Squash and Pumpkins: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

Prepared by the Economic Research Service
for the Federal Crop Insurance Corporation

February 28, 1996

Susan Pollack (202) 219-0505

Table of Contents

Executive Summary

Squash and pumpkins are produced commercially in almost every State. In most States, there are a large number of farms devoting a small number of acres to squash or pumpkin production. The States with the greatest acreage in squash production in 1992 included Florida, California, Georgia, Michigan, and New Jersey. For pumpkins, Illinois, California, New York, and Pennsylvania had the greatest acreage.

Both squash and pumpkin production have grown between 1987 and 1992, although pumpkin acreage has expanded much more rapidly. Between 1987 and 1992, total squash acreage increased 19 percent, while total pumpkin acreage increased 56 percent. Many farmers are interested in pumpkin production, viewing it as a lucrative activity for which there is great demand and involving lower input and harvesting costs than squash and other vegetables.

The U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) does not collect data on squash and pumpkins. Therefore, it is difficult to determine total U.S. production. California, Florida, and Michigan, however, do collect basic data. Florida has the largest squash harvested acreage in the U.S. and produces the largest quantity of squash. Florida’s peak production and shipment months are from November through April. California’s squash is marketed mostly from March through May.

Squash and pumpkins, which are members of the cucurbit family, are warm-season crops. They grow best during hot weather and cannot tolerate frost. Seeds will germinate at 60^0F, but ideal germination temperatures are between 85^0F to 90^0F. Pumpkins and squash grow best at temperatures ranging from 75^0F to 85^0F during the day and 60^0F to 70^0F at night. Growth virtually stops when temperatures are below 50^0F, and the plants may be severely injured and maturity delayed if temperatures fall below 40^0F for several days.

Summer squash are harvested while the fruit is immature. The skin and seeds should still be soft. In contrast, winter squash and pumpkins are harvested only after the fruit has matured, when the skin and seeds are hard. This difference in harvesting practice accounts for summer squash's shorter length of time from seed to harvest and its greater perishability.

Most squash grown for fresh-market use is sold wholesale either through produce terminals or State farmers’ markets. Occasionally, growers may have contracts with local retailers. Growers located near urban areas may have arrangements with restaurants, or they may sell their squash at roadside stands.

Pumpkins for fresh use are mostly purchased during October for use as jack o’lanterns. After October, demand drops off drastically. Some fresh pumpkin varieties are sold for homemade pies and as a vegetable. However, the quantity of pumpkins remaining in retail markets after Halloween is small and is usually non-existent after Christmas.

Since pumpkins and squash for processing are grown under contract, growers do not need to market them. Contracts are on a yearly basis, and price is based

on weight. Growers receive a base level for their produce plus a designated amount based on tonnage. During years of surplus production, processors may pay growers only the base level, and not buy their excess production.

Squash and pumpkin production is susceptible to insect, disease, and weather factors. The long growing time required for winter squash and pumpkins increases their likelihood of being affected by such perils. While breeding has helped reduce the risks of loss to some diseases, in some States disease can still be a major factor affecting overall production levels. Diseases can become a problem especially during years with poor weather conditions, such as excessive heat, moisture, or drought.

Large quantities of squash are grown in areas where weather factors have lead to large losses and disaster assistance payments. Florida and Georgia are susceptible to hurricanes. Drought, unpredictable frosts, excessive heat, and excessive moisture have hampered production in almost all States. These weather conditions are especially a problem for small growers and in States that tend to use fewer inputs, such as irrigation and plastic mulching, in their squash and pumpkin production.

Disaster assistance payments totalled almost $25 million for pumpkin losses and $62 million for squash losses over the 1988-93 period. The States receiving the largest disaster assistance payments over this period for pumpkins, in order of their ranking, were Ohio, Tennessee, Michigan, Texas, New Jersey, Wisconsin, and Illinois. The States receiving the largest payments for squash were Georgia, Florida, Michigan, New Jersey, Texas, and North Carolina.

Our assessment is that squash and pumpkins may be good candidates for crop insurance. Many squash and pumpkin growers also grow other crops that are presently covered by crop insurance, such as tomatoes, peppers, and field crops. Growers who already have insurance for these crops will likely add squash and pumpkins to their coverage.

While many squash and pumpkin specialists interviewed for this report stated that they believed squash and pumpkin growers would be interested in crop insurance, several also stated that smaller growers, in particular, may not be willing to invest in the added expense of crop insurance. Squash is often a second crop or is rotated in the field with other crops. Pumpkins are often planted on pastureland or by orchards as a supplemental crop. Therefore, growers may be willing to take the loss from a failed crop and hope to make up the loss with either their next vegetable or field crop that follows or with their main agricultural interest.

Squash and Pumpkin: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

Introduction

Squash and pumpkins belong to the genus Cucurbita, which also includes cucumbers and melons. Within the genus, there are four species of squash and pumpkin--C. maxima, C. moschata, C. pepo, and C. mixta (Madison, Zandstra, Grafius, and Stephens; Voigt). Squash and pumpkin varieties are found in each of the species except C. mixta, which includes only squash.

Squash and pumpkins are botanically similar. The major difference between the two vegetables is in how they are marketed (Voigt). Squash are associated with human consumption, while pumpkins are associated with Halloween displays and are not necessarily for eating. At times, the appearance of marketed squash closely resembles small pumpkins.

Squash and pumpkin types which may appear very different from each other often are grouped together into the same species. Species are determined by the resemblance of the vegetables' stem structure, seed formation, blossom, and leaf shape, and not final use. Therefore, the C. pepo species includes the popular jack o'lantern variety of pumpkin, and all summer squash--yellow, zucchini, and scallop. Very large pumpkins, those often seen in competitions to determine the largest pumpkin around Halloween each year, belong to another species, C. maxima, as do winter squash, such as hubbard and delicious. Pumpkin varieties used in canning belong to a third species, C. moschata, along with butternut squash.

The Squash and Pumpkin Market

Supply

Squash and pumpkins are produced commercially in almost every State. In most States, there are a large number of farms devoting a small number of acres to squash or pumpkin production. The States with the greatest acreage in squash production in 1992 included Florida, California, Georgia, Michigan, and New Jersey (Table 1). For pumpkins, Illinois, California, New York, and Pennsylvania had the greatest acreage (Table 2).

Both squash and pumpkin production have grown between 1987 and 1992, although pumpkin acreage has expanded much more rapidly. Between 1987 and 1992, total squash acreage increased 19 percent, while total pumpkin acreage increased 56 percent. Many farmers are interested in pumpkin production, viewing it as a

lucrative activity for which there is great demand and involving lower input and harvesting costs than squash and other vegetables (McLaurin).

Table 1--Top 10 States by acreage in squash production, 1987 and 1992

State	1992				1987			
	Harvested		Irrigated		Harvested		Irrigated	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
California	576	8,374	576	8,374	548	7,586	548	7,586
Florida	377	13,292	260	11,608	403	10,855	309	9,816
Georgia	437	8,339	204	5,440	326	3,572	156	2,231
Massachusetts	494	2,447	132	481	440	1,995	124	500
Michigan	511	4,277	140	1,570	507	3,386	137	1,063
New Jersey	501	3,951	225	2,954	472	4,328	232	2,868
New York	729	2,586	153	455	568	2,073	121	546
North Carolina	296	2,578	92	1,074	290	2,482	93	875
Oregon	213	2,286	201	2,236	187	2,060	176	1,980
Texas	504	2,833	221	1,862	487	4,417	246	3,187
U.S. Total	9,008	69,029	3,558	43,850	7,763	58,198	3,303	38,086

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

Table 2--Top 10 States by acreage in pumpkin production, 1987 and 1992

State	1992				1987			
	Harvested		Irrigated		Harvested		Irrigated	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
California	297	5,552	297	5,552	241	3,998	241	3,998
Illinois	448	8,297	77	2,184	326	6,442	42	1,745
Indiana	334	2,197	43	369	240	2,116	25	239
Michigan	663	2,976	134	420	524	2,145	113	355
Minnesota	286	2,406	56	175	252	1,413	40	76
New Jersey	624	3,314	142	766	442	2,165	104	496
New York	845	4,574	139	720	716	3,108	121	611
Pennsylvania	869	4,023	108	492	635	2,608	83	324
Texas	112	3,465	72	3,052	81	1,500	46	1,158
Wisconsin	396	1,800	65	253	298	1,050	50	137
U.S. Total	9,530	63,260	2,351	22,761	6,921	40,652	1,810	13,786

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

The U.S. Department of Agriculture’s National Agricultural Statistics Service (USDA NASS) does not collect data on squash and pumpkins. Therefore, it is difficult to determine the total amount produced. California, Florida, and Michigan, however, do provide some data (see Table 3). Since these three States are among the top squash producers, their data provides some idea as to the quantity of commercial squash produced each year in the United States.

The U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) does not collect data on squash and pumpkins. Therefore, it is difficult to determine total U.S. production. California, Florida, and Michigan, however, do collect basic data (Table 3). Since these three States are among the top squash producers, their data provide some idea as to annual U.S. squash production.

California and Florida mostly produce summer squash varieties for the fresh market, including crookneck and straightneck yellow squash and zucchini. These States also produce some winter squash varieties, such as acorn and butternut squash.

Florida has the largest squash harvested acreage in the U.S. and produces the largest quantity of squash. In the past several years, however, harvested acreage in Florida has fluctuated because major storms destroyed plants and resulted in acreage abandonment. California tends to have higher yields than most States because growers use more inputs, including more extensive use of irrigation and the use of tunnel plastic to protect early spring production. While both California and Florida produce squash most of the year, quantities vary monthly. Florida’s peak production and shipment months are from November through April. California’s squash is marketed mostly from March through May.

To supplement U.S. production, large quantities of squash are imported into the United States, mostly from Mexico. Imports into the U.S. market are highest from November through May, overlapping with marketings from both Florida and California. Imports drop off during the summer and early fall months, when other States provide supplies for their local markets (Figure 1, Table 4).

When compared with squash, pumpkin data are generally not available. In 1992, Michigan produced 19,960 tons of pumpkins on 2,100 acres (Michigan Department of Agriculture). The yield was 9.5 tons per acre, similar to the State’s yield for squash. Shipment data are unavailable for pumpkins.

Demand

Demand for squash is year-round. Summer squash varieties are available all year long throughout the United States as a result of California and Florida production, as well as imports. Winter squash becomes available in the fall and is often viewed as a winter vegetable. While winter squash may be harvested once in early fall, it can be stored for several months and is marketed throughout most of the winter months.

Pumpkins for fresh use are mostly purchased during October for use as jack o’lanterns. After October, demand drops off drastically. Some fresh pumpkin varieties are sold for homemade pies and as a vegetable. However, the quantity of pumpkins remaining in retail markets after Halloween is small and is usually non-existent after Christmas.

Table 3--Squash production by State, 1987-94.

Year	California			Florida 1/			Michigan 2/		
	Harvest-ed Acres	Prodn	Yield per acre	Harvest-ed Acres	Prodn	Yield per acre	Harvest-ed Acres	Prodn	Yield per acre
		--Tons--			--Tons--			--Tons--	
1987	5,895	40,383	6.85	15,200	63,210	4.16	--	--	-
1988	8,023	54,301	8.48	14,000	71,442	5.10	--	--	-
1989	7,934	59,559	9.07	13,650	79,485	5.82	--	--	-
1990	7,077	49,960	8.46	11,700	83,538	7.14	--	--	-
1991	8,008	71,418	8.90	11,800	79,296	6.72	--	--	-
1992	8,209	58,589	7.10	13,300	96,642	7.27	3,550	33,750	9.5
1993	8,971	71,839	8.00	10,500	73,878	7.04	--	--	-
1994	--	--	--	13,300	95,529	7.18	--	--	-

-- Data not available. Note: Data reported here may not be consistent with Census data.

1/ Florida production is based on a crop year basis. Data shown is ending year.
2/ Michigan production includes both fresh and processing squash.

Sources: California County Agricultural Commissioner Data; Florida Agricultural Statistics Service; and Michigan Department of Agriculture.

Table 4--Squash Shipments by State, 1990-94

State		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Arizona														
	1990								1					
	1991													
	1992													
	1993							6	1					
	1994							2						
California														
	1990				3	31	5							
	1991					29	17		1	1	1	2	1	
	1992													
	1993				2	17	2							
	1994				2	5								
Florida														
	1990	28	151	324	165	16	2	1	5	91	284	1588		
	1991	159	121	194	275	138	12			13	78	227	243	
	1992	190	203	240	287	179	19				45	185	160	
	1993	132	141	132	204	239	27			2	50	180	167	
	1994	152	166	179	242	83	8		1	1	24	96	95	
North Carlonia														
	1990						6	21	3					
	1991						9	19	1					
	1992							13	3					
	1993						1	19	1					
	1994							24	2					
Texas														
	1990					9	3							
	1991					2	1							
	1992					3	1						1	
	1993					1	1							
	1994					1	1						2	1
U.S. Total														
	1990	28	151	334	364	170	37	6	1	5	91	264	210	
	1991	159	121	194	306	183	31	2	1	14	80	228	243	
	1992	190	203	240	290	180	32	3			45	186	160	
	1993	132	141	134	222	242	52	2		2	50	180	167	
	1994	152	166	181	248	84	34	2	1	1	24	98	96	
Imports														
	1990	628	566	338	258	122	34	22	13	18	69	176	376	
	1991	487	514	358	263	145	51	23	20	21	59	239	524	
	1992	415	527	403	308	148	36	21	26	28	71	245	493	
	1993	455	526	535	271	144	69	18	24	32	58	304	573	
1994		621	535	555	331	234	78	45	22	85	85	303	639	

Source: Fresh Fruit and Vegetable Shipments By Commodities, States, Months. 1990-94

Cultivation and Management Practices

Climate

All vegetables in the cucurbit family are warm-season crops. They grow best during hot weather and cannot tolerate frost. Seeds will germinate at 60^{0}F, but ideal germination temperatures are between 85^{0}F to 90^{0}F.

Pumpkins and squash grow best at temperatures ranging from 75^{0}F to 85^{0}F during the day and 60^{0}F to 70^{0}F at night. Growth virtually stops when temperatures are below 50^{0}F, and the plants may be severely injured and maturity delayed if temperatures fall below 40^{0}F for several days. Temperatures over 85^{0}F will cause plants to drop blossoms and produce small fruit if the hot weather is combined with dry conditions (Zandstra, Grafius, and Stephens). Temperatures above 95^{0}F will slow plant growth and crop maturation (Orzolek, Greaser, and Harper).

Summer squash is usually planted around mid-April in the northern States and during all but the summer months in the southern States. Winter squash and pumpkins are planted later in the northern States, when the temperature averages at least 65^{0}F, which is usually around mid-June.

Soil Requirements

Squash and pumpkins grow well in most soil types, although the best soils are those that hold water well and have good air and water filtration, such as sandy loams (McLaurin; Orzolek, Greaser, and Harper). They also grow well on clay soils, but harvesting can be difficult if the soils are wet and the fruit becomes dirty and difficult to clean. In the northern States, areas that are susceptible to late spring and early fall frosts, such as low-lying or muck fields, should be avoided (Zandstra, Grafius, and Stephens).

Varieties

Squash and pumpkins belong to the genus Cucurbita, which includes cucumbers and melons. Within the genus, there are four species of squash and pumpkin--C. maxima, C. moschata, C. pepo, and C. mixta (Madison; Zandstra, Grafius, and Stephens; Voigt). Within each species, squash and pumpkin types vary greatly (see Table 5 for information on varieties by State):

Cucurbita pepo are hard shelled when mature. They have hard, solid, angular, grooved stems, and moderate storage capability. The *C. pepo* species includes:

Winter squash--Acorn, Delicata (also called Jack-be-Little and Munchkin), Sweet Dumpling, and Spaghetti squashes.

Summer squash--Yellow crookneck, yellow straightneck, zucchini, and scallop. Although summer squash belong to the C. pepo species, they are picked before maturing and therefore do not have the hard shell of the mature members of the species.

Most of the common pumpkin varieties

Table 5--Common squash and pumpkin varieties by State

State	Summer squash		Winter squash	Pumpkin
	Yellow and scallop	Zucchini		
California	**Crookneck** Early yellow **Straightneck** Early Prolific **Scallop** Early White Bush	Not available	Not available	not available
Florida	**Crookneck** Cracker Dixie Golden Rebel Sundance **Straightneck** Tara Goldbar Lemondrop Multipik Seneca Butterbar Seneca Prolific Smoothie	**Burpee** Hybird Elite Green Magic Onyx Senator Seneca	**Acorn** Royal Tay Belle **Butternut** Hercules Ponca Waltham **Calabaza** La Primera Elsegund	Small Sugar Spirit Funny Face Connecticut Field
Illionis	**Crookneck** Early yellow **Straightneck** Seneca Butterbar	Elite Hybrid	**Buttercup** Delicious Hubbard **Acorn** Royal **Butternut** Zenith	**Miniature** Jack Be Little Baby Boo-White Mini - Jack Munchkin **Small** Oz Small Sugar Spookie **Medium** Ghost Rider Funny Face Harvest Moon Jack O'Lantern Spirit Hybrid Tom Fox **Large** Connecticut Field Howden Jackpot Wizard Pankow's Field **Very Large** Atlantic Giant Big Autumn Big Max Prize Winner **Hull - less or naked seed** Trick or Treat

Table 5--Common squash and pumpkin varieties by State--Continued

State	Summer Squash		Winter Squash	Pumpkins
	Yellow and Scallop	Zucchini		
Michigan	**Crookneck** Sundance **Straightneck** Lemondrop Gold Rush Seneca Butterbar	Elite Select Senator	**Acorn** Table Ace Table Queen **Buttercup** Burgess Strain **Butternut** Hercules Ponca Waltham **Marrow** NK 580	**Small** Small Larger Spookie **Medium** Jack O' Lantern Spirit Youngs Beauty **Large** Connecticut Field Howden Jackpot Pankow's Field **Very Large** Atlantic Giant Big Max Big Moon
Mid-Atlantic States (Delaware, Maryland Virginia, New Jersey, Pennsylvania)	**Crookneck** Sundance Supersett **Straightneck** Sencea Prolific Leomondrop L Multipik Superpik Goldbar **Scallop (Pattypan)** Peter Pan (green) White Ruffles Sunburst (golden)	Elite Senator Milano Midnight Seneca Goldfinger Blondie Gold Rush	**Acorn** Table Ace Table Queen Tay Belle **Butternut** Waltham Hercules **Hubbard** **Golden Delicious** **Buttercup** **Sweet Mama** **Marrow** Boston NK 580	**Small** Jack-Be-Little Baby Pam Spooktacular Small Sugar Baby Bear **Medium** Spirit Young's Beauty Jumpin Jack Pro Gold 510 Ghostrider **Large** Howden Connecticut Field Big Autumn Prize Winner **Very Large** Atlantic Giant Big Max

Cucurbita maxima are medium-hard shelled when mature, with soft, hollow, round stems. They have long storage capability. The C.maxima species includes:

Winter squash--Australian Blue (also called Australian Queensland Pumpkin), Banana, Black Forest, Delicious, Marrow, Buttercup, Hokkaido
(also called Red Kuri), Honey Delight, and Hubbard.

Processing squash--Pink Banana, Golden Delicious.

Very large pumpkins used in competition.

Cucurbita moschata are hard shelled with small, hard, grooved stems that expand at the fruit union. C. moschata includes:

Winter squash--Butternut.
Processing pumpkins--Dickerson Field, Libby's varieties, Buckskin.

Cucurbita mixta are medium-hard shelled with enlarged, hard, grooved stems that do not expand at the fruit union. The C. mixta species includes:

Winter squash--Cushaw.

Planting

Most squash and pumpkin varieties are planted directly in the field from seed. Some growers in the northern States may also use transplants to obtain an early crop that can be marketed when prices would be high. Transplants may also be used for large pumpkins, giving the fruit more time to grow as large as possible for pumpkin competitions (Voigt; Zandstra, Grafius, and Stephens).
Transplants are, however, very tender and can be difficult to use. When transplants are used, it is often recommended that the seeds be started in peat pots, which can be set directly into the ground. This procedure minimizes damage to the roots and increases the chances of transplant survival (Zandstra, Grafius, and Stephens).

Squash grow either as a bush or a vine, depending on the variety. In the South, bush varieties are planted with 3-to-4 feet between rows and 1-to-2 feet between plants. Vine varieties are planted with 5-to-9 feet between rows and 3-to-5 feet between plants (Olson and Sherman).

Plant spacings are wider in the North. In these growing areas, bush varieties are planted with 5-to-6 feet between rows and 2-to-3 feet between the plants. Vine varieties are planted with 6-to-8 feet between rows and 2-to-5 feet between plants (Ferretti, Orzolek, MacNab, Fleischer, Smilowitz, and Hock).

Planting times vary greatly (Table 6). In warmer climates, growers can produce more than one crop of summer squash a year. In colder locations, only one crop can be produced in a year because of the length of time needed for the fruit to reach maturity.

Table 6--Squash and pumpkin planting schedules by State

State	Spring	Fall
California	February	
Imperial and Coachella valleys	December, if under brush	
Florida:		
North	February-April	August-September
Central	January-April	August-September
South	August-March	August-March
Georgia:		
North	April-June	late July
South	mid-March	August
Illinois:		
North	Last of May through 1st week of June	
South		
Fresh pumpkins	late-May-early June	
Processing pumpkins	mid-May	
Michigan:		
Summer squash	Mid-May	
Winter squash, pumpkin	Early-to-mid June	
Mid-Atlantic States:		
Winter squash, pumpkin	June 15-July 15	
Summer squash		
Seeds	April 15-August 15 South May 10-August 1 North	
Transplants	April 15 South June 1 North	

Sources: Sims and Schweers; Olson and Sherman; McLaurin; Zandstra, Grafius, and Stephens; Ferreti, Orzolek, MacNab, Fleischer, Smilowitz, and Hock.

Mulching

Black plastic mulch is commonly used in squash production. In the southern States, squash is often planted in succession with other vegetable plants and plastic mulching is a common practice. In the northern States, the mulch helps warm the soil in the spring, promoting germination. Plastic mulch may also be used with plant covers to protect transplants (Zandstra, Grafius, and Stephens).

Foil mulches can be used to repel aphids that transmit mosaic virus in fall-planted squash (those planted after July 1 in the North). For maximum virus protection, direct seeding is recommended through the mulch. Transplants should not be used with foil or other repellent mulches (Ferretti, Orzolek, MacNab, Fleischer, Smilowitz, and Hock).

Fertilization

Pumpkins and squash require moderate amounts of fertilization, with needs varying by soil type. The optimum pH range is between 6.0 and 6.8. Magnesium helps maintain pH levels. For optimal growth, plants need phosphate, potash, and nitrogen. Micronutrients, such as manganese, copper, iron, zinc, and boron, also may be needed. Fertilizer should be added to the soil before, during, or shortly after planting. Supplemental fertilizer can be added whenever needed during the growing season and especially after heavy, leaching rains.

Irrigation

Squash roots develop rapidly and grow at least 4 feet deep. If the soil is moist to a depth of at least 4 feet at planting time, this moisture is enough to carry the crop well into the growing season. In warmer climates, such as southern California and Florida, early season watering may cool the soil and slow down plant growth. Irrigation, however, becomes essential later in the season. Sandy soils require more frequent irrigation than do heavier soils. Adequate moisture is essential around the time of harvest to prevent misshapen fruit, poor fruit color, and rough or warted surfaces (Sims and Schweers; Granberry, Chance, and McLaurin).

Pumpkins require a constant supply of moisture during the growing season. Water deficiency or stress, especially during the bloom-fruit set period, can reduce fruit size or cause blossoms and the fruit to drop, reducing yields (Orzolek, Greaser, and Harper).

Crop Rotation

Crop rotation is helpful in retarding the build-up of nematodes and certain diseases in the soil. Squash yields well in soils where well-fertilized vegetable crops, such as fresh-market tomatoes, are grown. The residual fertilizer and organic material from these other crops help promote early growth.

Land used to produce cucurbit crops--including squash, pumpkins, melons, and cucumbers--in the past three years should not be used for further cucurbit crop production. This is because all cucurbit crops are susceptible to similar diseases and insects.

In addition, members of the squash family are very sensitive to residual herbicides. Production may be inhibited by soils that have been treated with residual herbicides within the last 12-to-18 months (Granberry, Chance, and McLaurin).

Pollination

In both squash and pumpkins, the male and female organs are borne in separate flowers on the same plant. In order for pollination to occur, a good supply of bees is necessary to obtain proper fruit set. Growers with large fields may need to rent bees to supplement wild populations. In the absence of wild bees, one strong hive of honey bees is considered adequate for 2-to-3 acres of bush-type squash, or for 3-to-4 acres of vining-type squash. One hive for every 1-to-3 acres is recommended for pumpkins. Bees should be placed in the field by the time the first blossoms open (Granberry, Chance, and McLaurin; Orzolek, Greaser, and Harper).

Harvesting, Packing, and Shipping Squash and Pumpkins

Summer squash is harvested while the fruit is immature. The skin and seeds should still be soft. In contrast, winter squash and pumpkins are harvested only after the fruit has matured, when the skin and seeds are hard. This difference in harvesting practice accounts for summer squash's shorter length of time from seed to harvest and its greater perishability (Olson and Sherman).

In the South, summer squash sown in the spring produce squash in 45-to-48 days. Crops sown for fall harvest produce squash in about 30 days because they are planted during hotter weather and grow more quickly (McLaurin). Winter squash take from 75-to-100 days in the South, and pumpkins take from 90-to-120 days, depending on the variety (Kelley).

In the North, summer squash is ready for harvest 50-to-60 days after sowing or transplanting. Most winter varieties are ready 90-to-120 days after seeding, while early varieties of acorn and butternut squash may be ready in 80-to-90 days. Pumpkin varieties mature 110-to-120 days after seeding (Zandstra, Grafius, and Stephens).

Summer Squash

Summer squash plants produce fruit until they are killed by frost. However, the amount of fruit a plant produces begins to decline after about 4 weeks from the first harvest. Prior to that time, fruit develop rapidly every 2-to-3 days. Removing all fruit of useable size at each picking allows the plant to continue producing.

Summer squash are harvested for the fresh market when they are very young and tender. The yellow squashes are harvested when the fruit are 4-to-6 inches long and have smooth or lightly warted skin. Zucchini squash are harvested when the fruit is 5-to-8 inches long and has a smooth, cylindrical shape and dark green skin. Scallop or pattypan squash are ready for harvesting when the fruit is 3-to-5 inches in diameter and the skin is light green to white in color (Zandstra, Grafius, and Stephens; Olson and Sherman).

Summer squash are all hand harvested. Harvesters should wear gloves because the plants are very spiny, and the fruit are very immature and bruise easily from fingernail punctures. Cuts, abrasions, and bruises on the skin darken during subsequent marketing and detract from the fruit's appearance, as well as increase water loss. The fruit are cut off the plant with knives. A portion of the stem is usually left attached to minimize bruising (Zandstra, Grafius, and Stephens; Olson and Sherman).

Summer squash are either packed in the field or in packingsheds. Once picked, they are washed quickly in a water-bleach solution before grading and packing (see Appendix for grading standards). The wash water kills decay-causing organisms. Next, the squash are packed in ¼ to ½ bushel lugs or cartons for shipping (Zandstra, Grafius, and Stephens; Olson and Sherman).

Summer squash need to be cooled quickly after picking because they are picked when immature and, as a result, are very perishable. For maximum shelf life, summer squash should be cooled to 40^{0}F soon after harvest. Field heat can be removed using hydrocooling or forced-air cooling. Temperatures below 40^{0}F, however, can damage the squash, causing chilling injury. Once chilled, the optimum transit and storage conditions range from 40^{0}F to 42^{0}F, with a relative humidity of 95 percent. Under these circumstances, summer squash should keep two weeks in good condition (Olson and Sherman).

Fresh-Market Winter Squash and Pumpkins

Winter squash are harvested after the vines decline and the fruit is mature. Plants are harvested only once or twice in a season. The mature fruit will have a hard rind which resists denting by thumbnail pressure. Its external color should be characteristic of the variety, and the seeds should have a hard shell. A mature butternut squash should have an even tan coloring and an acorn squash should have a small amount of yellowish-orange color on a dark green surface (Zandstra, Grafius, and Stephens; Olson and Sherman; Granberry, Chance, and McLaurin).

Once they have reached maturity, squash are harvested by cutting the fruit from the vines with knives or pruning shears, leaving some stem attached to the fruit. After they are cut, the fruit are placed in bulk boxes or left in the field and cured in a warm place for 2-to-3 weeks before they are ready for packing and shipping (Zandstra, Grafius, and Stephens; Olson and Sherman).

Pumpkins are usually harvested in early October and shipped during the last 3 weeks of the month for sale before Halloween. Because they are larger than most squash and the marketing period is very short, pumpkins are handled somewhat differently than winter squash. After the vines decline, pumpkins are harvested with the stem attached to the fruit and placed in rows in the field. After 2-to-3 weeks of curing, those that will be shipped can be loaded directly onto trucks in bulk, or placed in bulk boxes for shipping (Zandstra, Grafius, and Stephens).

Curing

All winter squash and pumpkins are cured before shipping and storage. Curing allows the fruit to fully mature, which hardens the shell. During curing, cuts and bruises heal, and some starch is converted to sugar. The fruit is cured by being placed in a well-ventilated location at 75^{0}F to 85^{0}F for 2 weeks. A less effective method is to harvest the fruit, leaving it in piles

in the field and letting it cure there for 2-to-3 weeks before storage (Zandstra, Grafius, and Stephens).

Storing

Once cured, winter squash and pumpkins should be stored in a dry, cool, well-ventilated area to extend their shelf life and keep the fruit from appearing shrunken. If stored properly, at 50-to-70 percent humidity and 50^0F to 55^0F, the pumpkins will retain good quality for 2-to-3 months. C. maxima and C. moschata squash can be stored for 3-to-5 months, and acorn squash can be stored for 6-to-8 weeks. The fruit continue to respire under these conditions and lose 3-to-5 percent of their weight per month (Zandstra, Grafius, and Stephens; Orzolek, Greaser, and Harper).

Packing, Handling, and Shipping

Small- and medium-size winter squash are usually washed, dried, and waxed with a vegetable washer before they are packed in 1-1/9 bushel boxes. During handling, shipping, and storage, optimum temperatures range from 50^0F to 55^0F.

Large squash and pumpkins are usually shipped in bulk or in large bins. To prevent decay, the skin must remain free of damage or breaks during handling.

Processing Squash and Pumpkins

Processing companies are very specific as to the variety of winter squash or pumpkins that they will use. For pumpkin pie filling, the Dickenson and butternut types are popular. Often, the larger companies have bred their own variety, and furnish growers with seeds.

Illinois is a major processor of pie fillings. Harvesting of processing pumpkins and squash is usually done by the processing company. The company arranges with the grower when it is ready to harvest. Once harvested, the fruit can be immediately processed.

Harvesting is entirely mechanized, with the equipment owned by the processor. A large machine, resembling a hay rake, moves through the field, digging up the plants and placing them in windrows. The fruit is then lifted off the plants and placed on a conveyor belt. From the conveyor, the fruit is transported to the processing plant.

In Michigan, most of the processing is for baby food. The NK580 variety of winter squash is made into baby food by Gerber’s. Unlike in Illinois, growers in Michigan do their own harvesting. The squash are harvested by hand in the same manner as for fresh-market use.

Some summer squash, particularly zucchini, is also processed. The volume of summer squash used for processing, however, is relatively small when compared with fresh-market use.

Marketing

Most squash grown for fresh-market use is sold wholesale either through produce terminals or State farmers’ markets. Occasionally, growers may have contracts with local retailers. Growers located near urban areas may have

arrangements with restaurants, or they may sell their squash at roadside stands.

Summer squash must be shipped through channels quickly because its quality deteriorates rapidly. Winter squash may be stored on the farm if prices are low, with producers able to wait until prices rise before marketing.

Pumpkins also are sold wholesale. A large volume of pumpkins, however, is sold on the farm. After picking, the pumpkins may be put in bins or left in the field for people to come and select their own Halloween pumpkin.

Since pumpkins and squash for processing are grown under contract, growers do not need to market them. Contracts are on a yearly basis, and price is based on weight. Growers receive a base level for their produce plus a designated amount based on tonnage. During years of surplus production, processors may pay growers only the base level, and not buy their excess production.

Costs of Production

Many fresh-market vegetables depend on manual labor for harvesting to ensure the quality and appearance of the product. Labor becomes an important cost component of production, pushing the costs of harvesting up relative to the total costs of production. For fresh-market summer squash, harvesting costs usually exceed two-thirds of the total variable costs of production, except in Florida (Table 7).

Most summer squash fields are harvested numerous times, with the plants continuing to produce fruit as long as those on the vine or bush continue to be removed. Over time, however, the quantity produced decreases, increasing the cost of harvesting. Also during the harvest period, the quantity of summer squash in the market increases, lowering the price producers receive for their crop. Once prices fall below the amount needed to cover the costs of harvesting, growers stop harvesting and abandon the remainder of the crop. While this practice is common in most States with significant squash production, in some States, where production is small, demand for local

Table 7--Costs of producing squash or pumpkins per acre, by State

State	Year	Cost of harvesting and marketing	Total variable H costs	Harvesting and marketing as percent of total variable costs
		--------$/acre-------		Percent
California				
Santa Barbara/San Luis Obispo Summer Squash	1983	2160	3223	67
Zucchini under Tunnel plastic	1982	4521	6958	65
Tulare County Summer squash	1981	3031	4222	72
Fresno County Zucchini	1993	3120	5285	59
Florida--Dade County Summer squash	1993/94	1169	1978	59
Georgia	1994			
Plasticulture		2539	3788	67
Double cropping		1704	2609	65
Bare ground				
Yellow squash		1015	1397	73
Zucchini		1798	2173	83
Pennsylvania-Pumpkins	1995			
Irrigated		380	1420	27
Nonirrigated		250	1160	22

Sources: Cooperative Extension, University of California; Smith and Taylor; Cooperative Extension, University of Georgia; Orzolek, Greaser, and Harper.

produce is usually great enough that the cost of harvesting does not become an issue and growers are able to harvest their entire crop (Orzolek).

Price is generally not a factor in harvesting winter squash and pumpkins for the fresh market. Winter squash are harvested regardless of the market price, and stored for several months until prices become more favorable. Pumpkins are harvested and sold almost entirely in October for Halloween, and the demand during this time is almost always high. Growers sell most of their crop during the weeks preceding the holiday regardless of price. Pumpkin harvesting costs tend to be low.

The cost of harvesting is not a factor in harvesting processing squash and pumpkins. Growers commit a quantity of their production to the processor and therefore, the crop will be harvested regardless of the cost. In some cases, processors do the actual harvesting, and growers incur no costs. Production in excess of a contracted amount, however, may be abandoned if the processor cannot use the remaining crop or if the grower cannot sell it on the fresh market.

Production Perils

As squash and pumpkins are members of the cucurbit family, they are susceptible to many of the same diseases, insects, and weather perils as cucumbers and melons. Because the same insects and diseases affect these plants, they should not be rotated in the same field after each other. Such practices prolong the survival of insects and diseases and worsen the damage they can cause. It is also suggested that squash and pumpkin seeds be treated with pesticides to reduce damage levels.

Excessive Moisture

Excessive moisture contributes to disease problems. In addition, the plant’s roots cannot breathe when excess moisture is present, and therefore they are unable to support the plant. If the soil is very moist over a period of time, it cannot dry out quickly enough to maintain healthy plants and fields will be destroyed. For example, excessive moisture in Illinois in 1993 caused the fruit to deflate. The fruit lay on the wet ground, temperatures were warm, and evenings were humid, promoting diseases and destroying the fruit (McLaurin; Voigt).

Excessive Heat

Squash and pumpkins are warm-climate plants. Excessive heat, however, can accentuate other problems in a plant. The heat stresses the plant, reducing its resistance and making it more vulnerable to insects and diseases (Voigt).

Excessive Coolness

Squash and pumpkin plants produce optimally if temperatures are warm. If temperatures range less than 75^0F to 85^0F during the day and 60^0F to 70^0F at night, the crop will produce fewer fruit, or the fruit that are produced will not be ready in time for growers to market during the optimal marketing windows. If cool weather is also accompanied by cloudiness, there will not be enough light for the plant to photosynthesize properly, further decreasing yields (Voigt; Orzolek).

Storms

The southern States are particularly susceptible to heavy storms (including hurricanes) during the summer and fall. Hurricanes and other strong storm conditions can destroy the entire crop. If the storm does not destroy the crop, strong winds can sandblast plants and fruit that are produced on sandy soils. Under such conditions, yields are reduced and the fruit is scarred and unmarketable (McLaurin).

Frost

In many southern States, frost is not a serious problem for squash production because squash is often planted after the threat of spring frost is past, and the production period usually ends before winter frosts occur (McLaurin). In Florida, however, where squash production is nearly continuous, frosts and winter freezes can reduce yields or kill plants (Hochmuth).

In the North, frosts can damage early crops, causing greater problems than in the South. Growers sometimes plant their summer squash crops early, in order to meet earlier market windows with higher prices. However, a late spring frost, arriving after seedlings have been planted, often will kill off the plant if it is not well protected. Early fall frosts can similarly affect fall crops.

Winter squash and pumpkins are less susceptible to fall frosts than are summer squash. The fruit’s hard shell and the plant’s vine-like nature provide protection from the cold. The shell acts as protection to the inside flesh. For vine-type varieties, where the fruit lays on the ground, the ground acts an insulator, radiating heat to the fruit and protecting it from the cold (Orzolek; Voigt).

Drought

Drought or excessive dryness may result in low yields or poor fruit formation (Zandstra). In most cases, the effects of drought can be alleviated with irrigation. In some States, however, water supplies are not always sufficient to provide the necessary water needed to combat the effects of drought.

Drought can also further stress plants that are already weakened by other adverse conditions. For example, a drought in Illinois in 1994 was accompanied by heat and low bee activity. As a result, pollination was poor, plants aborted their fruit, and yields were very low (Voigt).

Hail

In the northern States, hail can damage squash and pumpkin crops by ripping the leaves that protect the fruit and by pitting the fruit. Pitting is especially a problem with summer squash, because it is picked immaturely and the skin does not have time to heal before marketing. Pitted summer squash are unmarketable. Winter squash and pumpkins, however, are picked after maturing and the effects of hail on the skin is reduced because the scars usually have time to heal (Orzolek).

Poor Pollination

Bees are essential to the production of squash and pumpkins. If bees are not active when the plants are in bloom, they will produce poorly. Several factors can contribute to poor pollination. Cloudiness appears to reduce bee activity. Thus, extensive periods of cloudiness during the plants' blossom period can prevent the plants from becoming fully pollinated, and the plants will not produce fruit.

In recent years, wild bee numbers have declined as mites have killed off bee populations. Growers often can rent bee hives, but if they are unable to obtain a sufficient number of bees, the chances of fully pollinating the crop is reduced. Other unidentified weather factors have also contributed to poor pollination (Voigt).

Weeds

Weeds provide host environments for pests, such as aphids, which can transmit viruses to squash and pumpkin plants. Weeds also compete with the plants for nutrients, water, and light, and interfere with harvesting. Herbicides currently registered for use on vine crops do not provide season-long control of most weeds. Therefore, cultivation is important for weed control. The rows between plants should be spaced sufficiently to allow the plants to be cultivated until the vines spread out (Zandstra, Grafius, and Stephens; Olson and Sherman).

Insects

Insect control is an important economic practice in squash production. Most insect pests can be controlled with insecticides. The choice of chemicals and the timing of

application depends on the type of pest, pesticide registration requirements, and whether damage warrants pesticide application. Late-season crops may need a preventative program for some pests, since insect populations tend to be largest in the fall (Olson and Sherman).

Cucumber Beetles

Two varieties of cucumber beetle, the striped cucumber beetle and the spotted cucumber beetle, as well as their larvae (rindworm), affect squash and pumpkin plants. Adult striped cucumber beetles are about 1/5-inch long, with yellow and black stripes that run the length of their backs. They over-winter as adults and emerge during the first warm days of spring. The adults feed on young plants in greenhouses and fields soon after seedlings begin to emerge. Adult feeding damage appears as holes in the leaves. The adults lay eggs at the base of the plants and the larvae attack the roots. Heavy infestations can stunt or kill the plants. Adult beetles also can carry bacterial wilt organisms over the winter and infect plants in the spring.

Spotted cucumber beetle adults are about 1/4-inch long and yellow, with 12 black spots on their backs. They feed on over 200 host plants. The larvae attack corn roots and are called southern corn rootworm. The adults also carry the bacterial wilt organism.

If adult beetles are abundant and there is a history of disease problems, foliar insecticides should be applied early in the plant’s development, before the beetles feed extensively (Ferretti, Orzolek, MacNab, Fleischer, Smilowitz, and Hock; Zandstra, Grafius, and Stephens).

Cutworms

Cutworms chew on the plants’ fruit, rendering it unmarketable, or chew on the seedlings or transplants, killing them or making them unproductive. Most cutworms are night feeders and hide under sod clumps, stones, and decaying vegetation during the day. Weedy or minimum-tillage fields are especially attractive egg-laying sites for cutworm adults (moths). During periods of drought, low-lying areas in fields are more subject to attack than are other areas. Insecticides help control cutworms (Ferretti, Orzolek, MacNab, Fleischer, Smilowitz, and Hock).

Seed Corn Maggots

Adult seed corn maggots are similar in appearance to small house flies. They emerge in early spring. The maggots are attracted to soils that contain large amounts of organic matter or germinating seeds. Eggs are laid in the soil and the larvae feed on the organic matter or attack the germinating seeds. Several generations of seed corn maggots occur in one growing season, and they may attack seeds planted

at any time. Slow germination, as a result of cool weather, increases the chance of damage by the maggots.

Attacks by seed maggots can be reduced if cover crops and weeds are removed from the field early enough to allow decomposition of the remaining plant material before the squash seeds are planted. Seeds treated with appropriate insecticides also help control maggot populations (Zandstra, Grafius, and Stephens).

Sweet Potato White Flies

Sweet potato white flies carry viruses that can destroy squash plants. The flies are most prevalent in the fall when their populations are the largest. Because the fly population is so abundant in the fall in southern States, fall squash production in these States can be very difficult and often less productive. Because the flies die off in winter, populations are at their lowest in the spring.

The sweet potato white fly causes silver leaf disorder by feeding on plant leaves. The leaves turn silver, and the fruit do not color well and become unmarketable (Hochmuth).

Squash Bugs

Squash bugs are less than an inch long and brownish-black in color, and have a back shaped like a shield. The adults and larvae puncture leaves and suck the sap, causing leaves and vines to wilt, and fruit yields to decline. Ultimately, the wilt kills the plant. Insecticides can be used to control squash bugs (Zandstra, Grafius, and Stephens).

Thrips

Thrips are small, tan-colored insects that chew and rasp on the leaves of the plant, causing sap loss. They are mostly a problem during hot, dry weather. Thrips also attack the blossoms, and in heavy infestations, destroy flowers, reducing the plants' fruit yields. Insecticides can be used to control thrips (Zandstra, Grafius, and Stephens).

Leafminers

The adult leafminer is a small, black fly. It lays its eggs in the leaf tissue of the plant, causing the leaf to by spotted, or to have a white, stippled appearance. The larvae appear as small, yellow maggots, which feed just under the surface of the leaf tissue, leaving a winding trail. Because of the protected feeding habits of the larvae, it is difficult to control them. Insecticides must be alternated since leafminers readily develop resistance (G. Hochmuth).

Mole Crickets

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

Pickleworms

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

Four-to-five generations of the pickleworm can be produced in a season. The damage from the larvae causes the fruit to rot. Control of the pickleworm is difficult since the larvae must be killed before it bores into the fruit. Timing of insecticide application is critical for optimal pickleworm control (G. Hochmuth).

Wireworms

Wireworms are the slender, shiny, yellowish-brown larvae of click beetles. The larvae can live in the soil for extended periods of time, and the damage they cause can be quite sudden. Crop rotation is the best way to control the insect. Most growers, however, rely on pre-plant chemical control as a means of wireworm control (G. Hochmuth).

Aphids

Aphids are small insects that suck sap from plant leaves. Aphids create the greatest problems in the fall, when populations are the largest. Aphids injure pumpkin and squash plants primarily by transmitting mosaic viruses. Insecticides are more effective at killing aphids than they are at affecting the transmission of viruses. For the insecticide to be effective, the aphid must not have yet punctured the plant and transmitted the virus (Zandstra, Grafius, and Stephens). Using silver mulch on the soil can be effective in repelling aphids from a field and preventing them from puncturing and infecting plants (Orzolek).

Mites

Mite attacks are most prevalent in vine crops during hot, dry weather in mid-to-late summer. Mites are very small, 8-legged creatures that only can be seen with a magnifying lens. Leaves attacked by mites have a speckled appearance and may shrivel and dry. Insecticides or miticides can control mite populations (Zandstra, Grafius, and Stephens).

Squash Vine Borers

Squash vine borers are the larvae of a day-flying moth. The adults have clear wings and a red body. The borers lays their eggs near the base of plants and the larvae tunnel into the main stems. This tunneling causes the plants to wilt and die. Damage usually occurs about the time that the plant begins to vine. Insecticides can effectively control squash vine borers.

Butternut squash appears to have some natural resistance to attack by vine borers. Acorn and hubbard squash, however, seem to be especially susceptible to their attacks. Crop rotation helps reduce infestations because the insects over-winter in soil and crop debris. With rotation, they would no longer be present to attack subsequent cucurbit crops (Zandstra, Grafius, and Stephens).

Nematodes

Squash is susceptible to rootknot and sting nematodes. These nematodes cause plant stunting, wilting, and chlorosis (yellowing or blanching). Above-ground symptoms alone, however, are not sufficient in diagnosing their presence.

The roots of the plant infested with rootknot nematodes have galls which will interfere with normal water and nutrient uptake by the plants. In contrast, sting nematodes feed on the sap of small roots, leaving only brushes of coarse roots which are insufficient to absorb the necessary water and nutrients.

Planting in infested soils should be avoided whenever possible since crop loss is likely. Fallow cultivation, crop rotations, and flooding are possible ways of controlling nematodes (Olson and Sherman).

Diseases

Squash and pumpkin plants are susceptible to numerous diseases, including various fungi and viruses. Prevention and control of diseases vary, and accurate identification is necessary to properly select control measures. Preventative measures include use of certified treated seeds, fungicides, bactericides, and cultural practices that reduce the buildup and spread of diseases (Olson and Sherman).

Damping Off

Damping off (*Pythium* sp., *Phytophthora* sp., *Rhizoctonia solani*) is mainly a problem for transplants. Seed rot and pre-emergence damping off result in reduced seedling emergence. Post-emergence damping off causes young seedlings to become constricted just above the soil line. The risks of damping off are reduced by using pasteurized or soilless

media, using seeds treated with fungicide, and avoiding over-watering (Zandstra, Grafius, and Stephens).

Powdery Mildew

Powdery mildew (*Erysiphe cichoracearum*) attacks all vine crops. It usually appears on pumpkins and squash in mid-to-late summer during warm weather. It appears first as white, powdery spots on the upper sides of the leaves, but soon spreads and covers both leaf surfaces. Affected leaves turn yellow, then brown, and die. Heavy infestations before the fruit mature will reduce fruit size and yield. The fungus, however, rarely attacks the fruit.

Powdery mildew can be treated with fungicides. Fungicidal applications after the fruit are mature, however, are of little economic value. If powdery mildew affects the plant up to 3 weeks before harvesting, the mildew will not affect the fruit and no treatment is necessary (Zandstra, Grafius, and Stephens; Laemmlen).

Gummy Stem Blight and Blackrot

Gummy stem blight and blackrot (*Didymella bryoniae*) are the same disease but have different symptoms on different hosts. Stem and foliar spotting (gummy stem blight) is more common on melons and cucumbers, while fruit rotting (blackrot) is more common on pumpkins, squash, and gourds. Gummy stem blight appears as pale brown or gray spots on leaves, petioles, and stems. The spots on stems usually begin near nodes and elongate into streaks. Tiny black pycnidia develop on the spots. A red, gummy substance is exuded from stem spots. (A red substance often appears after other injuries to the plant, so it is not necessarily a sign of gummy stem blight).

Blackrot of fruit is a serious storage disease. It begins as irregular green or yellow spots on fruit that turn brown and black. The spots become slightly sunken and hard, and are dry. Other rotting organisms can then enter the fruit through these spots, causing watery, odoriferous collapse of the fruit. Fruit that appear sound when harvested may rot during curing or storage because of blackrot. The organism overwinters on crop debris and the seeds of diseased fruit. Crop rotation helps avoid the disease. Fungicide-treated seeds also help. If the disease has been a problem in previous growing seasons, fields need regular foliar fungicidal treatments. Fruit with the disease should not be stored (Zandstra, Grafius, and Stephens).

Alternaria Leaf Spot

Alternaria leaf spot (*Alternaria cucumerina*) is primarily a problem in melons, but does appear occasionally in pumpkins and squash, especially on weak, old, or senescing plants. Leaf symptoms begin as small, water-soaked spots that expand

and become dark brown with concentric rings. The spots join together, covering large portions of the leaves, and the centers of the spots often crack apart. The leaves may wither and die. Any fruit on the plant can be easily damaged without protection. The organism that causes Alternaria leaf spot overwinters in seeds and crop debris. Cultural practices that produce vigorous, healthy plants are the best defense. Fungicides can reduce the spread and severity of the disease (Zandstra, Grafius, and Stephens).

Choanephora Wet Rot

Choanephora wet rot (*Choanephora cucurbitarum*) is a fungal disease that infects the fruit of summer squash. The infection begins on wilted blossoms and spreads to the attached fruit. The fruit turn brown or black at the blossom end and the rot progresses toward the stem end. A gray-black mold covers the rotted area. The fungus looks as though many black-headed pins have been stuck into the fruit. It is mostly a problem under a heavy canopy and during damp weather (Zandstra, Grafius, and Stephens).

Bacterial Wilt

Bacterial wilt (*Erwinia tracheiphila*) affects all cucurbit crops but causes the greatest damage to cucumbers and melons. The wilt causes individual lateral vines of the plant to wilt during the heat of the day, although they will appear to recover at night. After several days, however, the vines wilt permanently and dry up. The bacteria mechanically plug the plant’s vascular system, causing its lateral stems to wilt.

The disease can be identified by cutting the affected stem near the crown of the plant, squeezing each cut end slightly, then touching them together and pulling apart slowly. If the disease is present, a white, sticky strand between the stem ends, which is the bacterial ooze, confirms the presence of the wilt. Bacterial wilt is carried by cucumber beetles, and is controlled by controlling the beetles (Zandstra, Grafius, and Stephens).

Angular Leaf Spot

Angular leaf spot (*Pseudomonas lachrymans*) is a bacterial disease that primarily affects cucumbers, but is occasionally seen on pumpkins, summer squash, and gourds. Leaf spots are watersoaked at first, then turn tan or brown, and the centers of the spots drop off. The spots occur between the leaf veins, giving the lesions an angular shape. The spots that appear on the fruit are small and watersoaked. Infected fruit break down quickly after secondary infection by bacterial soft rot.

The bacteria overwinter in crop debris and in seeds from infected plants. This disease can be spread easily in the field by splashing rain. Crop rotation and disease-free seeds

help avoid the problem. Copper sprays help control the disease, although dry weather is the best cure (Zandstra, Grafius, and Stephens).

Mosaic Viruses

There are several viruses that infect vine crops. The most important are cucumber mosaic virus, watermelon mosaic virus, and squash mosaic virus. Plants infected by these viruses are stunted, grow slowly, and produce few fruit. The leaves are mottled green and yellow, often rough, misshapen, and cupped. Young leaves are dwarfed and fail to expand, often forming a rosette at the ends of the vines. Fruit that develop after infection are mottled, poorly colored, rough, and small. Fruit that form before infection often develop normally.

The viruses affect other crops and weeds, as well as cucurbit plants, and therefore, are usually present in and near cucurbit fields. Some are spread exclusively by aphids, others by cucumber beetles, and others by mechanical means. Virus-resistant cultivars, virus-free seeds, and regular spraying to control aphids and cucumber beetles help control the disease. Perennial weeds need to be destroyed in and around the fields to reduce host plants where the viruses can overwinter (Zandstra, Grafius, and Stephens).

State Analyses

Squash and pumpkins are grown in almost every State. The States chosen for this section have the largest acreage in either squash or pumpkin production in the United States. States were also selected to represent squash and pumpkins grown for both the fresh market and processing.

California

California is the second-largest producer of squash and pumpkins in the United States, mostly producing summer squash varieties (including zucchini, yellow crookneck, and some scallop squash). It has a smaller number of acres planted to winter squash (Dept. of Commerce; Laemmlen; Molinar).

Squash is grown in all soil types, ranging from sandy to clay loam soils. Most of the squash production in the State uses drip irrigation. Some producers may also use black plastic mulch (Laemmlen).

Squash and pumpkins are planted from seed. Planting times for summer squash vary by county, reflecting the States' differing climates, as well as to spread out marketings and to minimize competition between production areas. In Fresno County, for example, growers plant their squash in raised tunnels, which are made with plastic covering wire hoops, in order to produce a crop in early February and March and meet an early market window. This expensive technique provides the plants with a

greenhouse environment, accelerating their growth and decreasing the effects of any frost at this time of year. Once the plants begin to bloom, the plastic is removed, allowing bees to pollinate the blossoms. In this way, the crop gets any early start over other California squash growers, increasing the number of pickings of a field and resulting in optimum prices (Laemmlen, Molinar).

Most of California's squash producers have small farms, with acreage totaling from 5-to-30 acres for all crops. Most of the growers also produce other vegetables, such as bell peppers, chile peppers, green beans, lettuce, cilantro, and cabbage, as well as strawberries. The larger squash and pumpkin growers in the State may plant squash on 10-to-15 acres at a time, with sequential planting on other acres (Laemmlen).

Squash is often produced as a second crop in California. In Santa Barbara County, for example, squash is often grown after strawberries have been harvested. The squash is planted among the strawberry beds in late August and early September (Laemmlen).

Squash are all hand harvested. Fields may be picked from 6-to-15 times. Harvesting often stops when disease takes over the field. Growers will also stop picking a crop once squash prices fall to low levels. California growers often compete with imported summer squash varieties, especially from Mexico. If California squash production misses its market window, it will be in direct competition with the squash coming in from Mexico. The market can quickly become flooded with zucchini and yellow squash, causing prices to fall rapidly (Laemmlen, Molinar).

Small growers pick the squash and put them into 5-gallon buckets as they move along the rows. Once the buckets are full, they are taken to the end of the field where the squash are dumped onto tables. Packers are stationed at the tables, where they size, cull, and pack the squash into 25-pound boxes. The boxes are then taken to coolers to remove the field heat from the fruit before they are trucked to market (Laemmlen).

Larger growers have field sheds where the squash is packed. Trailers hooked to tractors move slowly through the fields. Harvesters put the squash onto the trailers, where packers are stationed to box the squash. From there, the squash is taken to sheds to be cooled (Laemmlen).

Most summer squash is sold wholesale. Generally, the smaller growers sell their squash locally at roadside stands, certified farmers' markets, or wholesale at the State's produce terminals. Larger growers generally sell wholesale to a wider market. Their squash is often shipped throughout the United States. Pumpkins are mostly sold locally at roadside stands (Laemmlen).

Perils to Production

Viruses have been a major problem affecting California's squash and pumpkin production in recent years. Insecticides are not very effective at controlling diseases, although they are typically quite good at controlling the pests (such as the silver leaf white fly and aphids) that spread diseases. By the time the insecticide takes effect, the aphid or fly has typically infected the plant. The viruses deform the fruit, making it unmarketable (Laemmlen; Molinar).

Squash and pumpkin production in California is also susceptible to powdery mildew. The disease is a problem if the fungus invades the plant early in the production cycle. Growers can control the spread of the mildew by spraying. If, however, the plants become infected later in the production cycle, from 3 weeks before harvesting until the time of harvest, growers will not bother to spray. The fruit generally are not affected by the mildew and they can still be harvested. The mildew, however, will likely prevent any further harvesting of the infected field (Laemmlen).

Insects and diseases are generally more of a problem to California squash and pumpkin production than are weather-related perils. Nearly all growers irrigate their fields, and drought is usually not a problem.

Occasionally, however, there have been weather conditions causing squash yields to fall. For example, California squash and pumpkin plants have been damaged by rain, frosts, and hail. Rains decrease production if they are heavy or they occur early in the planting cycle. Heavy rains can soak the roots, providing an ideal environment for diseases. Early rains or rains at harvest can dirty the fruit, increasing the expense of harvesting. Hail can pit the fruit, which makes summer squash unmarketable (Laemmlen; Molinar).

Demand for Crop Insurance

While California is one of the largest producers of squash and pumpkins, disaster assistance payments to the State's producers have been low relative to other States. For the years 1988-93, California growers received about $535,000 in disaster assistance payments for both squash and pumpkin.

While two California farm advisors believe crop insurance would be useful for squash and pumpkin growers, neither believed many of the small growers would purchase insurance. One of the reasons given was that the small farmers often are unaware of the kinds of assistance available to them and therefore would not know about the availability of crop insurance (Laemmlen). Another reason is that squash production does not have a high profit margin due to heavy import competition. Thus, growers may not be willing to increase their squash production expenses by purchasing insurance (Molinar).

Florida

Florida is the number-one producer of squash in the United States. The State mostly produces summer squash types--yellow crookneck, yellow straightneck, and zucchini squash. Florida also produces scallop squash (sometimes known as pattypan squash), which is picked when immature and classified as a summer squash. Winter squash types produced in Florida include butternut, acorn, and, to a lesser extent, spaghetti squash.

Florida produces pumpkins, although production is small relative to the State's squash output. The hot Florida climate prevents pumpkins from obtaining the deep orange color that is preferred for jack o'lanterns. Despite this problem, many growers see pumpkins as a lucrative crop, and acreage is expected to increase (Hochmuth).

Squash is grown throughout Florida. The largest squash acreage is in Dade, Lee, and Collier counties (Florida Agricultural Statistics Service). Most of the squash is direct seeded. In the southern and northern parts of the State, almost all production takes place using plastic mulch. Producers in central Florida, however, are less likely to use plastic mulch. Almost all squash production is irrigated.

Squash is grown as the primary crop on a farm, or as a second crop after tomatoes or peppers. In the northern part of the State, farms average 10-to- 20 acres of squash. Growers also produce peppers, tomatoes, cucumbers, watermelon, greens, field crops, and tobacco. In the southern part of the State, growers plant about 20 to 40 acres of squash along with tomatoes, peppers, sweet corn, and other vegetables (Hochmuth).

Planting times vary across the State. In the North, most of the squash is planted in the spring, with planting taking place in March, after most of the dangers of frost have past. There is also a smaller fall crop, planted in August and September. In central Florida, planting takes place from January through April and in August and September. In southern Florida, planting is continuous from August through March. Not much planting goes on in Florida from May through July because of the very hot weather. The heat slows the plant's growth and the fruit's maturation. Planting begins again in late July and early August, with the fruit appearing once temperatures have begun to cool (Hochmuth; Olson and Sherman).

Squash are grown on a wide range of soil types in Florida. In Homestead (Dade County), which has the greatest squash acreage in the State, the soil is mostly marl rock. Much of the rest of the State's production is on deep, sandy soil (Hochmuth).

All squash are hand picked. Summer squash can be picked from 4-to-10 times, depending on demand. Summer squash is ready for harvest about 30-to-35 days after seeding. Some squash may be picked earlier, with smaller sizes receiving premium prices in certain markets. Winter squash is usually picked just once after being allowed to mature on the vine. Acorn squash is ready for harvest 60-to-70 days after seeding, while other types take up to 100 days after seeding.

Once picked, the summer squash are washed in a water and bleach solution to disinfect the surface. They are then graded, packed in boxes, and immediately shipped. The entire process takes place in the field. Large wagons are

brought into the field with vats of water on the wagon for washing. The packers are on the wagon, where they grade the squash as they pack (Hochmuth).
Once harvested, winter squash is often stored at the farm for several months until marketed. Both summer and winter squash types are typically shipped by refrigerated truck to wholesale terminal markets or directly to retail stores.

Perils to Production

Florida squash and pumpkins are susceptible to many diseases and insects. Important diseases include powdery mildew, downy mildew, and alternaria leaf spot. Insects that create problems for Florida's squash and pumpkin production include armyworms, pickleworms, melonworms, aphids, and sweet potato white flies. Sweet potato white flies are especially a problem for fall production, when their populations are at their peak. The flies cause silver leafing and spread mosaic viruses. Squash production in northern Florida is much more difficult in the fall because of the white fly problem (Hochmuth).

Heavy rains and hurricanes affect production in the summer and fall months. If storms do not completely destroy the fields, they will create environments where insects and diseases flourish and spread. Excessive heat is a problem in squash and pumpkin production in Florida. Because excessive heat affects the growth and maturation of the squash plant, production is often lower during the warmer months. Other weather- related problems in Florida include sandblasting (scarring of summer squash), and winter and late spring freezes (Hochmuth).

Demand for Crop Insurance

Florida received over $6.6 million in disaster assistance for squash losses during the years 1988-93. As the second largest recipient of disaster assistance for the commodity, it seems likely that squash growers would be interested in crop insurance. Since many squash growers also produce other vegetables covered by crop insurance, those who already have insurance would probably include squash in their coverage.

Georgia

Georgia had the third-largest squash acreage in the U.S. in 1992. While squash is grown throughout the State, the majority of production is in southern Georgia. The State produces mostly yellow summer squash and to a lesser extent, zucchini. Some winter squash and pumpkin varieties are grown in the northern part of the State, which is mountainous and has a cooler climate (McLaurin).

Most of the squash in Georgia is grown from seed. Planting begins around mid-March in southern Georgia for the summer crop, and in August for the fall crop. Summer squash is planted in June in northern Georgia, while winter squash and pumpkins are planted in July (McLaurin).

Squash is planted on all soil types in the State, with southern production mostly taking place on sandy soils and northern production on heavier soils.
Most of southern Georgia’s squash production is irrigated (Kelley). Northern soils are heavier and retain moister better than the sandier soils in the southern part of the state, and are less in need of irrigation. Overall, about half of the State's production is irrigated (McLaurin). Growers are beginning to use mulch more often in production, especially those who grow squash after other vegetables, such as tomatoes.

Pumpkin production is expected to increase in Georgia. The demand for Georgia's jack o’lanterns is believed to be high. Georgia is situated well, with its cooler climate in the mountains, to provide pumpkins to southern States where the crop cannot be produced as successfully (McLaurin).

Farms growing squash and pumpkins range from 10 acres to 300 acres. Pumpkins are mostly grown in conjunction with other crops. They are grown on pastureland, with row crops, and in orchards. Squash growers typically also produce other vegetables, growing tomatoes and peppers first, and then following with squash. Growers may also produce field crops, such as cotton, and use squash as a rotational crop.

In Georgia, many growers do not own all the land they farm. A producer may only own a small portion of the land he or she works, and rent the rest. Renting land allows growers to rotate their crops, because many would not otherwise have enough land for crop rotation (McLaurin).

The summer crop of summer squash is ready for harvest about 45-to-48 days after planting. The fall crop is ready about 30 days after planting. The hotter weather at the beginning of the fall planting season promotes growth and results in an earlier-maturing crop.

All the squash is hand picked, either by local or migrant labor. Summer squash fields are picked as often as markets

are available. Most fields, however, are picked only two or three times. After the third picking, disease often takes over the field. Picking will also stop once prices fall below profitable levels. In contrast, winter squash and pumpkins are picked once or twice.

Once picked, the squash is graded and boxed in the field or at a packinghouse (Kelley; McLaurin). Depending on the broker's requirements, the squash may also be washed and cooled.

Much of the squash is transported to State farmers' markets, where it is sold through brokers. Marketing channels, however, vary by type. Most yellow crookneck squash is consumed locally, while straightneck varieties are shipped to northern States, due to differing consumer preference in each region. For this same reason, most zucchini is shipped north. Small growers may sell to local retailers and, increasingly, they may sell directly to restaurants (McLaurin). Direct selling, however, is much less common than through farmers' markets (Kelley).

Pumpkins are sold through wholesale outlets, with some shipped out of Georgia, and through pick-your-own operations.

Perils to Production

Although most insects and diseases can be controlled with pesticides, they can be a problem for squash production in Georgia. Weather factors that have reduced squash production in Georgia in recent years include drought, excessive moisture, hail, frost, hurricanes, sandblasting, and flooding.

Drought can be a problem on farms that do not have irrigation in the southern part of the State. Drought is less of a problem in the northern part where soils are better able to hold moisture. Excessive wetness causes rot, reducing yields or killing plants (McLaurin; Kelley).

Hail can make summer squash unmarketable because it pits the fruit. Since squash is often planted after other vegetable crops, it is a late crop and is in the field when hail is most likely to occur. Early and late plantings are also susceptible to frost, which will kill the plant.

Hurricanes have hit Georgia and caused considerable crop destruction. Heavy winds from storms can also create sandblasting in the South, which scars the fruit. Georgia's squash production has also been hindered by flooding, which can destroy the entire field, killing all plants (McLaurin).

Demand for Crop Insurance

Georgia received over $21 million in disaster assistance payments for squash losses between 1988-93, the largest volume of payments made for squash in any State. The legitimacy of some of Georgia's payments in 1990 and 1991 have, however, been questioned (Kilman). It was reported that many growers were planting squash who did not usually grow the crop, and then were neglecting it in order to receive disaster payments. Payments for pumpkin losses totalled about $230,000 between 1988-93.

A State horticulturist believes that there would be demand for crop insurance for squash and pumpkins in Georgia. Many growers already have insurance for their crops that are insurable. Further, squash and pumpkin production is often risky, and they would likely want to cover these crops (McLaurin; Kelley).

Illinois

Illinois had the largest pumpkin acreage of any State in 1992. Illinois also produces squash, but squash production is minor relative to pumpkins (Dept. of Commerce). Illinois is the largest producer of processing pumpkins in the United States, with Tazewell County being the major producer. Production of pumpkins for fresh use is concentrated around the State’s major urban areas. Iroquois, Peoria, and Kankakee Counties produce mostly fresh-market types (Voigt).

Most of the growers for the fresh market average under 100 acres planted to squash or pumpkins. Growers of processing pumpkins are fewer in number and have larger acreage devoted to production, often thousands of acres each. Pumpkin and squash growers also produce corn or soybeans in the Tazewell area, where most of the soil is sandy. In other areas of the State, growers produce other vegetables or row crops as well as pumpkins or squash.

Most of the pumpkins and squash in Illinois are grown on dark-to-sandy loam soils, with some production also taking place on heavy-clay loams. Processing pumpkins are mostly irrigated, which is often required by the processing companies. Fresh-market crops may be irrigated if they are grown after other crops that require irrigation. The most common form of irrigation used in Illinois is central pivot (overhead). Growers may use mulch in combination with irrigation, but not alone (Voigt).

In southern Illinois, planting begins in late May for processing pumpkins and in June for fresh-market pumpkins. Fresh-market pumpkins cannot be planted too early or they will ripen before the Halloween season. In northern Illinois, pumpkin planting begins in late May. Growers may plant through July 4th, if they need to replant their fields because of damage to an earlier crop. Most planting, however, takes place from the end of May through the beginning of June.

Summer squash, such as zucchini, are often planted from transplants, starting in mid-June. Transplants enable the grower to sell during the early market. All other squash and pumpkins are planted from seed.

Summer squash are ready for harvest beginning at the end of July, while winter squash is harvested in August. Processing pumpkins are harvested in early September. Summer and winter squash are hand picked. Summer squash is generally harvested every other day, and 6-to-10 pickings typically occur. Picking stops once disease takes over or when market prices fall below the cost of harvesting. Winter types are usually picked just once after the fruit's shell has matured and hardened. During the single picking, those that are ready will be picked, while the remainder is left in the field (Voigt).

Fresh squash and pumpkins are generally marketed in bulk through wholesale channels. Farms located near urban locations, however, may market by pick-your-own or sell directly to retailers.

Processing pumpkins are grown under contract with the processing companies. The major processors in Illinois are Libby and Del Monte. Both companies use pumpkins for canned pumpkin-pie filling. Contracts are negotiated on a yearly basis, and specify the variety of pumpkin to be grown. The processing company often has developed its own pumpkin variety that growers under contract are require to plant. These varieties usually produce pumpkins that are smaller than fresh-use pumpkins, and that have dry, orange flesh.

The processing companies have field agents who visit the farms and test the pumpkins. Based on the field agents' findings, processors specify irrigation requirements, including the timing of irrigation and when irrigation is to stop. They also determine when the crop is ready for harvest based on the ripeness and moisture content of the fruit. The companies harvest the pumpkins, using their own equipment. The price growers receive for their pumpkins is set in the contract, based on tonnage, and includes an acreage fee as well as a base level based on tons (Voigt).

Processing pumpkins are harvested one time by a machine resembling a hay rake. The pumpkins are windrowed, put onto a conveyor and then into a truck, and taken to the factory. Damage to pumpkins may occur from mechanical harvesting, although damage to the fruit is not important because the pumpkins are immediately processed. Appearance is unimportant for processing pumpkins since only the inside flesh is used in the final product.

Perils to Production

In recent years, Illinois pumpkin and squash production has been affected by drought, excessive moisture, heat, cool weather, overcast weather, frost, and poor pollination.

Drought can decrease plant growth and yields in fields that are not irrigated. Further, heat and drought together have reduced bee activity. If bees do not pollinate the crop, fruit are aborted and yields are reduced.

Excessive moisture in some years has increased the presence of diseases. Once the soil becomes too wet, or stays moist for a long period, the roots cannot breathe and support the plants. In 1993, the fields were wet for a prolonged period. Within days, the fruit deflated. A combination of the fruit sitting on the wet ground, and warm, humid weather day and night, provided the perfect environment for diseases to reproduce and destroy the plants and their fruit (Voigt; Gyorkos).

Flooding has also reduced yields in Illinois. In 1993, pumpkin fields were flooded and never dried out. As a result, many plants died and yields from the remaining plants were reduced (Voigt).

Intense heat can accentuate problems that already exist in a field. While pumpkin and squash plants generally like hot weather, temperatures that are too hot can be hard on the plant. Heat stress can make plants more vulnerable to diseases and insects (Voigt).

Summers that have remained cool have also reduced pumpkin and squash yields. When overcast weather does not allow enough light to reach the plant, photosynthesis is reduced, and the plant does not produce fruit at its optimal level, resulting in low yields (Voigt).

Frost problems in Illinois affect mainly northern counties in the fall. In the South, frost does not usually occur until October. By then, the fruit are ready for harvest. Unless it is extremely cold, the fruit lying on the ground are able to tolerate low temperatures because the ground radiates heat back to the fruit, protecting it. In the North, frosts can occur in late September before the pumpkins are ready for harvest. In this case, the frost can damage the fruit (Voigt).

Disease is an issue in pumpkin and squash production in Illinois. During the mid-summer, evenings are often humid. Fungal diseases thrive in this environment. Diseases, however, can be controlled through spraying and using varieties that are disease resistant. The C. moschata variety used for processing pumpkins tends to be more disease resistant than other pumpkin and squash varieties (Voigt).

Demand for Crop Insurance

Illinois pumpkin and squash producers received over $1.9 million in disaster assistance between 1988 and 1993. Payments were made primarily because of crop losses due to drought, excessive moisture, and early freezes (Gyorkos).

A State horticulturist was not sure there would be much grower demand for crop insurance. He did state, however, that in light of recent crop failures due to weather problems, growers may now be interested in insuring their crops. The interest of processing pumpkin growers may depend on how their contracts with the processing companies are written, as well as their recent loss history (Voigt).

Michigan

Michigan ranked fourth in squash acreage and seventh in pumpkin acreage in the U.S. in 1992 (Department of Commerce). While all types of squash are grown in the State, it produces more winter types than summer types. The most common winter types produced in Michigan are butternut, buttercup, acorn, banana, spaghetti, and hubbard squash. NK580, a marrow type, is used in processing.

Michigan produces both fresh-market and processing squash. Processing squash is mostly used to make baby food for Gerber's, the only major squash processor in Michigan. Some summer squash, particularly zucchini, is also processed. The zucchini is diced and frozen (Zandstra).

In 1992, 157 growers produced summer squash on 1,550 acres, while 264 growers produced winter squash on 11,100 acres, and 388 growers produced pumpkins on 2,500 acres. Approximately 30 percent of the summer squash and 59 percent of the winter squash was for fresh use. The remainder of each type was processed (Michigan Department of Agriculture).

The size of farms producing squash and pumpkins varies greatly in Michigan. Many producers grow other crops and devote a few acres to squash or pumpkin production. Growers are not set in their production of these crops, and move in and out of production easily. Many vegetable and field crop growers may set aside a few acres and grow pumpkins and squash one year, and if returns are good, they may repeat production again the next year. If squash and pumpkin prices are low, however, the grower may choose not to produce these crops again the next year (Zandstra).

In Michigan, most squash and pumpkins are grown using minimal inputs. Only a small quantity of fresh summer squash is grown using plastic mulch. Most production takes place on bare ground.

All squash and pumpkins are hand picked, even for processing. Since all the squash is harvested by hand, growers produce for both the fresh and processing markets. This is a different situation than for other processing crops, such as cucumbers,

and for processing pumpkins in other States, such as Illinois, where producers generally grow for only one market (Zandstra).

Once picked, winter squash and pumpkins are cured in the field and stored in sheds on the farm. Fresh squash and pumpkins are then generally sold wholesale through brokers. Pumpkins sold wholesale either are destined for local urban markets or East Coast markets. Other pumpkins are sold locally in the field. Processing squash is produced under contract, at a set price for a set weight. Excess squash and pumpkins are either sold for feed or left in the field (Zandstra).

Perils to Production

Squash and pumpkin production in Michigan is affected by many insects and diseases. Infestations are often exacerbated by weather conditions. Winter squash and pumpkins are in the field for a longer time than most other vegetable crops, and diseases have more time to fester, sometimes making conditions worse than they might be with a shorter-term crop. Because of these conditions, pesticides are often the biggest expense incurred in squash and pumpkin production in Michigan (Zandstra).

Weather conditions that have reduced squash and pumpkin production in recent years include excessively wet weather, hail, and hot, humid weather. Long periods of hot, humid weather encourage bacterial and fungal diseases that reduce yields.

Demand for Crop Insurance

A State horticulturist did not believe there would be a great demand for crop insurance because of the nature of squash and pumpkin production in Michigan. Many of the growers do not produce squash or pumpkins on a regular basis, and production only takes place on a small portion of their land. Growers see squash and pumpkin production as a low investment crop with good returns. Many producers do not put a lot of money into inputs (except pesticides and harvesting), and as a result, may not be willing to incur crop insurance costs (Zandstra).

In light of the changes in Federal disaster assistance, however, growers may be more interested in purchasing crop insurance than in earlier years. In the past, Michigan growers relied heavily on disaster assistance payments when they had crop losses, to which squash and pumpkins are highly prone. From 1988 to 1993, Michigan squash growers received over $5 million in ad hoc disaster assistance. Pumpkin producers received about $1.8 million.

Pennsylvania

Pennsylvania produces mostly winter squash and pumpkins, and had the fourth- largest acreage planted to pumpkins of any

State in 1992 (Dept. of Commerce). Most of the pumpkins are for fresh use at Halloween, although about a fourth are used for processing. The State's vegetable crop specialist estimated that Pennsylvania grows about 3,500 acres of winter squash. The most common types of winter squash grown in Pennsylvania are butternut, acorn and hubbard. He also estimated that Pennsylvania produces about 1,000 acres of summer squash (Orzolek).

Squash and pumpkin production is scattered throughout Pennsylvania. The average size of farm ranges from 10-to-20 acres for squash, and up to 400-to-500 acres for pumpkins. Growers also produce other vegetables, such as tomatoes, peppers, lettuce, and potatoes, and fruit such as strawberries, raspberries, and blueberries. Some growers also produce field crops in rotation with their vegetable crops. Common field crops include corn, soybeans, winter oats, and winter wheat (Orzolek).

Summer squash planting begins around May 1 in Pennsylvania. Transplants are often used at the beginning of the planting season. For the remainder of the planting season, which continues through the end of July, summer squash is planted from seed. Winter squash types and pumpkins are planted in early-to-mid June, usually from seed.

Pumpkins and squash are planted on many soil types, including silt loam, clay loam, and sandy soils. While the Census data do not indicate much irrigation of pumpkin and squash acreage in Pennsylvania, the State's vegetable crops specialist estimated that about 80 percent of production takes place on plastic mulch with drip irrigation (Orzolek).

The summer squash harvest begins in late June and extends through September. Fields are picked several times. The winter squash harvest begins about August 1 and may extend through the end of October or early November, until the first frost. Pumpkins are harvested in October. Winter squash and pumpkins are picked just once. All squash are hand harvested (Orzolek).

Once picked, summer squash are immediately transported to a packing facility, where they are cooled, boxed in waxed-line boxes, and taken to market. Winter squash are brushed clean, dipped in a bleach solution, and put into bulk bins in storage where they can last from 3-to-5 months before being marketed.

Squash is usually sold wholesale, either through one of the State's three major packinghouses or at a terminal market. The packinghouses have contractual arrangements with buyers for squash purchases on a daily basis. Squash also is sold retail, directly to grocery chains, or at roadside stands (Orzolek).

Pumpkins are mostly picked in October, around Halloween. Some pumpkins are used for processing, although Pennsylvania

produces a much lower volume of processing pumpkins than does Illinois, Michigan, and Indiana. Most of Pennsylvania's processing pumpkins and some of its squash is sold to Consumer Foods-Hanover brand.

Summer squash is rarely abandoned in Pennsylvania. The State's production is low enough that demand often exceeds supply, and producers are able to sell all that they can harvest. Winter squash can be stored and released onto the market periodically, to control supply. Pumpkins are usually picked only one time. Any pumpkins that are not picked are either abandoned or used as feed (Orzolek).

Perils to Production

In recent years, adverse weather conditions have damaged Pennsylvania's squash and pumpkin crops on various occasions. Cold spring weather has delayed squash maturity, causing growers to miss early market windows for summer crops. Both early- and late-planted crops are susceptible to frost and cold weather. Temperatures below 45^0F have damaged the plants' foliage, and frost has killed plants.

Further, hail is common in western and southeastern Pennsylvania. Hail rips the leaves and damages the fruit, making summer squash unmarketable. Winter squash and pumpkins do not scar as easily, and the scarring heals over when the fruit is cured.

Poor pollination has also at times lowered yields. Reduced bee populations and low activity due to weather conditions, such as prolonged cloudiness or coolness, has hampered pollination, resulting in decreased yields.

Demand for Crop Insurance

The State's vegetable crop specialist believes that Pennsylvania squash and pumpkin growers would be interested in crop insurance. Many of these growers already have crop insurance for their other crops and would likely include squash and pumpkins under their coverage (Orzolek).

Between 1988-93, Pennsylvania growers received about $784,000 in disaster payments for pumpkins and about $439,000 for squash. The State's specialist also believes that demand would exist, as well, for fresh-market pumpkin crop insurance coverage. He expects fresh-market pumpkin acreage in the State to increase in the future.

Ad Hoc Disaster Assistance for Squash and Pumpkins

Ad hoc disaster payments were made available to squash and pumpkin growers for losses due to natural causes in each of the years 1988 to 1993. Since commercially-grown squash and pumpkins were not eligible for crop insurance in those years,

producers of these crops were required to realize a yield loss of at least 40 percent in order to collect any ad hoc disaster payments.

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 squash and pumpkins, and would likely have a relatively high demand for insurance for these crops.

Disaster assistance payments totalled almost $25 million for pumpkin losses and $62 million for squash losses over the 1988-93 period. The States receiving the largest disaster assistance payments over this period for pumpkins, in order of their ranking, were Ohio, Tennessee, Michigan, Texas, New Jersey, Wisconsin, and Illinois (Table 8). The States receiving the largest payments for squash were Georgia, Florida, Michigan, New Jersey, Texas, and North Carolina. (Also see Figures 2 and 3.)

Ad hoc disaster data can be used to indicate which squash- and pumpkin-producing areas received large payments relative to their acreage. Georgia and Florida accounted for a large share of total ad hoc disaster assistance payments for squash, receiving 34 and 11 percent of the U.S. total, respectively. Acreage in these States accounted for 12 and 19 percent of the total acreage producing squash.

Controversy exists about Georgia’s squash acreage and the payments received in Mitchell County. The payments to that county from 1989-91, the period in question, accounted for 16 percent of the State’s total. Even with total payments to Mitchell County during 1989-91 removed from the State’s payment calculation, Georgia would still be the leading State receiving disaster assistance payments for squash.

Ohio and Tennessee were the largest recipients of disaster assistance payments for pumpkins, accounting for 12 percent and 8 percent of the total, respectively. At the same time, Ohio had about 5 percent, and Tennessee had 2 percent, of total U.S. pumpkin acreage in 1992.

In contrast, California accounted for a relatively small share of payments relative to its share of acreage. The State received only about one percent each of total payments for squash and pumpkins over the 1988-93 period, and accounted for 9 percent of total pumpkin acreage and 12 percent of total squash acreage in 1992.

Squash and Pumpkin Insurance Implementation Issues

Adverse Selection

Actuarial difficulties may arise in insuring squash and pumpkins if a producer increases his or her risk-taking in terms of planting a crop in a season which that is not optimal for the crop's production in the area. For example, in Florida, not much squash is planted from May through July because temperatures get very hot in July and August when the plants would be bearing fruit. The excessively hot weather stresses the plant and contributes to poor set fruit. The heat also reduces bee activity and therefore, the plants would be poorly pollinated. With crop insurance, growers may increasingly try to plant squash under such conditions if appropriate underwriting and premium rate adjustments are not in place.

Setting Reference Prices

A reference price for squash and pumpkins should represent the in-field value of the crop, because growers would not incur the expenses of harvesting and marketing the portion of the yield that is lost. Variable harvesting and

Table 8--Total disaster assistance payments for pumpkin and squash for 1988-93

State	Pumpkin disaster assistance		Squash disaster assistance	
	Payment	Percent of total	Payment	Percent of total
	--$--	Percent	--$--	Percent
Alabama	285,048	1.2	1,501,833	2.4
Arizona	31,451	0.1	125,659	0.2
Arkansas	647,503	2.6	1,237,291	2.0
California	192,540	0.8	342,337	0.6
Colorado	262,649	1.1	174,703	0.3
Connecticut	300,717	1.2	389,001	0.6
Delaware	27,946	0.1	2,934	0.0
Florida	147,735	0.6	6,569,6311	0.6
Georgia	230,251	0.9	21,130,7723	4.0
Hawaii	720	0.0	2,897	0.0
Idaho	10,527	0.0	0	0.0
Illinois	1,113,150	4.5	809,508	1.3
Indiana	889,663	3.6	445,092	0.7
Iowa	601,564	2.5	408,019	0.7
Kansas	248,767	1.0	127,980	0.2
Kentucky	75,499	0.3	162,905	0.3
Louisiana	328,608	1.3	359,446	0.6
Maine	37,684	0.2	159,677	0.3
Maryland	254,236	1.0	185,705	0.3
Massachusetts	747,664	3.0	1,042,433	1.7
Mississippi	731,847	3.0	580,544	0.9
Missouri	630,864	2.6	196,944	0.3
Montana	50,524	0.2	76,516	0.1
Nebraska	269,197	1.1	112,813	0.2
Nevada	13,383	0.1	7,193	0.0
New Hampshire	32,562	0.1	7,064	0.0
New Jersey	1,451,325	5.9	5,005,813	8.0
New Mexico	559,594	2.3	146,881	0.2
New York	881,232	3.6	595,627	1.0
North Carolina	537,467	2.2	4,106,887	6.6
North Dakota1	3,247	0.1	98,657	0.2
Ohio	2,958,264	12.1	1,407,106	2.3

Table 8--Total disaster assistance payments for pumpkin and squash for 1988-93

State	Pumpkin disaster assistance		Squash disaster assistance	
	Payment	Percent of total	Payment	Percent of total
	--$--	Percent	--$--	Percent
Oklahoma	963,030	3.9	354,587	0.6
Oregon	1,614	0.0	21,289	0.0
Pennsylvania	783,812	3.2	439,038	0.7
Rhode Island	20,409	0.1	44,330	0.1
South Carolina	106,724	0.4	546,326	0.9
South Dakota	99,464	0.4	129,603	0.2
Tennessee	1,900,755	7.8	1,479,157	2.4
Texas	1,456,979	5.9	4,926,515	7.9
Utah	3,239	0.0	0	0.0
Vermont	9,293	0.0	4,242	0.0
Virginia	509,937	2.1	469,824	0.8
Washington	246,664	1.0	149,129	0.2
Wisconsin	1,328,796	5.4	439,442	0.7
West Virginia	175,692	0.7	17,204	0.0
Others	257,740	1.1	65,409	0.1
U.S. total	24,519,837	100.0	62,234,541	100.0

Source: U.S. Department of Agriculture, Farm Service Agency.

marketing expenses account for about one-half to two-thirds of total production costs for fresh-market squash and about one-quarter of total costs for fresh-market pumpkins. The harvesting cost of processing squash and pumpkins is the same for those growers who do their own harvesting by hand, or involves no cost to the grower if the processing company harvests the crop.

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

There are two approaches for deriving an in-field reference price. One is to deduct the estimated harvesting cost from an estimated market price. (The estimated market price for processing squash and pumpkins could be based on an average of contract prices by area and by final use.) The second approach is to estimate the cost of production (excluding harvesting and marketing expenses), using it as a proxy for the in-field price. In both cases, the market prices refers to the grower price and not the retail price.

Market Prices and APH Distortions

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

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

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

The situation is different for fresh-market winter squash and pumpkins. These crops are generally only picked once, or twice at the most. Winter squash is storable for months, enabling producers to keep production off the market when prices are low and to market their crop when prices are higher. Therefore, winter squash is rarely abandoned in the field due to price.

Pumpkins rarely experience low-price situations during the short period of time they are marketed. Excess pumpkins, after Halloween is over, are generally abandoned because a market no longer exists. Some types may still be marketed past Halloween, however, for use in pie-making by individuals who prefer to use fresh pumpkins instead of canned. A market may exist for these types of pumpkins through Christmas, after which the demand for fresh pumpkins drops dramatically.

Estimating "Appraised Production"

One approach to estimating appraised production for squash and pumpkins (harvestable, but unharvested yield) is to count and weigh the marketable squash and pumpkins in a sample of plots and expand the plot yields (in terms of weight) to a per-acre basis. For plantings in which the squash and pumpkins are young, yields per plot can be estimated by counting the potentially harvestable fruit in the plot and multiplying by an average or typical weight for the fruit.

Important differences among varieties and types should be taken into account in calculating appraised production. For example, the weights of different varieties and types of pumpkins and squash should be taken into account. Differences also depend on whether the plant is a bush variety or a vine variety, with the latter requiring more space, with plantings further apart.

Market Prices and Moral Hazard

Moral hazard is a potential problem in insuring fresh-market squash production. The situation sometimes arises where, due to low market prices, an indemnity payment would be larger than the net return from harvesting and marketing the crop. Moral hazard could arise in such circumstances if the grower contributed to causing a loss by neglecting prudent management practices. Poor management practices were attributed to the large disaster assistance payments in Georgia in 1990 and 1991 (Kilman).

Another potential moral hazard concern for fresh-market summer squash involves the timing of planting. Profitability sometimes depends on having squash for sale early in the season before prices decline. Planting dates largely determine when squash will be ready for harvest.

Some growers are faced, consequently, with a trade-off between planting earlier and risking losing their young plants to frost, and planting later, and risking losing plants to disease or confronting reduced market value at harvest-time due to low prices. With an insurance policy in place, some growers may rely on a potential crop insurance indemnity, and take greater risks at planting than they would without the insurance coverage.

Moral hazard may be less of a problem with processing squash and fresh and processing pumpkin insurance. Market prices are not an issue for growers of processing squash and pumpkins at harvest, because acreage is under contract with the processing company at the time of planting, with growers guaranteed a price based on the size and weight of the output. Production in excess of the contract, however, may be abandoned if processors are not willing to purchase over the contracted amount. For fresh pumpkin growers, the market window is such a short period of time, that prices do not have much opportunity to fall greatly during the period.

Availability of Individual Yield Data

Individual-grower yield data for squash and pumpkins does not appear to be available in any State. Processors may have some data for processed squash and pumpkin growers. Unlike other processed vegetables, however, growers of processing squash and pumpkins in some States are not always steady clients with processors, contracting one year and not another. Therefore, records would not be very reliable, and are most likely confidential and unaccessible. Florida, California, and Michigan have State agricultural statistics services that collect yield data. This information is also likely to be confidential at the individual-grower level.

Demand for Insurance

Our assessment is that squash and pumpkins may be good candidates for crop insurance. Many squash and pumpkin growers also grow other crops that are presently covered by crop insurance, such as tomatoes, peppers, and field crops. Growers who already have insurance for these crops will likely add squash and pumpkins to their coverage.

Squash and pumpkin production is susceptible to insect, disease, and weather factors. The long growing time required for winter squash and pumpkins increases their likelihood of being affected by such perils. While breeding has helped reduce the risks of loss to some diseases, in some States disease can still be a major factor affecting overall production levels. Diseases can become a problem especially during years with poor weather conditions, such as excessive heat, moisture, or drought.

Large quantities of squash are grown in areas where weather factors have lead to large losses and disaster assistance payments. Florida and Georgia are susceptible to hurricanes. Drought, unpredictable frosts, excessive heat, and excessive moisture have hampered production in almost all States. These weather conditions are especially a problem for small growers and in States that tend to use fewer inputs, such as irrigation and plastic mulching, in their squash and pumpkin production.

The availability of crop insurance can also increase growers' risk taking. For example, in Florida, squash is not commonly produced in the middle of summer. With crop insurance, some growers may try to plant during these months.

While many squash and pumpkin specialists interviewed for this report stated that they believed squash and pumpkin growers would be interested in crop insurance, several also stated that smaller growers, in particular, may not be willing to invest in the added expense of crop insurance. Squash is often a second crop or is rotated in the field with other crops. Pumpkins are often planted on pastureland or by orchards as a supplemental crop. Therefore, growers may be willing to take the loss from a failed crop and hope to make up the loss with either their next vegetable or field crop that follows or with their main agricultural interest.

References

California County Agricultural Commissioner Data. Various years.

Chastain, April. U.S. Department of Agriculture. Farm Service Agency. Alachua County, Florida. Personal communication. January 1996.

Ferretti, Peter, A. Michael D. Orzolek, Alan A. MacNab, Shelby J. Fleischer, Zane Smilowitz, and Winand K. Hock. *1995 Commercial Vegetable Production, Pennsylvania*. Penn State Cooperative Extension. Pennsylvania Agricultural Experiment Station. The Pennsylvania State University. 1995.

Florida Agricultural Statistics Service. *Vegetable Summary 1993-1994*. May 1995.

Granberry, Darbie M., W.O. Chance, and Wayne J. McLaurin. *Squash: Commercial Vegetable Production*. Cooperative Extension Service. The University of Georgia. August 1992.

Gyorkos, Joleen. U.S. Department of Agriculture. Farm Service Agency. Kankakee County, Illinois. Personal communication. January 1996.

Hochmuth, G.J., editor. *Cucumber Production Guide for Florida*. Florida Cooperative Extension Service. University of Florida. September 1988.

Hochmuth, Robert. Multi-County Extension Agent. Cooperative Extension Service. University of Florida. Personal communication. December 1995.

Kelley, Terry. Extension Horticulturist. Cooperative Extension Service. The University of Georgia. Personal communication. December 1995.

Kilman, Scott. “Crop Disaster Program Has Georgia Farmers Raising Lots of Squash.” *The Wall Street Journal*. October 31, 1994.

Laemmlen, Franklin. Farm Advisor. Santa Barbara County, California. Personal communication. December 1995.

Madison, Deborah. "Winter Squash." *Food and Wine*. December 1995.

Maizel, David. U.S. Department of Agriculture. Farm Service Agency. Berrien County, Michigan. Personal communication. January 1996.

McLaurin, Wayne J. Horticulturist. Cooperative Extension Service. The University of Georgia. Personal communication. December 1995.

Michigan Department of Agriculture. Michigan Agricultural Statistics Service. *Michigan Rotational Survey: Vegetables--1992*. MASS-94-01. January 1994.

Molinar, Richard. Farm Advisor. Fresno County, California. Personal communication. January 1996.

Olson, S.M. and M. Sherman. *Squash Production in Florida*. Florida Cooperative Extension Service. University of Florida. August 1990.

Orzolek, Michael. Professor of Horticulture. The Pennsylvania State University. Personal communication. December 1995.

Orzolek, Michael, George, L. Greaser, and Jayson K. Harper. *Agricultural Alternatives: Pumpkin Production*. The Pennsylvania State University. College of Agricultural Sciences. Cooperative Extension. 1995.

Pearrow, Joan and Charles Plummer. "Pumpkins: A Commodity Highlight." *Vegetables and Specialties: Situation and Outlook Report.* TVS-254. August 1991.

Sims, William L. and Vincent H. Schweers. *Growing Summer Squash*. Division of Agricultural Sciences. University of California.

Smith, Scott A. and Timothy G. Taylor. *Production Cost for Selected Vegetables in Florida, 1993-94*. Cooperative Extension Service. University of Florida.

University of California. Cooperative Extension Service. Cost of Production Budgets. 1981, 1982, 1983.

University of Georgia. Cooperative Extension Service. Production Budgets for Squash. 1994.

U.S. Department of Agriculture. Agricultural Marketing Service. *Fresh Fruit and Vegetable Shipments, By Commodities, States, and Months*. Calendar years 1990-94.

U.S. Department of Agriculture. Farm Service Agency. Disaster Assistance Data Files, 1988-93. Compiled by the General Accounting Office.

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

Voigt, Charles. Extension Vegetable Specialist. Department of Natural Resources and Environmental Sciences.

University of Illinois. Personal communication. December 1995.

Zandstra, Bernard. Extension Vegetable Specialist. Department of Horticulture. Michigan State University. Personal communication. December 1995.

Zandstra, Bernard H., Edward J. Grafius, and Christine T. Stephens. *Commercial Vegetable Recommendations: Pumpkins, Squashes, and Gourds*. Extension Bulletin E-1953. Cooperative Extension Service. Michigan State University. May 1986.

Squash and Pumpkin Contacts

California

Franklin Laemmlen
Farm Advisor for Vegetable Crops
and Pest Management
Santa Barbara County
University of California
(805) 934-6240

Richard Molinar
Farm Advisor
Fresno County
University of California
(209) 456-7285

Florida

Robert Hochmuth
Extension Vegetable Specialist
Suwannee Valley Agricultural Research
and Education Center
Live Oak, Florida
(904) 362-1725

Georgia

William Terry Kelley
Extension Horticulturist-Vegetables
Cooperative Extension Service
University of Georgia
(912) 386-3410

Wayne McLaurin
Horticulturist
University of Georgia
(706) 542-2340

Illinois

Charles Voigt
Vegetable Crop Specialist
Department of Natural Resources
and Environmental Sciences
University of Illinois
(217) 333-1969

Michigan

Bernard Zandstra
Extension Vegetable Specialist
Cooperative Extension Service
Michigan State University
(517) 353-6637

Pennsylvania

Michael Orzolek
Professor of Vegetable Crops
Pennsylvania State University
(814) 863-2251