring, summer, fall, or winter crop, depending on the location.

This report examines those aspects of the U.S. cabbage industry that relate to the demand for crop insurance and the feasibility of developing a cabbage insurance policy.

The U.S. Cabbage Industry

Cabbage is generally classified as head cabbage and Chinese cabbage. Head cabbage represents over 90 percent of commercial U.S. cabbage production. Depending on the variety, head cabbage produces round, oval, or flat heads that vary widely in size and weight. This category also produces cabbage heads that are usually firm and that often have tightly layered, smooth leaves. Chinese cabbage heads, on the other hand, are oval and flat, more loosely formed, and lighter in weight. The leaves of this category are crinkled rather than smooth.

Some head cabbage varieties are sold for fresh use, while others are primarily processed into sauerkraut (kraut). Also, some head cabbage varieties are called storage cabbage because they can keep for up to five to six months. A small proportion of head cabbage is classified as red cabbage because of its color (purple-red). Red cabbage is sold as fresh whole heads or shredded and packed with other leafy greens as a salad mix. Chinese cabbage is sold mainly fresh for use in stir fries and other dishes.

Farms Growing Head Cabbage

According to the Census of Agriculture, 5,464 farms harvested head cabbage from a total of 95,445 acres in 1992 (Table 1). The number of farms with head cabbage increased nearly 9 percent from the 1987 Census year, and harvested acreage was about 6 percent higher. New York, California, Wisconsin, Texas, Florida, and Georgia accounted for 65 percent of harvested acreage in 1992.

Thirty-seven percent of all farms with head cabbage production in 1992 used irrigation, and about 56 percent of total head cabbage harvested acreage was irrigated. The number of irrigated farms and the irrigated head cabbage area dropped 4 percent and 1 percent, respectively, between 1987 and 1992. The six leading cabbage-producing states (in terms of harvested area) accounted for 69 percent of total U.S. irrigated acreage.

Farms Growing Chinese Cabbage

The Census reported that the number of U.S. farms harvesting Chinese cabbage also increased between 1987 and 1992, from 246 farms in 1987 to 253 farms in 1992 (Table 2). Chinese cabbage was harvested from 8,824 acres in 1992, up one percent from the level in 1987. California, Florida, and Hawaii accounted for 81 percent of all farms with Chinese cabbage in 1992, and 91 percent of the harvested acreage.

Eighty-four percent of all farms with Chinese cabbage in 1992 were irrigated. The farms with irrigation accounted for 98 percent of the harvested acreage.

Cabbage Production: Fresh Market Versus Kraut Processing

Farms growing cabbage for the fresh market represent a significant proportion of the industry. According to USDA's National Agricultural Statistics Service (NASS), about 92 percent of harvested cabbage area in 1994 was for the fresh market, while the remaining share was for kraut production (Tables 3 and 4). Output for the fresh market accounted for 97 percent of the total value of U.S. cabbage production in that year.

Cabbage for kraut is increasingly sold under contract. Of the 184,960 tons of cabbage produced for kraut processing in 1994, 98 percent was sold under contract while the remaining 2 percent was sold in the open market. In 1992 and 1993, 84 percent and 90 percent, respectively, of the cabbage used for kraut was sold under contract.

Income Diversification

Many of the farms producing cabbage in the U.S. also produce other crops. Industry sources indicate that crop rotation is a very common practice among growers. Growers usually plant cabbage in rotation with row crops (such as cotton or corn) or other vegetable crops. Hence, additional income can be derived from these crops, and the price and yield risks associated with producing a single crop are lessened.

Table 1--Head cabbage production, 1992 and 1987

Geographic area	1992				1987			
	Harvested		Irrigated		Harvested		Irrigated	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
Alabama	61	513	12	96	45	231	14	64
Alaska	24	38	15	28	24	47	13	33
Arizona	24	1,949	24	1,949	20	748	20	748
Arkansas	30	198	11	107	28	70	11	44
California	221	11,887	221	11,887	206	9,918	206	9,918
Colorado	52	2,274	52	2,274	47	1,452	47	1,452
Connecticut	90	161	15	24	75	260	19	64
Delaware	10	612	9	612	15	(D)	11	(D)
Florida	99	9,022	73	7,982	111	10,173	97	9,841
Georgia	150	6,593	85	4,332	109	3,319	62	2,735
Hawaii	49	458	36	428	62	646	52	604
Idaho	11	23	10	23	9	29	9	29
Illinois	106	1,238	41	591	106	1,036	28	494
Indiana	126	845	38	525	119	979	34	346
Iowa	90	284	24	102	57	305	13	63
Kansas	24	113	11	88	30	77	15	36
Kentucky	191	558	17	31	149	373	34	58
Louisiana	87	587	24	120	86	459	29	126
Maine	80	151	23	50	56	94	8	20
Maryland	122	365	30	165	82	436	27	116
Massachusetts	168	557	46	157	143	540	51	239
Michigan	334	2,523	119	1,181	327	2,929	101	1,179
Minnesota	122	708	30	445	115	693	31	477
Mississippi	53	257	8	67	32	105	6	(D)
Missouri	74	220	34	158	71	209	31	163
Montana	17	15	17	15	19	30	19	30
Nebraska	14	54	9	43	18	31	8	10
New Hampshire	32	36	10	22	24	34	12	17
New Jersey	250	2,227	139	2,005	229	2,414	159	2,236
New Mexico	55	1,097	55	1,097	22	179	22	179
New York	537	13,842	129	1,740	579	15,004	166	2,683
North Carolina	328	6,453	66	611	281	4,652	78	1,086
North Dakota	20	(D)	11	38	10	25	6	13
Ohio	257	2,122	59	516	267	2,712	66	738
Oklahoma	22	125	9	102	25	73	19	46
Oregon	83	898	77	718	83	896	77	788
Pennsylvania	448	2,009	81	250	477	2,349	109	489
Rhode Island	14	35	6	(D)	12	52	2	(D)

South Carolina	87	540	15	104	37	238	12	43
South Dakota	13	4	6	2	7	(D)	5	(D)
Tennessee	139	675	16	130	94	748	22	186
Texas	176	9,312	132	9,122	216	13,698	181	13,633
Utah	16	276	16	276	18	203	18	203
Vermont	46	50	13	13	36	43	11	18
Virginia	170	1,721	55	658	134	1,649	56	1,075
Washington	75	466	53	404	92	932	69	648
West Virginia	49	40	5	9	25	42	2	(D)
Wisconsin	216	11,250	39	1,863	191	8,294	28	309
Wyoming	2	(D)	2	(D)	3	(D)	3	(D)
United States	5,464	95,445	2,028	53,186	5,023	90,011	2,119	53,902

(D) = Data are not published to avoid disclosure, but are included in U. S. totals.

Source: 1992 Census of Agriculture.

Table 2--Chinese cabbage production, 1992 and 1987

Geographic area	1992				1987			
	Harvested		Irrigated		Harvested		Irrigated	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
Arizona	3	(D)	3	(D)	6	138	6	138
Arkansas	3	3	--	--	--	--	--	--
California	120	4,540	120	4,540	98	3,749	98	3,749
Florida	27	3,053	26	3,033	23	2,924	21	2,911
Hawaii	59	399	46	338	44	312	40	294
Massachusetts	5	27	1	(D)	(NA)	(NA)	(NA)	(NA)
Michigan	8	83	6	70	8	(D)	7	(D)
Minnesota	3	(D)	--	--	--	--	--	--
New Jersey	4	(D)	3	(D)	15	697	14	695
Washington	3	4	2	(D)	3	(D)	2	(D)
All other States	18	416	6	323	(NA)	(NA)	(NA)	(NA)
United States	253	8,824	213	8,610	246	8,724	214	8,433

(NA) = Not available.

(D) = Data are not published to avoid disclosure, but are included in U. S. totals.

Source: 1992 Census of Agriculture.

Table 3--Cabbage for fresh market: Area planted and harvested, yield per acre, production, and value of production, by State and United States, 1993-94

Area	1994				State
	Area	Yield		Production	Value
	planted	harvested	per acre	1,000 Cwt	1,000 Dollars
	----- Acres-----		Cwt		
California	10,500	10,500	385	4,043	55,793
Colorado	1,800	1,700	480	816	6,365
Florida	9,300	8,800	320	2,816	29,568
Georgia	11,000	9,000	300	2,700	24,300
Hawaii	600	600	210	126	2,520
Illinois	1,000	960	176	169	1,540
Maryland	800	750	100	75	990
Michigan	2,200	2,000	320	640	5,632
New Jersey	2,300	2,300	300	690	7,797
New York 1/	12,300	12,000	395	5,490	42,828
North Carolina	5,400	5,000	200	1,000	9,500
Ohio	2,100	1,900	265	504	4,586
Pennsylvania	1,900	1,800	210	378	3,969
Texas	11,900	11,200	370	4,144	30,666
Virginia	1,700	1,500	500	750	5,700
Wisconsin	5,000	4,800	270	1,296	5,119
United States	79,800	74,810	343	25,637	236,873

Area	1993				State
	Area	Yield		Production	Value
	planted	harvested	per acre	1,000 Cwt	1,000 Dollars
	----- Acres-----		Cwt		
California	12,000	12,000	360	4,320	59,184
Colorado	1,600	1,400	390	546	4,859
Florida	10,000	9,500	300	2,850	42,465
Georgia	12,000	11,000	310	3,410	33,418
Hawaii	600	600	230	138	2,622
Illinois	1,100	900	180	162	1,430
Maryland	700	650	160	104	2,080
Michigan	2,200	1,900	260	494	4,742
New Jersey	2,400	2,300	250	575	8,050
New York 1/	14,100	13,600	380	5,608	46,992
North Carolina	5,700	5,300	180	954	8,586

Ohio	2,000	1,900	280	532	6,544
Pennsylvania	2,000	1,900	250	475	5,605
Texas	10,300	9,700	350	3,395	46,851
Virginia	1,800	1,700	445	757	4,921
Wisconsin	6,000	5,200	200	1,040	5,772
United States	84,500	79,550	319	25,360	284,121

1/ Totals are a sum of data for Long Island and upstate New York, except on yield per acre which is an average.

Source: USDA, National Agricultural Statistics Service.

Table 4--Cabbage for kraut: Area planted and harvested, yield per acre, production, and value of production, by State and United States, 1993-94

State	1994				
	Area planted	Area harvested	Yield per acre	Production	Value
	-----Acres-----		-----Tons-----		1,000 Dollars
New York	2,100	2,100	29.00	60,900	2,436
Wisconsin	3,500	3,400	29.65	100,810	3,790
Other States 1/	820	790	29.43	23,250	1,159
United States	6,420	6,290	29.41	184,960	7,385

State	1993				
	Area planted	Area harvested	Yield per acre	Production	Value
	-----Acres-----		-----Tons-----		1,000 Dollars
New York	2,100	2,000	36.50	73,000	3,577
Wisconsin	2,800	2,000	17.20	34,400	1,032
Other States 1/	1,340	1,320	20.55	27,120	1,661
United States	6,240	5,320	25.29	134,520	6,270

1/ Includes Florida, Michigan, Ohio, Oregon, Virginia, and Washington in 1993 and Michigan, Ohio, Oregon, and Washington in 1994.

Source: USDA, National Agricultural Statistics Service.

The Cabbage Market

Supply

Fresh-market cabbage production in the United States has increased in 16 of the last 25 years. A total of 2,563.7 million pounds of fresh cabbage (mostly head cabbage) was produced in 1994, up 1 percent from a year earlier, and up 36 percent and 37 percent from production in 1980 and 1970, respectively (Table 5). Production in 1994 was valued at \$236.9 million. Fresh-market production is forecast to reach 2,575.0 million pounds in 1995, up slightly from the level realized in 1994.

Cabbage is grown throughout the United States. The five leading states in fresh-market production are New York, Texas, California, Florida, and Georgia, accounting for 75 percent of total production (Table 3). These five states produced 19,193,000 cwt of fresh-market cabbage in 1994, with a total value of \$183.2 million (77 percent of the U.S. total value). In terms of value of production, the top three states, in order of their ranking, are California, New York, and Texas.

Cabbage for processing into sauerkraut is grown primarily in Wisconsin and New York. A total of 184,960 tons of processing cabbage was harvested from 6,290 acres in the United States in 1994, with the volume of production up 37 percent from 1993 (Table 4). Wisconsin accounted for 55 percent of the volume of processed cabbage output in 1994, and New York accounted for 33 percent. Cabbage for processing in the U.S. was valued at \$7.4 million in 1994, up 18 percent from the prior year.

U.S. cabbage supplies are available fairly consistently throughout the year. However, the peak shipping time for cabbage typically occurs between November and April, with the heaviest shipments often in March (Table 6). Most winter and spring cabbage, which is available during the December-through-June period, is produced in Florida, Texas, and Georgia (Tables 6 and 7). The southern portion of California also produces a winter crop (Rubatzky). The majority of the summer crop is grown in areas where summer temperatures are relatively mild, including New York, Wisconsin and Michigan, and some portions of northern and central California. The fall crop is produced in New Jersey, Georgia, Texas, Florida, and other states.

U.S. imports of cabbage from foreign sources generally have increased over the last 22 years (Table 5). An average of 2 percent of U.S. cabbage supplies were imported from foreign sources during the 1980's and 1990's, mainly from Canada, Mexico, and the Netherlands. This share is up from an average of less than one percent during the 1970's. The United States imported approximately 51.7 million pounds of cabbage in 1994, and is expected to import 55.0 million pounds in 1995. Shipments from Canada were heaviest in August through January and those from Mexico were heaviest between December and February (Table 8).

Table 5--Cabbage, fresh: Supply, utilization, and price, 1970-95 1/

Year	Supply			Utilization			Season-ave price	
	Production 2/	Imports 3/	Total	Exports 3/	Total	Per capita use	Current dollars	Constant 1987 dollars
----- Million pounds-----						Pounds	-----\$/cwt-----	
1970	1,866.9	7.7	1,874.6	61.1	1,813.5	8.8	3.41	9.72
1971	1,921.5	7.5	1,929.0	71.0	1,858.0	8.9	3.32	8.97
1972	1,861.1	6.4	1,867.5	90.2	1,777.3	8.5	3.52	9.05
1973	1,990.7	12.7	2,003.4	101.8	1,901.6	9.0	5.09	12.32
1974	1,971.2	0.8	1,972.0	55.8	1,916.2	9.0	4.60	10.24
1975	2,019.7	5.3	2,025.0	65.1	1,959.9	9.1	5.37	10.91
1976	1,912.2	0.6	1,912.8	56.4	1,856.4	8.5	5.87	11.22
1977	1,917.4	39.9	1,957.3	72.8	1,884.5	8.6	8.91	15.94
1978	2,013.4	24.0	2,037.4	107.3	1,930.1	8.7	8.37	13.88
1979	1,936.9	17.1	1,954.0	101.7	1,852.3	8.2	8.09	12.33
1980	1,884.9	29.8	1,914.7	73.5	1,841.2	8.1	8.10	11.30
1981	1,981.1	5.9	1,987.0	92.8	1,894.2	8.2	7.16	9.07
1982	2,087.7	26.6	2,114.3	78.3	2,036.0	8.8	9.20	10.98
1983	1,975.0	30.8	2,005.8	61.2	1,944.6	8.3	8.90	10.21
1984	2,002.3	143.2	2,145.5	78.8	2,066.7	8.7	11.90	13.08
1985	2,132.2	39.1	2,171.3	63.0	2,108.3	8.8	8.80	9.32
1986	2,143.4	28.5	2,171.9	64.7	2,107.1	8.8	8.20	8.46
1987	2,275.9	29.1	2,305.0	68.4	2,236.6	9.2	7.90	7.90
1988	2,251.2	30.7	2,281.9	50.3	2,231.5	9.1	7.70	7.41
1989	2,146.5	57.3	2,203.8	50.3	2,153.5	8.7	7.60	7.00
1990	2,163.4	88.2	2,251.6	59.2	2,192.4	8.8	7.70	6.80
1991	2,187.1	45.5	2,232.6	77.0	2,155.6	8.5	8.30	7.06
1992	2,326.7	39.5	2,366.2	86.9	2,279.3	8.9	9.11	7.54
1993	2,536.0	58.1	2,594.1	81.5	2,512.6	9.7	11.40	9.23
1994	2,563.7	51.7	2,615.4	82.9	2,532.5	9.7	9.34	7.40
1995 f	2,575.0	55.0	2,630.0	85.0	2,545.0	9.7	--	--

-- = Not available. f = ERS forecast.

- 1/ Largely head cabbage. End of year stocks and shrinkage are not included.
- 2/ Source: USDA, National Agricultural Statistics Service. From 1981-91, production and value data was estimated by ERS based on available State reports.
- 3/ Source: U.S. Dept. of Commerce. Bureau of the Census. From 1978-89, U.S. exports were adjusted using Canadian import data. Excludes sauerkraut.
- 4/ Deflated by the GDP implicit price deflator, 1987=100.

Source: USDA, Economic Research Service.

Table 6--U.S. monthly cabbage shipments, by origin, 1994

Origin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
----- 1,000 cwt -----													
<u>By piggyback:</u>													
Arizona	8	3	--	--	--	--	--	--	--	--	--	--	11
California, Central	--	--	--	1	5	11	1	3	--	--	--	--	21
California, South	--	1	2	3	1	--	4	--	1	1	3	--	16
Florida	--	--	1	--	--	--	--	--	--	--	--	--	1
Sub-total	8	4	3	4	6	11	5	3	1	1	3	--	49
<u>By available truck:</u>													
Arizona	21	17	22	17	17	8	3	1	--	3	12	17	138
California, Central	--	--	--	--	--	--	--	--	--	--	1	--	1
California, Imperial Valley	22	20	15	--	--	--	--	--	--	--	2	26	85
California, South	6	8	4	--	--	--	--	--	--	--	1	3	22
Colorado	--	--	--	--	--	--	62	120	108	57	--	--	347
Florida	196	287	408	286	52	--	--	--	--	--	--	26	1255
Georgia	70	--	--	297	340	14	--	--	--	--	16	168	905
New Mexico	--	--	--	--	--	47	11	--	--	--	--	--	58
New York	187	176	189	142	--	--	53	208	263	261	258	283	2020
North Carolina	--	--	--	--	133	324	48	--	--	83	204	99	891
Texas	412	472	728	402	226	58	18	45	6	18	160	292	2837
Virginia	--	--	--	--	--	--	58	104	68	19	--	--	249
Wisconsin	--	--	--	--	--	--	169	298	220	280	276	--	1243
Sub-total	914	980	1366	1144	768	451	422	776	665	721	930	914	10051
U. S. Total	922	984	1369	1148	774	462	427	779	666	722	933	914	10100

Source: USDA, Agricultural Marketing Service.

Table 7--Area harvested to cabbage, by season, selected states

Year and State	Winter (January- March)	Spring (April - June)	Summer (July- September)	Fall (October- December)
1994:	--- Acres ---	--- Acres ---	--- Acres ---	--- Acres ---
Florida	5,800	3,000		
Georgia		4,000	1,000	4,000
Michigan 1/ New Jersey 2/ New York 3/ Long Island Upstate		1,000	2,000	1,200
Ohio			1,000	
Texas 4/ Wisconsin 5/	8,200	1,900	11,000	1,100
Total	14,000	10,000	21,700	6,300
1993:				
Florida	6,000	3,000		500
Georgia		5,000	1,000	5,000
Michigan 1/ New Jersey 2/ New York 3/ Long Island Upstate		1,100	1,900	1,200
Ohio			1,300	
Texas 4/ Wisconsin 5/	6,300	2,200	12,300	1,200
Total	12,300	11,300	23,600	7,900
1992:				
Florida	6,600	4,800		800
Georgia		4,000	2,000	3,000
Michigan 1/ New Jersey 2/ New York 3/ Long Island Upstate		1,200	2,000	1,400
Ohio			1,200	
Texas 4/ Wisconsin 5/	5,900	3,300	10,900	1,100
Total	12,500	13,300	24,900	6,300

1/ Usual harvest period for the summer season is June to November.

2/ Usual harvest period for the spring season is June to August and for the fall season is September to October.

3/ Usual harvest period for the summer season is July to October.

4/ Usual harvest period for the winter season is December to March.

5/ Usual harvest period for the summer season is August to October.

Source: USDA, National Agricultural Statistics Service.

Table 8--Total U.S. imports by individual country (1,000 cwt), 1994

Country	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1994
Canada	26	14	8	4	4	5	19	37	49	65	70	81	382
Chile	--	--	--	--	1	--	--	--	--	--	--	--	1
Mexico	26	20	13	4	7	10	16	8	8	12	9	19	152
Netherlands	3	--	--	--	--	--	--	--	--	--	--	--	3
Total	55	34	21	8	12	15	35	45	57	77	79	100	538

Source: USDA, Agricultural Marketing Service.

Demand

Per capita consumption of all cabbage (fresh and kraut) during the 1990's has trended upward, nearly reaching the levels of the early 1970's (Figure 1). Per-capita use of cabbage has been boosted by improved marketing (including better packaging and the availability of pre-cut cabbage for cole slaws and salads), and the growing popularity of salad bars in restaurants and grocery stores. Per-capita consumption had generally trended downwards during the mid-1970's until the early 1990's.

Per capita use of all cabbage is forecast to reach 11.0 pounds in 1995, about the same as in 1973. Per capita use of fresh-market cabbage is expected to reach 9.7 pounds (farm weight) in 1995, up from 9.0 pounds in 1973. Per capita use of canned cabbage (kraut), on the other hand, is forecast at 1.3 pounds (farm weight) in 1995, down from 2.1 pounds in 1973.

Over the last 22 years, fresh-market cabbage has accounted for an increasing share of total cabbage consumption. During the 1990's, fresh-market cabbage accounted for an average of 87 percent of total per capita use, up from an average of 80 percent in the 1970's, and 83 percent in the 1980's. Consumers typically prefer dark blue-green cabbage heads that are firm, compact, and nearly round in shape, and that average between 2.5 to 3.0 pounds in weight (Longbrake, et al.).

U.S. cabbage exports have accounted for about 3 percent of domestic production during the 1980's and the 1990's, down from an average share of 4 percent during the 1970's. The United States exported 82.9 million pounds of cabbage in 1994, and is expected to export 85 million pounds in 1995 (Table 5). The largest market for U.S. cabbage is Canada, followed by Hong Kong.

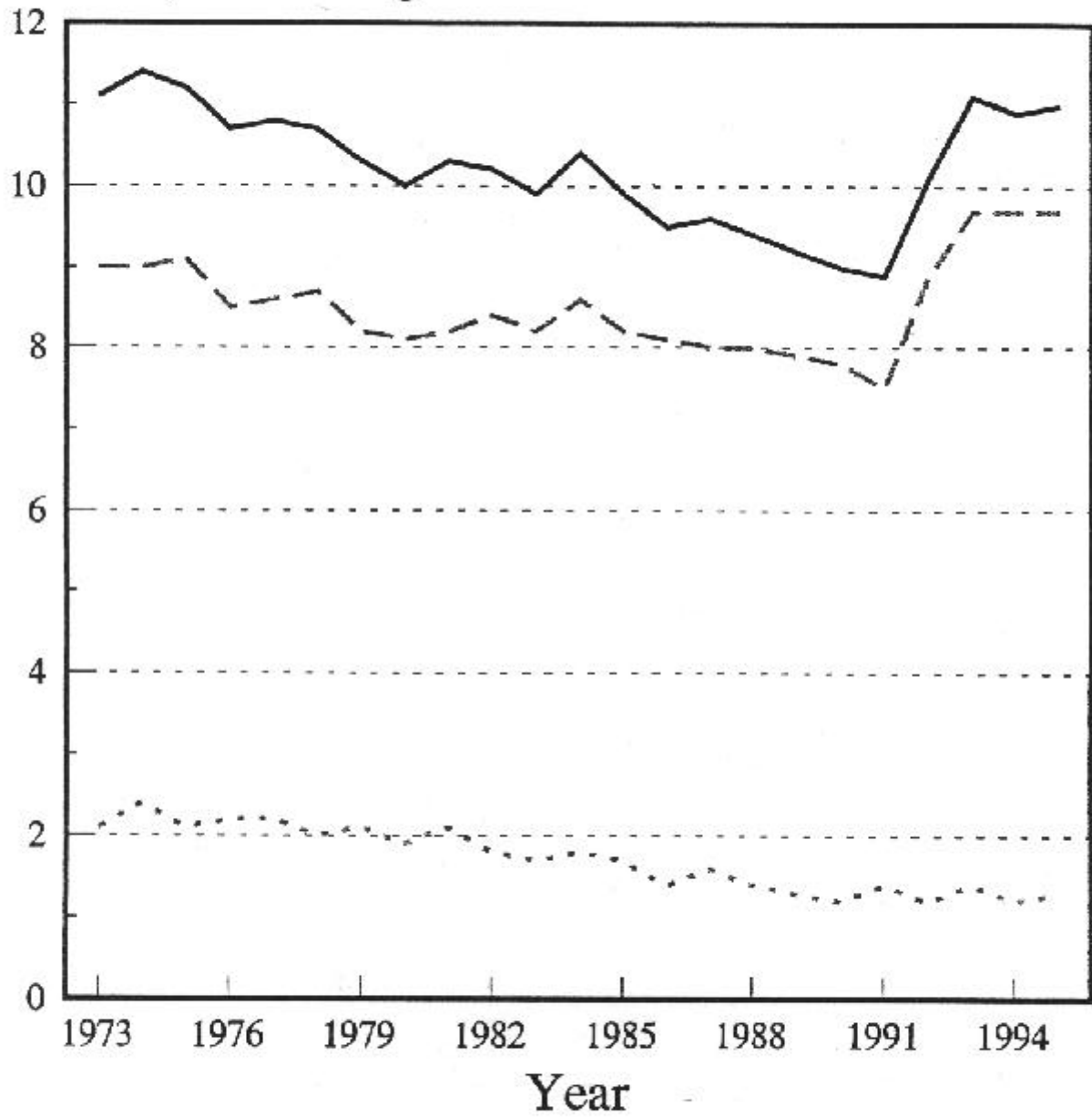
Prices

Cabbage prices are available for certain markets, and can be obtained from three sources. USDA's National Agricultural Statistics Service began publishing market-year average grower prices for fresh-market cabbage in 1992. USDA's Agricultural Marketing Service (Fruit and Vegetable Division) collects representative weekly wholesale prices at the New York and Chicago markets for cabbage shipped from Arkansas, Georgia, Illinois, New Jersey, Texas, New York, and California. Representative prices from these two markets, however, are not always available. The Department of Labor's Bureau of Labor Statistics reports retail prices for fresh cabbage in Florida.

Retail prices for fresh-market cabbage have a distinct seasonal pattern, with the variation due mostly to seasonal changes in availability and the effects of weather on production (Figure 2). Cabbage prices generally drop sharply between December and March, when large-volume shipments arrive from Texas, Florida, and California.

Year-to-year price fluctuations are attributed mainly to the effects of weather and changes in acreage. Very little price variation is caused by demand changes, which are slight from year-to-year (Mizelle and Westberry).

Figure 1
U.S. Per Capita Use of Cabbage
 Pounds, farm-weight

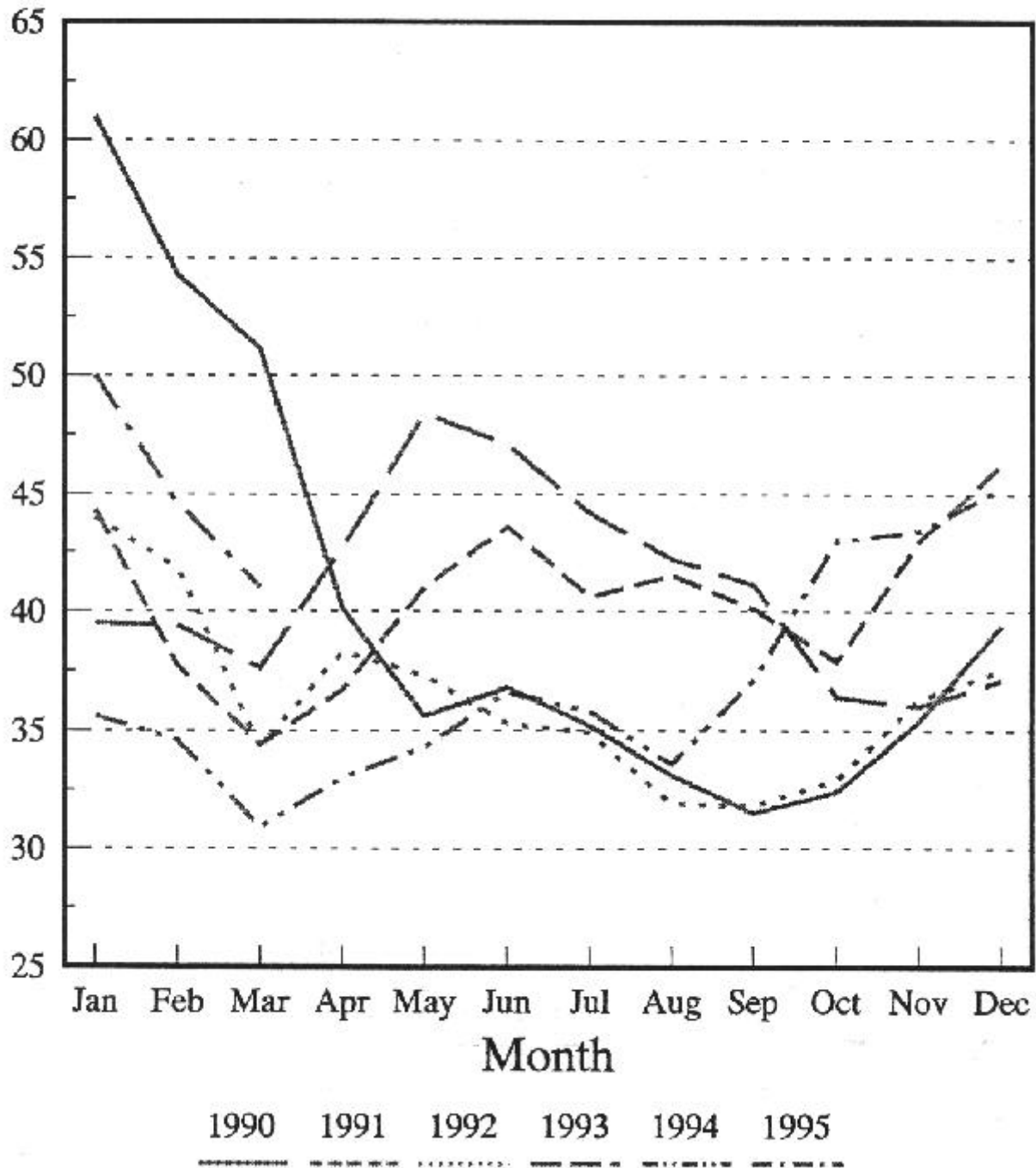


Cabbage, all **Fresh** **Canning (kraut)**
 _____ - - - - -

"All" refers to all uses (fresh and processing).
 Source: Economic Research Service, USDA.

Figure 2

U.S. Average Retail Prices for Cabbage Cents/lb.



Source: Bureau of Labor and Statistics,
U.S. Department of Labor

Cultivation and Management Practices

Land Preparation

A level, well-prepared seedbed is important for successful cabbage production. Deep plowing and disking are activities performed to insure good drainage and promote deep root penetration. In addition, leveling the soil will maintain the correct slope for uniform irrigation and adequate surface drainage (Longbrake, et al.). Sometimes, a green-manure crop is turned under at least a month in advance of planting.

Climate

Cabbage can tolerate wide temperature variations, but produces the highest yields in cool, moist conditions. Temperatures ranging from 59° F to 68° F are optimum for good growth (Yamaguchi). Even as a cool-season crop, the plants should be well-hardened. (Hardening is a technique used to slow plant growth so that the plant can better withstand unfavorable environmental conditions.) If plants are not well-hardened, the heads may be damaged by temperatures below 25° F (Longbrake, et al.). Well-hardened young cabbage plants can tolerate temperatures as low as 15° F without serious damage.

Soil Requirements

Successful cabbage production requires soils with good drainage and adequate organic matter. Fall, early winter, and summer cabbage crops grow best on medium- and moderately-heavy loam soils, while spring cabbage thrives on sandier loam soils, which drain better than do the heavier soils (Ware and McCollum).

Soils with a pH of 6.0 to 6.5 are preferred because phosphorus, an important element, is most available in this range (Ware and McCollum). In addition, cabbage is very sensitive to strongly acidic soils (those with low soil pH). Strongly acidic soils may cause tipburn, a symptom of calcium deficiency and manganese toxicity, and should be limed well ahead of planting.

Cabbage seeds germinate at soil temperatures of 45° F to 95° F (Boudreaux, et al.).

Varieties

Although several hundred cabbage varieties (or cultivars) are produced in the United States, they can generally be categorized into four major types (Table 9). Cabbage heads may be round, oval, or flattened spheres, and they may be more or less compact, depending on the variety. While most varieties have green foliage, some have red or purple foliage. The overlapping leaves that compose a cabbage head are very crinkled in some varieties, particularly the savoy types (Seelig). However, the market for red and savoy cabbages is very limited (Longbrake, et al.).

Table 9--Four major types of cabbage varieties grown in the United States

Type	Flavor	Characteristics	Use	Availability
Domestic	Sweet	Medium-sized; early or mid-season crop; heads usually less compact and leaf tissues more tender and brittle than Danish; both flat and round varieties; does not keep well and is seldom stored except for short periods.	Some later maturing varieties are grown for sauerkraut as well as for fresh market; for coleslaw or cooking.	Year-round
Danish	Spicy to sweet depending on variety	Large storage cabbage; late-maturing, solid-headed type used mainly for late fall market and storage; leaves usually closely compacted and smooth; heads are round or oval.	Good for cooking, preferred for coleslaw, egg rolls.	Year-round
Savoy	Mild, sweet	Readily identified by crinkled leaf tissues throughout the leaves and head; heads are loosely formed, usually flattened, sometimes round or pointed, and yellowish-green.	Used largely for salad purposes and specialty recipes.	Year-round
Red cabbage	Mild, sweet	Known for its distinctive reddish or purple color; has crinkled leaves.	Used largely for pickling and salad purposes.	Year-round

Sources: The Packer; Seelig.

Cabbage varieties may also be classified according to their end-use purpose. There are specific varieties intended for the fresh-market, for processing (kraut), and for storage. Cabbage that is stored generally has white foliage.

Hybrid and open-pollinated varieties are available. Hybrid varieties are generally more expensive, but most growers prefer them over open-pollinated varieties. Hybrid varieties tend to have higher yields, improved seedling vigor, better color, and a longer shelf life (Longbrake, et al.). They also mature earlier and more uniformly. Uniform maturity reduces the number of harvests required during a season, with a majority of the heads cut during the first harvest.

Planting

Most commercial cabbage in the South (particularly Texas and Florida) and in California is planted in the fall and winter for winter and spring shipment. Plants for the early crop in the North are transplanted to the field as soon as hard freezes are over, while late cabbage is set out in the latter half of June and in July (Ware and McCollum).

Cabbage can be planted either through direct seeding or transplanting. Seeds can be sown directly in the field using either the broadcast system or the row system. When the row system is used, seeds can be sown in one or two rows per bed. The row system is usually preferred to broadcast seeding because it ensures adequate plant spacing and facilitates cultivation and harvesting.

The distance between plants affects the size of the heads, with smaller heads associated with a closer plant spacing. A 12- to 14-inch spacing is commonly recommended for fresh-market cabbage (Boudreaux, et al.).

Field beds are usually 5- to 6-feet wide (Ware and McCollum). Seeding rates range from 1/4 pound per acre if precision planted to 1 pound per acre if drilled. Seeds germinate in 6-15 days from planting, given soil temperatures between 59° F to 77° F (McLaurin, et al.). The plants are thinned once they reach transplanting size.

Transplanting is usually done via the row system to ensure consistent plant spacing. While a mechanical transplanter is typically used, transplanting can also be done by hand when labor is not a problem and the number of transplants is manageable. An ideal transplant is a young plant, about four inches tall, with a stem approximately 1/4- to 3/8-inch in diameter. Flower buds should be absent, and the plant should exhibit rapid vegetative growth. It should be slightly hardened at transplanting time (McLaurin, et al.).

Transplants are generally ready for field setting about 4-5 weeks from seeding (Boudreaux, et al.). During the winter and early spring, cabbage transplants are typically grown in covered beds. Growers along the Gulf and Atlantic Coasts may also take the precaution of planting cabbage in cold frames made of glass, cloth, or transparent polyethylene. Plants grown in cold frames serve as reserve plants in case of a heavy freeze. They also mature more quickly than plants grown in covered beds (Ware and McCollum).

Cabbage transplants should be hardened-off, a technique used to slow plant growth prior to transplanting. Hardening off helps cabbage plants withstand unfavorable conditions in the field, and increases the chances of them becoming well-established. Hardened plants tend to develop new roots faster and have higher water-retaining power (Ware and McCollum). Green varieties of cabbage that are hardened prior to transplanting show a slight purpling in the outer parts of the leaves (McLaurin, et al.).

Newly-set plants that are not hardened-off are prone to bolting in the early stages of plant development, especially when exposed to stressful conditions. Bolting in cabbage refers to the development of small, unmarketable heads or flower stalks while the plant is still immature. Flower stalk formation is prompted on newly-set plants during cool weather, when temperatures range from 35° F to 50° F (McLaurin, et al.).

When transplanting, the plant roots should be placed 3 to 4 inches deep and an appropriate fertilizer starter solution should be applied. Irrigation should immediately follow and be maintained so that the plants' roots become well-established (McLaurin, et al.).

Since cabbage has a shallow root system, deep cultivation is typically not encouraged. The exceptions are when the soil is very hard and when weeds become a problem. Fall and spring crops usually require three cultivations, while the winter crop requires fewer. Cultivation should end when cabbage heads start to form, as tools or equipment may injure or wound the head. Cultivation is also discouraged early in the morning because the leaves are turgid at this time and prone to breaking (Ware and McCollum).

Fertilization

Cabbage requires high rates of nitrogen, phosphorus, and potassium to achieve maximum yields. Heavy applications of nitrogen alone may result in loose, puffy heads (Boudreaux, et al.). Phosphorus and potassium are usually applied before or during planting by broadcasting or banding, while nitrogen may be applied as a side dressing (Ware and McCollum).

Foliar nutrients are sometimes applied, often after a frost or hail storm, to promote rapid plant recovery. Foliar nutrients help rejuvenate frost- or hail-damaged plants, and increase plant resistance to stresses and pests (McLaurin, et al.).

Irrigation

Because of the cabbage plant's extensive and shallow root system, a successful cabbage crop requires abundant moisture throughout development. Cabbage plants normally require about 20-30 inches of water during the season. Frequent, light irrigation, particularly for summer-seeded crops, may be necessary to maintain favorable conditions for development. Heavy irrigation is required from head formation until harvest-time (Longbrake, et al.). Either furrow or sprinkler systems can be used successfully (Ware and McCollum).

Moisture must be evenly available. Uneven moisture or moisture stress after the cabbage heads are formed may cause splitting or bursting, and can cause serious yield reductions (Tyson).

Crop Rotation

Crop rotation is a common practice in cabbage production, primarily to control insects, pests, and diseases. Many spring and summer crops are good rotation crops for fall cabbage. Cabbage-related crops such as broccoli, cauliflower, mustard, turnips, and brussels sprouts should not be used in rotation with cabbage (Boudreaux, et al.). Diseases common to these crops persist in the soil when grown in succession on the same land (Longbrake, et al.).

Harvesting Practices

Different cabbage varieties require varying lengths of time to reach maturity. Generally, most transplanted cabbage varieties mature in 70 to 120 days, while direct seeded cabbage matures in 90 to 140 days (McLaurin, et al.). Cabbage is usually harvested when 50 to 60 percent of the heads are firm (Longbrake, et al.). Another indication of maturity is the slight curling back of the edge of the top leaf.

A cabbage field is generally harvested 2-4 times in a season. With most hybrid varieties, however, 60 to 70 percent of the heads are cut during the first harvest, as they mature fairly uniformly (Boudreaux, et al.).

Harvesting usually involves cutting the cabbage heads by hand with a large knife. The harvested heads are moved from the field via tractor-drawn belt conveyors and then hauled to central loading stations or packing sheds for final trimming and packing (Longbrake, et al.). Some cabbage is generally also field-packed for the fresh market.

Careful handling of cabbage during harvest and packing should be observed to avoid bruising and to reduce storage losses. About three to four of the green wrapper leaves are left attached to the head at harvest, except when damaged by worms. The wrapper leaves not only protect the head during harvest and shipping, but also give it a fresh appearance.

Grading, Packing, Storing, and Shipping Practices

The two U.S. grade standards for cabbage are U.S. No. 1 and U.S. Commercial. U.S. No. 1 applies to heads that are reasonably solid and not withered and puffy. They should be well-trimmed and free from soft rot, seedstems, and damage caused by discoloration, freezing, diseases, insects, or machines (Hurst). They should be of one cultivar or of varieties with similar characteristics. The U.S. commercial grade is similar, but requires that the heads be reasonably firm (instead of "reasonably solid"), and allows an increased tolerance for defects.

The standard containers for packing cabbage are 50-pound mesh sacks, wooden crates, or fiberboard waxed cartons. Each container holds about 18 to 24

heads. The heads are arranged in orderly layers in the crates (or cartons), with the stem ends to the outside. They should be packed firmly, but not tightly enough to cause bruising.

After packing, the filled containers are precooled to 35° F to 45° F using the forced air method (with high humidity) to remove field heat. Precooling helps prolong quality and reduces losses due to soft rot damage and other transit diseases. Cabbage is transported in refrigerated trucks or rail cars, each with the capacity for 700 to 800 containers (Longbrake, et al.).

Cabbage heads, free of any diseases or injuries, can be stored for 3 to 6 weeks provided that temperatures are maintained at near 32° F with relatively high humidity (90 to 95 percent). Cabbage should not be stored and shipped with fruits and vegetables that emit ethylene gas, which promotes ripening. Exposure to ethylene can cause yellowing and shedding of the outer leaves, which reduces quality (Hurst). Commodities that emit ethylene include tomatoes, cantaloupes, and peaches.

Marketing Practices for Cabbage

Fresh-market cabbage is sold mostly to brokers, supermarket warehouses, or central markets in large cities (Longbrake, et al.). Some cabbage is also sold directly to retail food chains, including fast food restaurants. Some large buyers seek the services of local agents or brokers to facilitate trading activities. The top three cabbage markets are Los Angeles, Chicago, and Boston.

Some produce agencies may arrange for their own production and marketing. A limited quantity is also shipped on consignment. The southern markets receive less than 20 percent of all shipments (Mizelle and Westberry).

Growers of kraut cabbage (for processing) most often have a ready market for their product at the time of planting because they produce under contract with kraut processors. Kraut processors are very particular concerning the cabbage variety that growers plant. Hence, not all fresh-market cabbage can be sold to the kraut market. Contracts between kraut processors and growers are often based on tonnage. Production exceeding the required tonnage is often left unsold or sold at a discount.

Costs of Production

Harvesting costs for cabbage are about 30 to 60 percent of total production costs (Table 10, also see Appendix A). Harvesting costs are high, especially when cabbage is harvested manually. High harvesting costs can encourage moral hazard when cabbage prices are low. In general, however, industry sources indicate that prices must be very low before growers abandon their cabbage crop, due to their desire to supply established markets. Moral hazard would be most likely to occur when very low prices are realized, and growers at the same time have large quantities (in excess of demand) available for harvest.

Table 10--Cabbage: Variable harvesting costs, selected states ¹

State	Yield	Variable harvest cost	Total cost	Variable harvest percent of total
	50-lb cartons per acre	-----\$/acre-----		Percent
California:				
Imperial County	500	1,700	3,029	56
Florida:				
Hastings Area	425	1,148	2,428	47
Georgia	500	1,066	1,683	63
Kentucky				
(Overhead Irrigated)	800	939	1,766	53
Michigan	400	680	2,145	32
New York ²				
(Kraut cabbage)				
Direct seeded	1,028	235	751	31
Transplanted	976	224	773	29
(Storage cabbage)				
Direct seeded	988	398	899	44
Transplanted	1,060	415	984	42
Texas				
South Texas District				
(Irrigated)	600	1,917	2,821	68

¹ Costs may not be comparable among states because budgets may be for different seasons and may not include the same cost items.

² Selling costs were added to harvesting costs. Yield per acre (in tons shown in Appendix A) was converted to the number of 50-lb cartons per acre.

Sources: California Cooperative Extension, University of California; Isaacs, et al.; Nott, et al.; Smith and Taylor; Snyder; Texas Agricultural Extension Service, Texas A&M University; Westberry and Mizelle.

Production Perils

Cabbage growers, particularly in the southern, northeastern, and North Central states, are often confronted by crop losses due to weather, pests, and diseases. Excessive rain and drought are the major production perils in these areas. Many pest and disease problems, although usually controllable through proper crop management, are promoted by very wet or very dry conditions. Cabbage growers in the western states, particularly California, confront fewer natural perils.

Excessive Rain

Due to their shallow root system, cabbage plants require plenty of moisture. However, some varieties are subject to bursting when dry weather is followed by heavy rains (Seelig). Excessive rains can also flood low-lying areas, with prolonged periods of standing water causing root suffocation and plant death. Wet conditions can also promote diseases by providing an environment conducive to the rapid multiplication of rot pathogens.

Because they are shallow-rooted, cabbage seedlings and plants can be uprooted by exposure to heavy rains and long-standing water. Heavy rains can also wash away newly-planted seeds.

Rainy weather may also delay harvesting. Muddy conditions in the field make it difficult to bring in the heavy equipment needed for loading and hauling (Price).

Excessive Cold, Frosts, and Freezes

Exposure of newly-sown seeds and newly-transplanted seedlings to frosts or freezing temperatures may cause bolting, or the formation of flower stalks (Kelly). This situation will significantly reduce yields because, most often, cabbage heads do not form when flower stalks appear during the first year. When cabbage heads do appear, they are usually deformed.

Plants that are past the juvenile stage will flower when temperatures are less than 50° F for 5-6 weeks. The lower the temperature, the shorter the time required for flowering (Yamaguchi).

Drought

Very hot, dry weather (or severe water stress) immediately after transplanting may stunt plant growth and result in bolting. Bolting is a condition wherein the plant produces flower stalks rather than normal cabbage heads, reducing yields. Newly-sown seeds may also fail to germinate under drought conditions. Severe water stress during head formation may result in deformed or shrivelled cabbage heads. Drought conditions can typically be mitigated by irrigation.

Hail

Hail damage to plant buds and leaves results in distorted cabbage heads or the failure to produce heads (Kelly). Hail occurring later in the season after head formation may wound or lacerate the wrapper leaves, resulting in a poor appearance for the fresh market. In addition, wounds may also promote pre- and post-harvest rot problems.

Diseases

Various diseases infecting cabbage may reduce yields. Some diseases may cause minor spotting, while others cause serious damage or completely devastate the crop. The most important cabbage diseases are black rot, black leg, yellows, and club root.

Black Rot

Black rot is a bacterial disease caused by *Xanthomonas campestris*, and infects cabbage through natural openings or injuries on the leaves. The most serious damage from this disease usually occurs under wet, warm conditions. Initial symptoms are stunting, yellowing of the leaves, and blackening of the veins. Later, the plants show dwarfing and produce one-sided heads.

This disease is seed-borne, and is often introduced via contaminated seeds or infected transplants. It is also spread by rain, irrigation, running surface water, and insects and other movement in the field while the plants are wet.

Black rot can infect cabbage at any stage of plant growth. Infected seeds that germinate usually die quickly. Infected young seedlings usually fail to produce heads. Heads from infected plants deteriorate rapidly after harvest. In the most serious cases, the crop may be destroyed.

Varieties are available that are resistant to black rot. For those varieties that are not resistant, prevention is the key to avoiding losses. The use of disease-free seeds or transplants, crop rotation, and good sanitation practices are recommended.

Black Leg

Black leg is caused by the fungus *Phoma lingam*, and can cause serious yield losses. The fungus can live for at least three years in the soil, and is also carried by the seeds. When present, light brown cankers and spots initially form near the base of the stem and on the leaves, followed by numerous black dots which are actually the fruiting bodies of the fungus. Wet conditions promote the spread of black leg (Gay). Seeds should be treated, and resistant varieties are recommended.

Yellows

Yellows is a disease caused by the fungus *Fusarium oxysporum f. conglutinans*. While primarily a northern disease, it also may damage cabbage grown in the

upper South (Ware and McCollum). Infected plants turn yellow soon after they are transplanted. Later, the disease causes leaf drop, curving stalks, and the formation of buds on leafless stems. Severe cases result in plant death.

The causal organism, *Fusarium*, can persist in the soil for several years and is spread by rains and field equipment. It enters plants through the root hairs. Resistant varieties should be used.

Club Root

Club root (*Plasmodiophora brassicae* Wor.) attacks the roots of cabbage plants, causing club-like swellings near the stem of the plant. The disease can be controlled by avoiding infested areas, planting resistant varieties, using crop rotation, keeping the soil alkaline (pH 7.2), and using PCNB at the time of transplanting (Ware and McCollum).

Downy Mildew

Downy mildew is a disease caused by the fungus *Peronospora parasitica*, and attacks seedlings or mature cabbage that has headed. It can be introduced by infected transplants or windblown spores found on the undersurface of the leaves of infected plants. Cool, moist weather is very favorable for disease development.

Downy mildew can destroy a field within 3 to 4 days after it is first noticed (Gay). Initial symptoms of the disease are yellow-brown spots that form on the upper leaf surfaces and a fluffy growth of mold on the undersurface of the leaves. Young infected leaves may drop off. Wounds caused by the disease can serve as entry points for soft rot bacteria. The spread of downy mildew can be controlled through repeated applications of fungicides such as Bravo and Maneb.

Powdery Mildew

Powdery mildew is a fungal disease causing white, talcum-like mold growth on the leaf surfaces. It is sometimes found on cabbage, although rarely is the damage serious. If not properly controlled, it may result in stunted, wilted growth. In the most serious cases, it can result in plant death. Fungicidal sprays can be used for control.

Damping-Off

Damping-off is a disease that causes young plants to rot at the soil surface and collapse suddenly. Infected seeds fail to germinate. Cold, damp weather and thick stands promote its development. For control, treated seeds should be used. Other controls include the sterilization of plant beds, use of good drainage, and the avoidance of thick stands (Boudreaux, et al.).

Nematodes

Root knot nematodes (*Meloidogyne sp.*) are parasitic eelworms that attack the roots of cabbage plants, producing irregularly shaped galls. Above-ground symptoms of nematode-infected plants are stunted growth coupled with chlorosis (Gay). Seriously damaged plants fail to survive. The root-knot nematode thrives in well-drained locations and is seldom evenly-distributed over a large area. Soil fumigation and crop rotation with a nematode-resistant crop are control practices (Ware and McCollum).

Viruses

Turnip Mosaic

Cabbage plants infected by the turnip mosaic virus exhibit stunted growth, mottling, distorted leaves, and a reduced leaf bloom. This virus may also cause spotting on the outer and inner leaves of the cabbage heads, making them unmarketable. It is transmitted by various aphid species (Gay). Disease prevention involves using insecticides to control aphid populations.

Cabbage Mosaic

Cabbage mosaic lowers the quality of cabbage heads by causing black specking of the heads near harvest-time or when in storage. Serious losses from this disease are observed most often when infection occurs early in the season. Cabbage mosaic is transmitted by cabbage and peach aphids (Gay). Control involves the use of insecticides to control aphids.

Tomato Spotted Wilt Virus (TSWV)

The tomato spotted wilt virus can infect cabbage plants at any stage of growth. Young seedlings can be easily infected and may die from the virus. Symptoms include spot formation and wilting of the leaves, which eventually results in the death of the plant. The virus is transmitted by thrips. Crop rotation practices and the use of thrip-resistant varieties help prevent the development of TSWV. Growers should also spray insecticides to control thrips.

Insects and Other Pests

Insects can be a serious peril to cabbage. Most insects, particularly cabbage loopers, diamond back moths, and cutworms, cause the greatest destruction during their larval stage. Most insects feed on the cabbage leaves. Aphids, in addition to feeding, can also transmit viral diseases.

Cabbage Loopers

Cabbage loopers (*Trichoplusia ni*) spend their entire life cycle on the cabbage plant. In the larval stage, cabbage loopers appear as large worms (about 1-1/2 inches long). The larvae feed on the underside of the cabbage leaves, producing large holes. They are most destructive during early summer and

fall. Insecticides should be applied at the first signs of moth activity (Adams).

Imported Cabbage Worms

Imported cabbage worms, *Pieris rapae*, feed on the cabbage leaves. However, they very rarely cause serious economic losses if controlled through the use of pesticides. The adult is a common butterfly that lays eggs singly on the leaf surface. The larvae are green and have a velvety appearance, with a narrow, light yellow stripe down the back. Controls should be initiated when a buildup of larvae occurs (Adams).

Cabbage Aphids

The cabbage aphid (*Brevicoryne brassicae*) is a sucking insect with a powdery and waxy covering that is similar in appearance to the leaves of the cabbage plant. Although cabbage aphids may be present year round, they do not always cause significant damage. They are most destructive when cool, dry weather is present during the spring or fall, which favors the build-up of large aphid populations. Heavy infestations may cause the cabbage leaves to curl, and may prevent head formation (Curwen, et al.). Aphids may also transmit viral diseases to the cabbage plant.

Cabbage aphids are difficult to control because their waxy covering somewhat protects them from spray materials. Cabbage plants should be treated with insecticides before aphid populations explode to damaging levels (Adams).

Turnip Root Aphids

The turnip root aphid, *Pemphigus populitransversus*, feeds on cabbage plants, causing yellowing and stunting. They are very destructive when present in large numbers, and can particularly cause damage to late fall or early spring plantings. Under favorable growing conditions, however, infestations late in the season do not cause serious yield reductions. The application of soil insecticides prior to planting is the best means of control (Adams).

Cabbage Webworms

The cabbage webworm, *Hellula rogatalis*, can be a serious pest of cabbage. It feeds on the bud area of the cabbage plant, resulting in moderate- to heavy-webbing. Insecticides should be applied at the first signs of an infestation.

Diamond-back Moths (DBM)

The diamond-back moth, *Plutella xylostella*, is one of the most destructive pests of cabbage and may attack at any stage of plant growth. The moths lay eggs on the undersides of the leaves, which hatch in a day or so. The larvae feed on the leaves, resulting in holes that enlarge as the leaf develops. The larvae also attack the developing heads, causing deformity and encouraging soft rots (Adams).

Temperatures below 50° F discourage feeding activity of the larvae, while temperatures above 80° F favor rapid population growth. Heavy rains may reduce populations dramatically (Adams). Preventive insecticide treatments are the most efficient control method.

Cutworms

Cutworms, *Feltia subterranea*, are greasy, gray caterpillars that feed on the stems and leaves of cabbage at night, then retreat into the soil in daytime. Heavy populations may be present during the spring since cutworms may survive the winter in the larval stage. Most cutworms cut plants off at, or slightly below, the soil surface, which makes newly set transplants very susceptible (Curwen, et al.). Mature plants, with thicker and tougher stems, are less susceptible to cutworm damage. Insecticides are used for control.

Maggots

Maggots are the immature stage of flies, and are attracted to decaying organic matter. They damage plants by feeding on the roots and stems. Young cabbage seedlings or transplants are the most prone to maggot attack, particularly during the cooler months when the plants are developing slowly. Seedling plants can be killed rapidly, whereas transplants tend to wilt and die slowly (Curwen, et al.). Soil-applied insecticides are used to prevent maggot damage.

Flea Beetles

Flea beetles usually feed on the leaves of cabbage seedlings, producing small circular holes. These beetles are small and shiny black in appearance. Their feeding activities can quickly kill young seedlings.

Harlequin Bugs

Harlequin bugs (*Murgantia histrionica*) can damage cabbage plants with their piercing, sucking mouthparts. Both the young and adult insects feed on the veins of the cabbage leaves, sucking plant juices and injecting a poison into the plant (Ware and McCollum). Their feeding often results in wilting of the leaves. Insecticides are applied for control, usually when one bug is found per 10 plants (Adams).

Stink Bugs

Stink bugs, *Nezara viridula*, also feed on the leaf veins using their piercing, sucking mouthparts. They suck out plant sap, which consequently results in wilting. Stink bugs are a more common problem among turnips and mustard than cabbage or other leafy greens (Adams). Insecticides are used for control.

Weeds

Weeds compete with cabbage for water, nutrients, and light. They become a more serious problem as temperatures rise. Fields heavily invaded by weeds

are likely to suffer from reduced crop yields and reduced quality. Growers may have to sell their cabbage at a discount due to inferior quality, or worse, they may find the heads unmarketable. Harvesting is also very difficult and time-consuming in weed-infested fields. Herbicide applications and crop rotation are control methods.

Physiological Disorders

Internal Tipburn

Tipburn is a physiological disorder in cabbage plants, and is caused by hot, dry, windy, weather during head formation. It occurs on the leaf margins inside the head, and thus is undetectable until the cabbage head is cut open. Prevention practices include the use of tipburn-resistant hybrids, and the avoidance of a heavy, single nitrogen application during head formation. In addition, cultivation may be avoided to save feeder roots and to maintain the plant's water uptake (Longbrake, et al.).

Bruises

Cabbage heads are prone to bruises, especially during harvesting and packing. Stems should be cut at most one-half inch beyond the point of attachment of the outermost leaves. Otherwise, they become prone to damage from the long, protruding stems. Sometimes, cabbage heads are subject to impact damage when thrown into bulk containers in the field or at the packing shed, resulting in broken outer leaves and bursting (Hurst).

Wilting

Cabbage heads wilt quickly when there is a delay in removing them from the sun after harvesting (Hurst). Harvested cabbage heads should be protected from too much sunlight exposure. They should also be precooled immediately after harvest to prevent the accumulation of field heat.

Bolting

Bolting occurs when the cabbage plant produces flower stalks, rather than a marketable head. Bolting is prompted by various factors that slow vegetative growth, including a lack of nitrogen or other nutrients, drought stress, insects, diseases, and competition from weeds. Exposure of newly-planted seeds and newly-transplanted seedlings to excessively cool temperatures may also cause bolting.

State Analyses

California

California is the leading U.S. cabbage-producing state in terms of value of production, but ranks third, behind New York and Texas, in terms of harvested acres and output volume. According to NASS, California produced 4,043,000 cwt of cabbage in 1994, valued at approximately \$55.8 million (Table 3). The

value of California's output represented about 24 percent of U.S. total fresh-market cabbage production in 1994.

Cabbage production in California in 1994 decreased 6 percent from the previous year, due to a reduction in planted and harvested acreage. Yields, however, reached 385 cwt per acre in 1994, up about 7 percent from 1993.

The Census of Agriculture reported that 221 farms in California harvested head cabbage from a total of 11,887 acres in 1992 (Table 1). The Census also reported California as the leading producer of Chinese cabbage in 1992, with 120 farms harvesting 4,540 acres, about 51 percent of the U.S. Chinese cabbage area (Table 2). Virtually all of California's cabbage farms are irrigated.

Sixty-six percent of California's harvested cabbage acreage in 1992 was along the Pacific Coast, in Santa Barbara, Ventura, Monterey, and San Luis Obispo counties (Census). Santa Barbara and Ventura counties each accounted for about 20 percent of the state's total harvested area in that year. Imperial and Riverside counties, in the southernmost portion of the state, each accounted for about 6 percent of California's harvested acreage.

Grower Practices

California-grown cabbage is available almost year round. Southern California produces the winter and spring crops, while northern and central California produce the summer crops (Rubatzky). The winter and spring crops, however, dominate the state's cabbage production.

Growers plant from September through October for the winter crop, which is usually harvested from late December through February. They also plant from November through early February for the April through June harvest.

While some cabbage growers prefer to transplant, direct seeding is the most common method of planting. Sprinkler irrigation is typically used when the crop is germinating, while furrow irrigation is more common once seedlings have emerged (Rubatzky).

Cabbage is grown as an annual crop in California, meaning that the plant is harvested for one season and then destroyed. Cabbage is regarded as a low-input crop and a small industry in California as compared to lettuce, celery, and strawberries. Cabbage is usually grown in rotation with celery, lettuce, tomatoes, and potatoes.

Hybrid varieties comprise a majority of the state's plantings. Since hybrids mature much more uniformly than open-pollinated varieties, growers try to enforce a single harvest (one cutting) as much as possible. "Headstart" is a common green-cabbage variety. Almost all growers produce a certain proportion of red cabbage. "Rubyball" is the standard hybrid red variety (California Cooperative Extension).

Mature cabbage heads are usually hand harvested. The harvested heads are typically field-packed, with 50 pounds to a carton, and transported via refrigerated trucks.

California's cabbage is grown entirely for the fresh market, and is sold mainly through terminal markets and to direct retail chains. However, there has been a steady decline in the volume of cabbage sold through terminal markets in recent years. Out-of-state shipments are limited to the western states.

Production Perils

California growers face no major perils in growing cabbage (Rubatzky). There have been occasional heavy rains and floods between 1991 and 1993, but they have not affected cabbage plantings to the same extent as certain other crops (CFSA, Tulare County). There are also occasional frosts, but these occurrences also have not caused any serious crop losses, especially since the crop can more or less withstand some freezing temperatures.

Cabbage worms, diamond back moths, and cabbage aphids are common insect pests found in cabbage fields in California, while fusarium yellows is the most common disease problem. There also have been occasional nematode problems. However, pest and disease problems can be brought under control through the use of prudent management practices.

Demand for Crop Insurance

Most California growers would likely have little interest in a crop insurance policy for cabbage because they have not faced serious production perils in the past. Ad hoc disaster payments for cabbage losses between 1988 and 1993 have been small when compared with the payments received by other major cabbage-producing states (Table 11). Further, since cabbage is regarded as a low input crop in California, it is considered less important than the high-input crops such as lettuce, celery, and tomatoes (Rubatzky). Growers are more likely to have an interest in insuring these high-input crops.

Florida

Florida's cabbage industry ranks fourth in the nation in terms of value of production. In 1994, Florida growers harvested 2,816,000 cwt of cabbage from 8,800 acres (Table 3). Production was valued at \$29.6 million, approximately 12 percent of the U.S. total.

The Census of Agriculture reported that 99 Florida farms grew head cabbage in 1992, down from 111 farms in 1987 (Table 1). These farms harvested a total of 9,022 acres of cabbage, down from 10,173 acres in 1987. Seventy-four percent of these farms had irrigation, covering 88 percent of the state's total harvested crop acreage.

Table 11--Disaster assistance payments for cabbage, 1988-93

Region/State disaster	Estimated average cabbage harvested acreage, 1988-93	Share of U. S. acreage	Total cabbage disaster payments, 1988-93	Share of U. S. cabbage payments
	---Acres---	---Percent---	---Dollars---	---Percent---
Northeast	19,757	21.18	7,244,529	27.76
Connecticut	201	0.22	115,279	0.44
Maine	128	0.14	60,337	0.23
Massachusetts	550	0.59	398,609	1.53
New Hampshire	35	0.04	819	0.00
New Jersey	2,302	2.47	864,424	3.31
New York	14,307	15.34	4,865,537	18.65
Pennsylvania	2,145	2.30	933,408	3.58
Rhode Island	42	0.05	229	0.00
Vermont	47	0.05	5,887	0.02
North Central	18,523	19.86	6,846,764	26.24
Illinois	1,157	1.24	920,457	3.53
Indiana	899	0.96	917,684	3.52
Iowa	292	0.31	130,335	0.50
Kansas	99	0.11	44,466	0.17
Michigan	2,685	2.88	618,185	2.37
Minnesota	702	0.75	190,304	0.73
Missouri	216	0.23	126,081	0.48
Nebraska	45	0.05	18,038	0.07
North Dakota	NR	NR	16,415	0.06
Ohio	2,358	2.53	1,135,520	4.35
South Dakota	2	0.00	563	0.00
Wisconsin	10,068	10.79	2,728,716	10.46
South	37,047	39.72	11,440,505	43.84
Alabama	400	0.43	292,361	1.12
Arkansas	147	0.16	986,346	3.78
Delaware	367	0.39	0	0.00
Florida	9,482	10.17	527,999	2.02
Georgia	5,283	5.66	1,600,991	6.14
Kentucky	484	0.52	86,158	0.33
Louisiana	536	0.57	349,016	1.34
Maryland	393	0.42	237,295	0.91
Mississippi	196	0.21	218,822	0.84
North Carolina	5,733	6.15	1,254,100	4.81
Oklahoma	104	0.11	291,823	1.12
South Carolina	419	0.45	361,216	1.38
Tennessee	704	0.75	1,145,716	4.39
Texas	11,066	11.86	3,723,147	14.27
Virginia	1,692	1.81	324,554	1.24
West Virginia	41	0.04	40,961	0.16

Table 11, continued--Disaster assistance payments for cabbage, 1988-93

Region/State disaster	Estimated average cabbage harvested acreaage, 1988-93	Share of U. S. acreage	Total cabbage disaster payments, 1988-93	Share of U. S. cabbage payments
	---Acres---	---Percent---	---Dollars---	---Percent---
West	17,660	18.93	490,070	1.88
Alaska	42	0.05	0	0.00
Arizona	1,469	1.57	0	0.00
California	11,099	11.90	129,819	0.50
Colorado	1,945	2.09	155,794	0.60
Hawaii	533	0.57	328	0.00
Idaho	25	0.03	24,166	0.09
Montana	21	0.02	2,077	0.01
Nevada	0	0	0	0.00
New Mexico	730	0.78	76,752	0.29
Oregon	897	0.96	23,385	0.09
Utah	247	0.26	0	0.00
Washington	652	0.70	77,749	0.30
Wyoming	NR	NR	0	0.00
Other 1/ United States	NA 93,271	NA 99.70	60,280 26,093,313	0.23 100.00

NR= Not reported to avoid disclosing individual operations.

NA= Not available.

1/ Includes disaster payments collected by U. S. territories.

Note: Cabbage acreage is averaged for the years 1987 to 1992 only. A linear trend was used to estimate acreage data for 1988 through 1991 utilizing 1987 and 1992 Census of Agriculture data. Disaster assistance data are averaged over the 1988-93 period.

Sources: 1987 and 1992 Censuses of Agriculture and ASCS data files.

The Census also reported Florida as the second-largest producer of Chinese cabbage in 1992, accounting for 35 percent of total U.S. harvested area (Table 2). Almost all of Florida's Chinese cabbage area is irrigated.

Cabbage production is spread across the state. Over one-fourth of Florida's production originates in Manatee County on the central Gulf coast. St. Johns, Seminole, Putnam, and Volusia counties, in the northeast portion of the state, each account for between 3 percent and 8 percent of the state's harvested cabbage area.

Grower Practices

Cabbage is grown extensively as an annual crop in the fall, winter, and early spring months (from about the first of October through mid-March) in Florida. Transplanting using a mechanical transplanter is the most popular planting method. Harvesting, on the other hand, utilizes mostly hand labor. Seepage-type irrigation is the most commonly used system.

Hybrid varieties of green cabbage dominate Florida's plantings. Less than one percent of the state's production is red cabbage. Cabbage plantings are often followed by a cover crop and then by potatoes.

Production is exclusively for the fresh market. Only a small proportion of production is hauled to a packing shed for packing. Brokers and retail chain stores are the major buyers. Very little of Florida's cabbage is sold through roadside markets.

Refrigerated trucks are the most common means of transporting Florida cabbage. Almost all out-of-state shipments are destined for the Northeast or markets east of the Mississippi River (Hensel).

Production Perils

Freezes caused crop losses to Florida's cabbage in the 1980's (Hensel). Many growers were not able to recover from these losses and went out of business. Excessive rain and hail also pose a potential threat to production, but crop losses due to these perils have not been serious thus far (Hensel). Disaster payments to Volusia County growers, amounting to \$29,075 in 1993, were attributed to losses caused by too much rain and hail around March of that year, coinciding with the planting season (Thigpen).

Hurricanes and drought are not considered a serious threat because cabbage is not planted during the hurricane season, and most plantings are irrigated. Nematodes are one of many pests which may cause extensive injury to vegetable crops grown in fine sandy soils in Florida (White and Rhoades). However, most insects and diseases can be controlled with good management practices.

Demand for Crop Insurance

Florida growers are likely to indicate a moderate interest in a crop insurance policy for cabbage. Minor, but frequent weather-related perils, such as heavy

rains, hail, and droughts, continue to pose a threat to cabbage production. The potential for losses due to drought, however, is relatively low because of the significant proportion of the state's cabbage acreage that is irrigated. Large crop losses experienced during the 1980's remain in the minds of many growers, and a crop insurance policy will likely serve as an attractive option for these growers as a means to ease the risks involved in cabbage production (Hensel).

Georgia

Ranking fifth in the U.S. in terms of value of production, Georgia harvested 2,700,000 cwt of cabbage from 9,000 acres in 1994. The state's output was valued at \$24.3 million (Table 3). Production was approximately 10 percent of the total U.S. value.

According to the Census of Agriculture, 150 farms in Georgia harvested head cabbage in 1992, up from 109 farms in 1987 (Table 1). These farms harvested a total of 6,593 acres, up from 3,319 acres in 1987. Sixty-six percent of the harvested acreage was irrigated.

About 61 percent of production in 1992 was concentrated in Georgia's southern portion, specifically in Colquitt, Tift, Brooks, Worth, Atkinson, Grady, Berrien, Lowndes, Tattnall, and Cook counties. About 36 percent of Georgia's production was in Rabun County, in the northeastern tip of the state.

Grower Practices

Georgia growers produce cabbage as an annual crop. Transplanting and direct seeding are both used, but transplanting is the dominant practice. Mechanical transplanters and seeders are used during planting. However, when grown under plastic mulch, cabbage is planted by hand. Only a small number of growers use this method.

Growers direct seed from July through August for fall production, which occurs between October and December, or they transplant from mid-August through mid-September. For the winter crop, which is harvested from late December through February, they direct seed or transplant between September and October (McLaurin, et. al.). They also plant between November and early February for the spring crop, which is harvested from April through June. The period from the middle of June through early July is the only time when there is no cabbage growing in the field.

Hybrid varieties account for the majority of Georgia's cabbage production, although open-pollinated varieties are also cultivated. Overhead irrigation is most commonly used, except for the small proportion of cabbage grown under plastic mulch that is irrigated using trickle systems.

Crop rotation practices vary among locations. Farms that also grow cabbage, but that are agronomic in nature, use cotton, corn, or peanuts as rotation crops. Growers that primarily have vegetables, on the other hand, typically plant peppers, squash, and tomatoes in rotation with cabbage.

About 98 percent of Georgia's output is grown for the fresh market (Kelly). Harvesting is done by hand. Most newly-harvested cabbages are hauled to a packing shed for packing into 50-lb cartons. Most of Georgia's cabbage is marketed through brokers for shipment out-of-state. Some cabbages are also sold directly to chain supermarkets and fast food chains, and a very small proportion is sold in roadside markets. Out-of-state shipments are mostly to the eastern states and the Midwest.

Production Perils

Georgia growers in recent years have confronted yield losses caused by excess moisture, hail, frost, and drought. The most common insect pests affecting Georgia's cabbage plantings include diamond back moths, cabbage loopers, and imported cabbage worms, while black rot is the most common disease problem. Insect and disease problems can generally be controlled.

Excessive moisture was the cause of large ad hoc disaster payments in 1989 and 1992. Disaster assistance payments for losses caused by very wet conditions amounted to \$151,370 in Rabun County in 1989 and \$91,063 in 1992 (CFSA, Rabun County). Very wet conditions coincided with cabbage head formation during those years, and resulted in significantly lower yields. In addition, muddy field conditions made it very difficult to control insects and diseases. Ad hoc disaster payments in 1991 and 1993 were due to drought.

Demand for Crop Insurance

Georgia growers will probably have a strong interest in a cabbage insurance policy. Georgia has in recent years realized sizeable losses, collecting the country's fourth largest total ad hoc disaster payments for cabbage--at \$1.6 million--during the 1988-93 period. This total accounts for about 6 percent of the U.S. payments made for cabbage losses, a slightly larger share than Georgia's estimated 5.7 percent share of total harvested cabbage area (Table 11). According to Dr. W. T. Kelly of the University of Georgia, growers will likely be interested in crop insurance, especially with the dissipation of ad hoc disaster payments and their knowledge of the risks involved in producing cabbage in Georgia.

New York

New York is an important producer of cabbage, harvesting 5,490,000 cwt for the fresh market in 1994, the largest volume of any state in the country. New York's output accounted for 21 percent of the U.S. total in that year (Table 3). Fresh-market cabbage was harvested from 12,000 acres in 1994, the largest acreage of any state, and accounted for 16 percent of the U.S. total. New York ranked second to California in value of production, amounting to \$42.8 million in 1994. According to the Census, New York accounted for the largest number of farms growing head cabbage in 1992, with 537 farms or 10 percent of the U.S. total.

New York also produces cabbage for sauerkraut. In 1994, the state reported 2,100 harvested acres of cabbage for kraut production, at a value of about \$2.4 million.

Cabbage production is concentrated in the northwest portion of New York, in Monroe, Genessee, Orleans, Ontario, and Niagara counties. These counties accounted for 73 percent of the state's harvested cabbage acreage, and each reported over a thousand acres of cabbage harvested in 1992. Suffolk County, in the southeast portion of the state, also had about a thousand acres of harvested cabbage in 1992.

Grower Practices

New York growers plant cabbage mainly as a summer crop. They usually begin planting early in the spring, from about the first of April through the end of July. Direct seeding and transplanting are both used, although growers are increasingly using the transplanting method. However, a fairly large number of growers still direct seed (Price).

Cabbage is grown as an annual crop. Due to the very cold winters in New York, the crop does not overwinter. Cabbage plants that survive to the second year usually produce a seed stalk rather than a head (Price).

Growers plant cabbage for the fresh market, for storage, and for processing into kraut. About 82 percent of the cabbage crop in 1994 was for the fresh market and for storage, while the remaining 18 percent was destined for the kraut market (Tables 3 and 4). Storage cabbage (mainly white cabbage) can be kept for as long as five to six months. Growers ensure that their storage facilities are empty by about March, when shipments arrive from Florida.

Only 13 percent of the state's harvested cabbage acreage was irrigated in 1992 (Census). Of the 164 farms growing head cabbage in the state's five-leading counties, only 9 farms had irrigation. In Suffolk County, 56 of the 70 farms had irrigation in that year, accounting for 87 percent of the total harvested acreage. Furrow irrigation is the most popular method among growers (Price).

Growers usually harvest from July to October. The fresh market and storage types of cabbage are harvested manually to reduce the chances of bruising the heads. Bruises on the wrapper leaves make the heads less visually appealing and more susceptible to rot. Most cabbage is field packed, except for storage cabbage, which is usually moved to packing sheds. Kraut cabbage is usually harvested by machine.

Crop rotation is a standard practice among cabbage growers. Common rotation crops include field and sweet corn, alfalfa, and snap beans. Growers often plant a cover crop, usually winter wheat or rye, to replenish the organic content of the soil.

Fresh-market cabbage is sold to various brokers, as well as directly to retail chains, the New York terminal market, and terminal markets outside the state, usually in the South. Only a small portion of New York's cabbage is sold

through roadside markets. All of New York's kraut cabbage is sold under contract with processors, with the contracts based on tonnage.

Production Perils

Drought has reduced New York cabbage yields in dry years, and is a particular concern since a majority of the state's cabbage farms have no irrigation (Price). Excessive rains have also been a problem, especially since cabbage plants cannot withstand prolonged periods of standing water. Excessive moisture led to large ad hoc disaster assistance payments during 1992 and 1993, particularly in upstate counties (CFSA, Niagara County & Erie County).

Growers also encounter insect and disease problems, although most such perils can be controlled through prudent management practices. Club root and black rot are the most common diseases in cabbage plantings in New York (Price).

Demand for Crop Insurance

Having been faced with major crop losses in the past, New York growers are likely to show an interest in a cabbage insurance policy, especially with the reduced likelihood of future ad hoc disaster assistance payments. New York collected the largest ad hoc disaster payments for cabbage losses among any state during the six years between 1988 and 1993. Disaster payments to New York growers amounted to about \$4.9 million over this period, about 19 percent of the U.S. total (Table 11). The state's share of U.S. harvested cabbage acreage, on the other hand, was estimated at about 15 percent.

Texas

Texas is the third largest cabbage-producing state in the country, accounting for 13 percent of the total value of U.S. cabbage production in 1994. Unlike California and New York, Texas's harvested cabbage area increased 15 percent between 1993 and 1994. Production increased 22 percent between the two years, reaching 4,144,000 cwt.

According to the Census, 176 Texas farms harvested head cabbage from a total of 9,312 acres in 1992 (Table 1). Seventy-five percent of these farms used irrigation, and irrigated acreage accounted for 98 percent of the state's harvested acreage.

Eighty percent of Texas's cabbage production in 1992 was concentrated in the southern portion of the state, in Hidalgo, Uvalde, Zavala, Cameron, and Medina counties (Census). Hidalgo County alone accounted for 56 percent of Texas's output. All the cabbage farms in these five leading counties, except one in Hidalgo County, had irrigation.

Grower Practices

Cabbage is grown as an annual crop in Texas (Dainello). Nearly all of the crop is direct seeded. Transplanting is done primarily when prolonged rains delay scheduled plantings. Hybrid varieties are used almost exclusively, and

fewer than 10 percent of the hybrid varieties planted are red cabbage types (Dainello).

South Texas produces a fall, winter, and spring cabbage crop. The lower Rio Grande Valley direct seeds about 10,000 to 13,000 acres during the months of July through November, for harvest from October through April. The San Antonio-Winter Garden area produces 2,500 to 3,500 acres, which are mostly direct seeded during August through September for harvest from October through March. Some acreage in this area is seeded in January through February for harvest in May and June. The Trans-Pecos and High Plains areas direct seed 1,200 to 1,500 acres during March through May for the June through October harvest. The Coastal Bend, Upper Coast, East, Far West, and North Central areas of Texas also each grow 200 to 400 acres annually (Longbrake, et al.).

Crop rotation is a common practice among growers. Since most of the farms growing cabbage are agronomic farms, cotton, wheat, and corn are the most common rotation crops used. However, some vegetable crops are also planted in rotation with cabbage, particularly on those farms specializing in vegetable production.

Almost all of the cabbage produced in Texas is for the fresh market. Most of the state's cabbage is moved to packing sheds after harvest, although some field packing also occurs. When prices are low, portable packing lines are at times brought into the field to reduce costs. It is quite common for growers to abandon their crop during periods of depressed prices (Dainello).

Cabbage is sold to brokers, packing houses, and shippers. Most produce houses sell to food chains and other retail outlets. Only a small proportion of the state's production is sold through roadside markets. Most of Texas's cabbage is shipped in refrigerated trucks. Out-of-state shipments are generally destined for the Northeast or Midwest.

Production Perils

Hail storms are a major production peril in Texas's cabbage-producing areas. In the Winter Garden area, hail damage can occur even early in the spring (Dainello). Other natural perils causing cabbage losses include freezes, excessive rains, and flooding. Hidalgo County growers collected \$562,259 in disaster payments in 1989 for cabbage losses due to a severe freeze (CFSA, Hidalgo County). Disaster payments amounting to \$221,724 were made to Uvalde County growers for crop losses due to excessive rains in 1992 and 1993 (CFSA, Uvalde County). Losses due to drought have not been widespread because a majority of the state's production is irrigated.

Tipburn, a physiological disorder favored by hot, dry, windy weather during head formation, is also a common problem among cabbage farms (Dainello). Common insect pests in cabbage plantings in Texas include cabbage loopers, cabbage worms, diamond back moths, and white flies. Black rot is the most common disease problem.

Demand for Crop Insurance

Texas growers are likely to show an interest in cabbage insurance. Because of past losses due to natural causes, growers are always in a constant search for ways to keep themselves solvent (Dainello). Texas ranked second in the U.S. in terms of total ad hoc disaster payments received for cabbage losses between 1988 and 1993. The state's received 14 percent of the total disaster payments made for cabbage, while accounting for 12 percent of harvested cabbage area.

Wisconsin

According to the Census, 216 Wisconsin farms harvested cabbage from a total of 11,250 acres in 1992. The number of farms and harvested acreage increased 13 percent and 36 percent, respectively, from levels reported in the 1987 Census. Only 18 percent of the farms, and 17 percent of the state's harvested acreage, were irrigated in 1992.

Production is concentrated in the southeast portion of the state. Seventy-one percent of Wisconsin's harvested acreage is in Racine, Columbia, Dane, and Waukesha counties. Outagamie County, located in the east central portion of the state, is also a large producer, accounting for 22 percent of the state's output.

In 1994, 59 percent of Wisconsin's cabbage area was harvested for fresh-market use, while 41 percent was used for processing (kraut) cabbage (USDA, NASS). In terms of quantity, however, fresh-market cabbage accounted for 39 percent (129.6 million pounds) of the state's total cabbage output, while processing cabbage accounted for 61 percent (201.6 million pounds).

Grower Practices

Growers usually begin planting cabbage from April through July, and harvest beginning in late August. Most growers use the transplanting method, and plant mostly by mechanical means. Harvesting, on the other hand, is often done by hand cutting and picking of the mature heads, with the harvested heads then loaded onto trailers for hauling to the packing shed.

Most of Wisconsin's growers use hybrid varieties. In order to avoid over-supplies, growers usually plant different hybrid varieties at different dates to avoid harvesting large quantities at one time (Biese).

All of the cabbage produced in Outagamie County, a major production area, is used for kraut processing (Biese). None of the cabbage-growing farms in this county are irrigated. In Racine County, also a major production area, cabbage production is mixed: both fresh market and processing varieties are grown.

Cabbage for sauerkraut is produced mainly under contract with processors, with the contracts usually based on tonnage. Quantities produced over the required tonnage may be bought at a lower price (Biese). Excess supplies are also at times shipped to processors in Ohio and in the South.

Fresh-market cabbage often is sold directly to farmer's markets. Some fresh-market cabbage is also sold to retail grocers for deli cole slaw or for sale as fresh cabbage heads.

Production Perils

Drought and excessive moisture are the major perils to cabbage production in Wisconsin. Serious crop losses in 1988 were caused by severe drought (CFSA, Racine County). Damage in that year was most serious in Racine County, and resulted in about \$1.0 million in ad hoc disaster payments. Drought extended somewhat through the following year, although yield losses were less severe in 1989.

Disaster payments to Racine County growers ranged between \$4,276 and \$31,182 between the years 1989 and 1993, and were caused by perils including very dry weather, very wet weather, and early frost (CFSA, Racine County). Excessive moisture was the main reason for cabbage losses in Outagamie County in 1993 (CFSA, Outagamie County). Among all cabbage-producing counties in Wisconsin, Outagamie County collected the highest disaster payments in 1993, amounting to \$478,154.

Demand for Crop Insurance

Wisconsin growers will likely have an interest in a crop insurance policy for cabbage. The state's growers collected the third-largest disaster assistance payments for cabbage losses in the U.S. during the 1988-93 period, following New York and Texas. Wisconsin ranked first among the North Central states in payments. The state's share of total disaster assistance during the six-year period was 10 percent, relatively close to its 11 percent estimated share of U.S. harvested acreage (Table 11). The high risk of crop loss due to drought is of particular concern to growers, as only a small portion of the state's cabbage acreage is irrigated.

Ad Hoc Disaster Assistance for Cabbage

Ad hoc disaster payments were made available to cabbage growers for losses due to natural causes in each of the years 1988 to 1993. Since commercially-grown cabbage was not eligible for crop insurance in those years, cabbage producers were required to realize a yield loss of at least 40 percent 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 cabbage, and would likely have a relatively high demand for crop insurance for cabbage.

Disaster assistance payments for cabbage losses totalled \$26.1 million over the 1988-93 period. The largest payments were made in 1988, at \$7.4 million, due mainly to severe drought (Table 12). Payments were large again in 1993, at \$5.3 million, 34 percent higher than in 1992, but about 30 percent below

Table 12--Ad hoc disaster assistance payments for cabbage, individual years

State	1988	1989	1990	1991	1992	1993	1988-93
-----Dollars-----							
Alabama	52,858	51,942	50,898	26,943	40,275	69,445	292,361
Arkansas	49,052	47,772	254,564	199,711	43,776	391,471	986,346
California	.	.	21,527	64,244	.	44,048	129,819
Colorado	.	.	74	.	59,619	96,101	155,794
Connecticut	35,917	15,397	8,453	17,339	9,737	28,436	115,279
Florida	99,048	43,643	92,374	135,142	40,295	117,497	527,999
Georgia	195,692	248,670	201,597	484,868	367,164	103,000	1,600,991
Hawaii	.	.	.	.	328	.	328
Idaho	.	.	.	.	3,024	21,142	24,166
Illinois	507,468	31,153	19,363	109,245	18,617	234,611	920,457
Indiana	452,932	115,717	63,237	132,207	48,495	105,096	917,684
Iowa	21,850	1,511	5,702	3,067	215	97,990	130,335
Kansas	6,852	.	.	646	132	36,836	44,466
Kentucky	68,218	5,485	122	7,899	210	4,224	86,158
Louisiana	60,375	123,797	9,922	141,857	13,065	.	349,016
Maine	17,715	.	4,293	3,753	7,869	26,707	60,337
Maryland	63,661	7,951	46	5,446	285	159,906	237,295
Massachusetts	156,949	78,636	21,486	43,154	19,040	79,344	398,609
Michigan	293,691	145,136	14,018	58,151	46,642	60,547	618,185
Minnesota	101,004	6,440	11,167	21,321	8,627	41,745	190,304
Mississippi	48,632	22,756	64,359	26,102	37,800	19,173	218,822
Missouri	5,613	1,027	6,628	21,981	31,369	59,463	126,081
Montana	.	1,538	.	.	539	.	2,077
Nebraska	2,155	.	.	2,576	84	13,223	18,038
New Hampshire	146	673	.	.	.	.	819
New Jersey	178,504	407,255	19,607	87,965	15,674	155,419	864,424
New Mexico	4,713	.	6,139	1,602	62,001	2,297	76,752
New York	1,572,377	1,130,357	115,414	357,919	1,597,675	91,795	4,865,537
North Carolina	56,164	252,439	158,990	133,289	216,690	436,528	1,254,100
North Dakota	7,701	6,744	.	13	.	1,957	16,415
Ohio	426,467	158,955	60,905	190,645	126,579	171,969	1,135,520
Oklahoma	80,027	56,308	46,543	29,562	43,197	36,186	291,823
Oregon	.	.	4,421	3,010	.	15,954	23,385
Pennsylvania	440,716	130,284	11,625	126,722	84,013	140,048	933,408
Rhode Island	.	.	.	.	.	229	229
South Carolina	11,381	36,712	23,987	13,322	81,637	194,177	361,216
South Dakota	563	.	.	.	.	.	563
Tennessee	256,453	141,182	178,857	178,061	100,113	291,050	1,145,716
Texas	227,724	906,154	625,153	271,649	722,858	969,609	3,723,147
Vermont	.	2,984	2,903	.	.	.	5,887
Virginia	51,665	39,616	41,368	10,116	19,407	162,382	324,554
Washington	11,137	.	2,987	3,923	.	59,702	77,749
West Virginia	34,680	4,504	381	590	198	608	40,961
Wisconsin	1,810,739	32,909	51,499	67,554	24,933	741,082	2,728,716
Other 1/	0	0	20,179	5,534	45,732	0	71,445
Total	7,410,839	4,255,647	2,220,788	2,987,128	3,937,914	5,280,997	26,093,313

1/ Includes disaster payments collected by U.S. territories.

the peak realized in 1988. Excessive moisture, due mainly to flooding, as well as insect and disease problems, were the major causes of loss in 1993.

Total disaster payments during the six-year period were scattered across the United States, with 44 states receiving payments in at least one of the six years. Twenty-seven of these states, representing most states in the Northeast, North Central area, and South, received payments in each of the six years. These three regions accounted for 98 percent of total disaster payments for cabbage losses during the six-year period.

Nearly 70 percent of total disaster payments for cabbage losses between 1988 and 1993 were made to growers in New York, Texas, Wisconsin, Georgia, North Carolina, Tennessee, Ohio, Arkansas, Pennsylvania, and Illinois. New York received a total of \$4.9 million in disaster assistance during the six-year period, nearly 20 percent of the U.S. total, and the largest amount received by any state. Texas received \$3.7 million, the second largest amount, accounting for 14 percent of the U.S. total. Wisconsin received \$2.7 million, 10 percent of the U.S. total. California, a major producing state, received \$129,800, only 0.5 percent of the U.S. total.

A total of 779 U.S. counties received ad hoc disaster payments for cabbage losses in at least one of the six years between 1988 and 1993. Thirty-one counties in New York received payments, 38 counties in Texas, 11 counties in California, 26 counties in Florida, and 42 counties in Georgia.

Hidalgo County in Texas received the largest ad hoc disaster payments for cabbage losses during the six-year period, collecting a total of \$1.4 million, five percent of the U.S. total. The next counties in the series are Orleans County and Niagara County in New York, with \$1.4 million and \$1.2 million, respectively, and Racine County and Outagamie County in Wisconsin, with \$1.1 million and \$624,500, respectively. These top five counties represented only 22 percent of the total disaster payments made for cabbage losses.

Ad hoc disaster data can be used to indicate which cabbage-producing areas received large payments relative to their acreage (Table 11). New York, Texas, and Georgia were major cabbage-producing states whose shares of total disaster payments were somewhat larger than their estimated shares of U.S. harvested cabbage acreage between 1988 and 1993. In contrast, California and Florida accounted for a small share of payments relative to their respective acreage.

Cabbage Insurance Implementation Issues

Adverse Selection

Floods caused by excessive rains and frosts are key adverse selection concerns when insuring cabbage because both perils, particularly frosts, tend to cause field-specific damage. Some of the most serious crop losses in the past were due to excessive rains, while minor losses were occasionally caused by frosts. Furthermore, growers are likely better informed about the likelihood of crop losses due to floods and frosts than the insurer, and may use this advantage

in deciding whether or not to purchase insurance. Fields in low-lying areas or flood plains are the most prone to losses due to floods. Fields located in low, flat areas tend to be more prone to yield losses due to frost damage than areas with slopes and at higher elevations.

Setting Reference Prices

Cabbage prices vary significantly throughout the year due to weather impacts and the seasonality of supplies from major competing markets. Year-to-year price fluctuations, affected mostly by changes in acreage, tend to be less variable. Hence, an average annual price appears to be an appropriate guide in setting the reference prices used in valuing a producer's claim in the event of yield loss.

An in-field value represents the best reference price for estimating the value of cabbage losses prior to harvest. This reference price will ensure that indemnity payments to producers will not cover non-incurred harvesting and marketing expenses on that portion of production that was lost. For cabbage, these expenses account for about 30 to 60 percent of total production costs. Pre-harvest losses may be due to excessive rains, drought, frost/freeze, and pest and disease problems.

An estimated cost of production, excluding harvesting and marketing expenses, could approximate an in-field value of the crop. The in-field value could also be represented by the average annual grower price for fresh-market cabbage reported by USDA's National Agricultural Statistics Service beginning in 1992, with some adjustments for non-incurred harvesting and marketing expenses.

Market Prices and APH Distortions

Market price fluctuations are likely to cause some yield distortions, due to economic abandonment, when estimating a grower's average production history, particularly for cabbage grown for the fresh market. The extent of economic abandonment in the event of low prices, however, appears to vary by area. Industry sources indicate that growers in Florida and Texas have been known to abandon their cabbage plantings when prices fell below breakeven levels, while most growers in New York, California, Wisconsin, and Georgia were reported as very seldom abandoning their crop.

Crop abandonment could occur during periods of depressed fresh-market prices because fresh-market cabbage cannot be diverted easily for processing use. Most cabbage for kraut processing is grown under contracts with processors. Kraut processors will only buy from producers of fresh-market cabbage when processing cabbage is in short supply.

Further, not all fresh-market varieties are acceptable for kraut processing. Processors prefer compact and round heads for easier handling by processing machines. They also prefer heavier heads, that range from 7 to 8 pounds, to maximize tonnage. Some varieties of head cabbage produce oval and somewhat flat heads and weights may also vary widely. In addition, the heads of Savoy

varieties and Chinese cabbage are more loosely formed than the types used for processing, the leaves are crinkled rather than smooth, and they are lighter than other varieties.

Estimating "Appraised Production"

Estimating appraised production is fairly straightforward for cabbage because each plant produces only one head. Appraised production could be estimated by multiplying the average weight of marketable heads from a sample plot by the total number of plants in a given planting area.

Market Prices and Moral Hazard

There are opportunities for moral hazard under a crop insurance policy for cabbage, particularly for fresh market growers, because alternative markets for fresh-market cabbage during glut periods are limited. Since most of the cabbage for kraut processing is sold under contract with processors, fresh market producers can only divert their output to the processing sector if processors are short of the required processing volume. In addition, fresh-market cabbage cannot be easily diverted for processing because processors have certain varietal preferences. With these market limitations, adopting a practice that increases a growers' chances of receiving an indemnity may be very appealing to cabbage producers, particularly when the insurance indemnity is expected to be higher than the grower's market returns.

Moral hazard will not likely be an issue in the production of storage and processing cabbage. Producers of storage cabbage harvest their crop regardless of current market prices because they are able to store their harvested crop for up to five to six months. Producers of processing cabbage inform kraut processors of their capacity to produce. Supplies that exceed contract requirements may be sold to the processing sector at a discount or may be diverted to the fresh market.

Availability of Individual Yield Data

Individual grower yield data for cabbage is not available except from growers themselves. However, county yield data in California are available from the County Agricultural Commissioners annual reports, which are compiled by the California Agricultural Statistics Service (Appendix B). Also included in the annual reports are county data on harvested acreage, production, price per unit, and value of production. The collection of county data for New York's cabbage was discontinued in the recent past.

Demand for Crop Insurance

The demand for cabbage insurance will probably be strong, particularly among growers in the southern, northeastern, and North Central regions. These areas have collected about the same proportion of total U.S. disaster assistance payments for cabbage between 1988 and 1993. Several contacts indicated that growers in these areas would likely be interested in a cabbage policy due to the reduced likelihood of individually-based ad hoc disaster assistance.

Cabbage producers from the western United States, particularly in California, will probably have less of an interest in crop insurance. Disaster payments for cabbage losses in California accounted for a relatively small proportion (less than 1 percent) of the nation's total payments for cabbage, even though California accounted for about 12 percent of U.S. average harvested acreage between 1988 and 1993.

Nationally, drought is a major threat to cabbage production and as of the 1992 Census, only 37 percent of the farms growing cabbage had irrigation. These farms accounted for 56 percent of cabbage harvested area. Among the major cabbage-producing states, New York and Wisconsin had less than 50 percent of both their farms and harvested acreage under irrigation. All the cabbage acreage in California, on the other hand, is irrigated.

Other Implementation Issues

FCIC may wish to investigate mandating prerequisites for cabbage producers who apply for cabbage insurance coverage. These mandatory requirements could include soil tests for nematodes, soil fumigation, the use of resistant varieties, as well as the use of pest- and disease-free seeds and seedlings. These prerequisites would help reduce the likelihood of crop losses.

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Appendix A

Production Budgets, Selected States

Appendix B
County Data for California
compiled by California Agricultural Statistics Service