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Eastern Broccoli Crop Budgets

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CONTENTS

INTRODUCTION

This bulletin presents the sample costs to produce broccoli crowns in the states of New York, Virginia, North Carolina, South Carolina, and California. The agricultural production systems are described briefly and the cost assumptions explained. Costs are broken down by stage of production and type of costs for the baseline yield and price. A ranging analysis considers yield and price values below and above the baseline.

The practices described are based on production procedures reported for broccoli in each growing region. The cost studies presented follow similar formats of those developed at the University of California, Davis[1] and Clemson University.[2] However, the content is more aggregated to focus on the cost items that are likely to differ among broccoli production regions in the United States.

This cost study may be used as a guide in preparing budgets and determining potential returns based on market input and output prices. Projections in this report will vary for each grower and region due to differences in farm management, soils, weather, input and output prices and cultural practices. For that reason, a "*Your Costs*" column is included next to sample costs for each cost item to allow entry of case-specific figures.

The main assumptions on production practices and cost calculations are described in the following section. Cultural practices are a sample of production practices in each study region. They are not recommendations and are not endorsed by Cornell University. For additional information or explanation please contact the authors S. S. Atallah and M. I. Gómez at the Dyson School of Applied Economics and Management, Cornell University.

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[1] http://coststudies.ucdavis.edu/

[2] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/index.html

CHAPTER 1

BROCCOLI PRODUCTION IN NEW YORK: SAMPLE COSTS AND PROFITABILITY ANALYSIS

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The sample broccoli production costs in this study are based on primary data collected in 2010/11 and secondary data available from vegetable cost studies for New York, in which case a link to the document is provided in a footnote. The assumptions below pertain to the agricultural practices of producing, harvesting and cooling fresh market broccoli crowns in Western New York and their associated costs. In the cost estimates below, broccoli is transplanted, overhead irrigated, and top-iced.

A. Assumptions

The hypothetical farm in this study is based on a 35 contiguous acre operation dedicated to fresh market broccoli crowns. Other crops grown are leafy lettuce, cauliflower, cucumber, and summer squash. The costs are for one broccoli crop.

1. **Land Preparation**. Conventional tillage is practiced. Costs for this sub-section are those reported in the Clemson Cooperative Extension Enterprise Budget for spring cabbage (South Carolina)[3]. Machinery and labor costs amount to approximately $90/acre. That includes around 5 machine-hours (excluding the transplanter) and 5-6 person-hours.

2. **Stand Establishment**. A hybrid broccoli variety (Diplomat, Imperial, Green Magic or Castle Dome) is seeded in March and grown in greenhouses. Plants are transplanted in late April. Transplanting is mechanical and uses a four-row carousel transplanter for 2 hours at a cost of approximately $15/acre. Planting density is around 22,000 plants per acre (6-7 inches spacing). Twenty four person hours are needed for stand establishment an hourly rate of $8.5 per hour (weighted average of twenty nonoperating labor at $8/hr and four operating labor at $9.5/hr). This labor time includes seeding in trays, transplanting and irrigation, fertilization and application of insecticide at the time of transplanting. Stand establishment material, machinery and labor costs amount to approximately $950/acre.

[3] http://www.clemson.edu/extension/aes/budgets/index.html (cabbage, spring)

3. Irrigation. Broccoli, like cabbage and lettuce, is typically irrigated with an overhead sprinkler system. The machinery proportion of the cost is obtained using a factor of 1.38 to update 1996 cost data for vegetable overhead irrigation in the Northeast[4] into 2010 dollar terms. That factor is obtained by computing the change in BLS's PPI industry data from 1996 to 2010 for the category of 'agricultural machinery'.[5] Irrigation variable costs (excluding labor)[6] amount approximately to $266/acre.

4. Fertility management. A dry fertilizer 15-15-15 at 400-500 lb/acre (3.5-4.5 cwt/acre) is applied at listing and liquid nitrogen (33%) is sidedressed at a rate of 300 lb/acre (2.7 cwt/acre). The costs of fertilizers are taken from the above-mentioned South Carolina spring cabbage crop budget. Fertility management costs (excluding labor) amount to $145/acre.

5. Pest Management. Given that broccoli and cabbage pest management use similar inputs, pesticide related costs included in this study are those reported in the above mentioned South Carolina spring cabbage crop budget. Pest management costs, excluding labor, amount to $225/acre. This figure might be slightly overestimated given that some of the cabbage pests in South Carolina such as thrips are not a broccoli pest in Western New York.

6. Yields. Yields are expressed in twenty-one pound boxes per acre. Typical broccoli yield in Western New York varies between 400 and 500 boxes per acre[7]. We consider a yield of 450 twenty-one pound boxes (4.72 tons) per acre in the baseline case and other yield values in the ranging analysis.

7. Labor and wages. We use labor hours from the Northeast cabbage crop budget to approximate irrigation, fertility and pest management labor input. We add them to the total preharvest labor costs (Table 1) rather than disaggregate them by activity.[8] Prevailing hourly wage is $8/hr for nonoperating labor. We consider a wage that is 20% higher for operating labor ($9.5/hr).

8. Harvest. Broccoli is hand harvested at a rate of three to five cuts per growing season using a harvest aid. The harvest window is mid-June through late July then late August to late October[9].

a. *Labor*: harvesting, grading and field packing requires 75 person-hours per acre for the baseline yield of 450 boxes per acre. Harvest labor is comprised of 14 non-operating workers and one operating worker.
b. *Boxes*: broccoli is packed in waxed non-recyclable boxes that cost $1.5 /box.
c. *Machinery*: harvest costs attributable to machinery are estimated at $ 0.25/box[10].

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[4] http://aesop.rutgers.edu/~farmmgmt/ne-budgets/organic/cabbage.html

[5] 'Water Supply and Irrigation Systems' are currently not covered the PPI system. We used the 'agricultural machinery' as an approximation

[6] See comment in section 7

[7] A box consists of 34 to 38 bulk-packed crowns and weighs a minimum of 20 pounds

[8] http://aesop.rutgers.edu/~farmmgmt/ne-budgets/organic/cabbage.html .

[9] http://www.thepacker.com/fruit-vegetable-news/shipping-profiles/new-york-state-vegetables/Business-updates-New-York-Vegetables-125640228.html

[10] Boxes and machinery costs are those reported in the above-mentioned South Carolina Broccoli Cost Study

9. Postharvest. Broccoli crowns are weighed, top iced and placed in cold storage.

a. *Labor*: fourteen person-hours are needed to weigh 450 boxes, top them off with ice and transport them to the cold storage facility.

b. *Top-icing and cold storage*: Broccoli boxes are top iced after harvesting and then top iced a second time within 2 days at the time of shipping. Broccoli is stored at 34-35° and a relative humidity above 70%. We use the figures reported in the SC study for the cost for icing ($0.25/box) and cooling ($0.5/box). The ice generator costs $50,000; it is used exclusively for broccoli.

10. Returns. Typical broccoli price paid for the grower is reported to fall between $8 and $10 per box. For that reason, the ranging analysis has $9/box as a baseline price and a price range of $3-15/box.

11. Equipment Operating Costs. Methodology on this section is explained in the Vegetable Enterprise Budgets of Clemson University[11] (computed using the University of Georgia's interactive enterprise budgets[12]).

12. Interest on Operating Capital. Interest on operating capital is charged based on the local Production Credit Association's (PCA's) rate for medium-sized commercial farms**,** 9.25 percent annually. It was assumed that operating capital was borrowed for six months.

13. Land rent. Cropland rented for cash average cash rent per acre for 2010 in New York is $ 43.5[13].

14. General Overhead. A general farm overhead cost of 9 percent of total variable costs is included. These are "catch-all" costs including telephone, utilities and contingencies[14].

B. Summary of Costs

The estimate of the total costs of broccoli production in Western New York is around $4,943/acre. Figure 1 represents the total cost breakdown: harvest and postharvest constitute 35% of total costs. Table 1 presents costs by type (variable costs, fixed costs, and overhead costs), stage of production (pre-harvest, harvest, and postharvest), and type of input (material/machinery and labor). A column titled 'Your Costs' is provided in Table 1 for comparison of case-specific figures with the sample costs of this study. Please note that, due to rounding, the totals given in Table 1 differ slightly from the sums of their constituent numbers.

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[11] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf

[12] http://www.ces.uga.edu/Agriculture/agecon/interactive/squash/general.html

[13] http://usda.mannlib.cornell.edu/usda/current/AgriLandVa/AgriLandVa-08-04-2010.pdf

[14] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf

Figure 1 Proportion of broccoli production costs, Western New York 2010/11

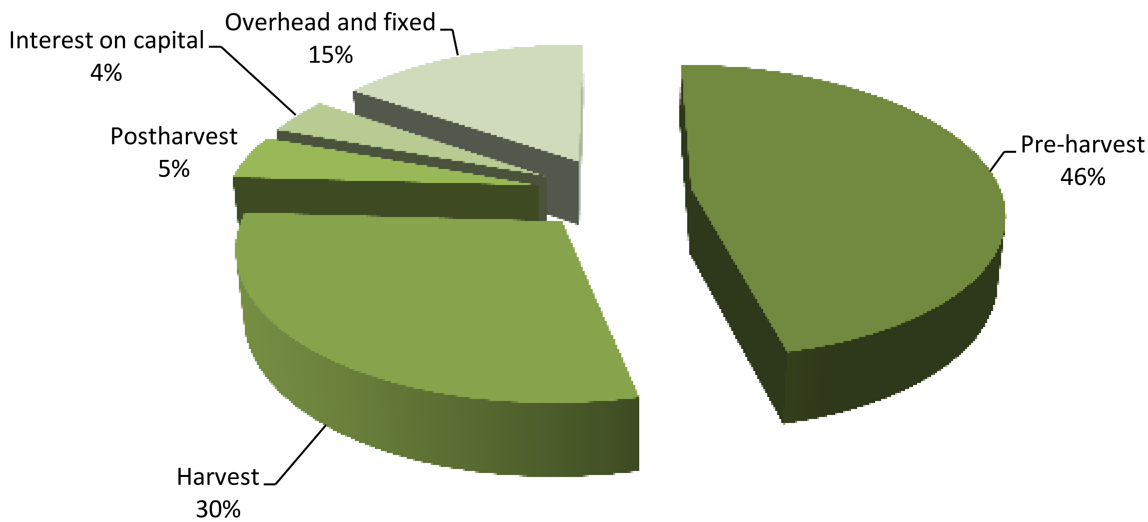

Table 1. Costs per acre to produce broccoli crowns, Western New York, 2010/11

			MATERIAL/MACHINERY			LABOR			TOTAL	YOUR COSTS
1. VARIABLE COSTS		unit	quantity	$/unit	Total	hrs	$/unit	Total		
PREHARVEST	Land preparation	acre	1	$40	$40	6	$9.5	$52	$92	______
Stand establishment	Transplants	plant	22,000	$0.033	$726	24	$8.50	$206	$932	______
	Transplanter	acre	1	$14	$14	-	-	-	$14	______
Fertility management	15-15-15 (spread)	cwt	4	$20	$80	-	-	-	$80	______
	side dressing-calcium nitrate	cwt	2.7	$24	$65	-	-	-	$65	______
Pest management	Herbicides	acre	1	$4	$4	-	-	-	$4	______
	Insecticides	acre	1	$150	$150	-	-	-	$150	______
	Fungicides	acre	1	$72	$72	-	-	-	$72	______
Irrigation		acre	1	$266	$266	-	-	-	$266	______
	Other labor					60	$8.50	$512	$512	______
	TOTAL pre-harvest				$1,416			$770	**$2,186**	______
HARVEST	***TOTAL harvest***	box	450	$1.75	$787	75	$8.1	$607	**$1,395**	______
POSTHARVEST	Top-icing and cold storage	box	450	$0.75	$337	14	$8.1	$113	$451	______
	TOTAL postharvest								**$451**	______
	Interest on op. capital	USD	$2,016	9.25%	$186	-	-	-	$186	______
	TOTAL VARIABLE COSTS								**$3,949**	
2. FIXED COSTS										
	Tractor/Machinery	acre	1	$85	$85	-	-	-	$85	______
	Irrigation	acre	1	$113	$113	-	-	-	$113	______
	Ice generator	acre	1	$103	$103	-	-	-	$103	______
	TOTAL FIXED COSTS								**$301**	______
3. OTHER OVERHEAD COSTS										
	Land rent	acre	1	$44	$44	-	-	-	$44	______
	General overhead	USD	$4,219	9%	$380	-	-	-	$380	______
	TOTAL OVERHEAD COSTS								**$423**	______
4. TOTAL COSTS									**$4,943**	______

C. PROFITABILITY ANALYSIS

For the baseline yield of 450 boxes/ acre, the break-even price is estimated at about $10.4 to cover variables costs and $8.9 to cover total costs (Table 2, part a). Break-even price is calculated as the cost of production per acre divided by the yield per acre. Net returns for the baseline yield and price ($9/box) are estimated at $67/acre when measured with respect to variable costs (Table 2, part b) and -$636/acre when measured with respect to total costs (Table 2, part c). Profitability changes greatly depending on the prices received by growers and the realized crop yields. In order to illustrate scenarios with different yields and prices, Table 2 (parts a through c) considers yield increments of 50 boxes/ acre above and below the base yield, and price increments of $2/ box above and below the base price.

Table 2. Ranging analysis of broccoli production costs and returns, Western New York, 2010/11

a. Per acre costs at varying yields			**Yield (boxes/acre)**			
	300	**350**	**400**	**450**	**500**	**550**
Pre-harvest	2186	2186	2186	2186	2186	2186
Harvest	930	1085	1240	1395	1550	1705
Postharvest	151	176	201	226	251	276
Interest on operating capital	151	159	168	176	184	193
TOTAL VARIABLE COSTS/ACRE	3418	3606	3795	3983	4172	4360
Total variable cost/box	11.4	10.3	9.5	8.9	8.3	7.9
TOTAL FIXED COSTS/ACRE	301	301	301	301	301	301
OVERHEAD COSTS/ACRE	351	368	385	402	419	436
TOTAL COSTS/ACRE	4070	4275	4481	4686	4892	5097
Total costs/box	13.6	12.2	11.2	10.41	9.8	9.3
b. Per acre net returns above variable costs						
Price ($/box)	**300**	**350**	**400**	**450**	**500**	**550**
3	-2,518	-2,556	-2,595	-2,633	-2,672	-2,710
5	-1,918	-1,856	-1,795	-1,733	-1,672	-1,610
7	-1,318	-1,156	-995	-833	-672	-510
9	-718	-456	-195	67	328	590
11	-118	244	605	967	1,328	1,690
13	482	944	1,405	1,867	2,328	2,790
15	1,082	1,644	2,205	2,767	3,328	3,890
c. Per acre net returns above total costs						
Price ($/box)	**300**	**350**	**400**	**450**	**500**	**550**
3	-3,170	-3,225	-3,281	-3,336	-3,392	-3,447
5	-2,570	-2,525	-2,481	-2,436	-2,392	-2,347
7	-1,970	-1,825	-1,681	-1,536	-1,392	-1,247
9	-1,370	-1,125	-881	-636	-392	-147
11	-770	-425	-81	264	608	953
13	-170	275	719	1,164	1,608	2,053
15	430	975	1,519	2,064	2,608	3,153

CHAPTER 2

BROCCOLI PRODUCTION IN VIRGINIA:
SAMPLE COSTS AND PROFITABILITY ANALYSIS

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The sample broccoli production costs in this study are based on secondary data available from a broccoli crop budget for Southwest Virginia (Morris and Light, 2010). The assumptions below pertain to the agricultural practices of producing, harvesting and cooling fresh market broccoli crowns in Southwest Virginia and their associated costs. In the cost estimates below, broccoli is transplanted, hydro-cooled, packed in Reusable Plastic Containers (RPCs) and top-iced.

A. Assumptions

The costs below are for one broccoli crop and are based on a 17 acre broccoli farm. They are summarized in Table 1. Wherever it is not indicated, costs are those in Morris and Light (2010).

1. Land Preparation. Land preparation variable costs amount to approximately $45/acre.

2. Stand Establishment. Stand establishment variable costs amount to approximately $500/acre. Those costs reflect the cost of transplants and do not include labor involved in planting. Morris and Light (2010) provide one aggregated figure for pre-harvest hired labor.

3. Irrigation. It is not clear in Morris and Light (2010) which irrigation system is considered in the study. Irrigation variable costs amount to approximately $96/acre.

4. Fertility management. The fertility program is composed of a starter at 20 lb/acre, 10-20-20 at 600 lb/acre, calcium nitrate at 300 lb/acre, ammonium nitrate at 80 lb/acre and lime at 2 tons/acre. Costs amount to approximately $590/acre.

5. Pest Management. The broccoli pest management program uses herbicides, insecticides and fungicides. The pest management program costs approximately $500/acre.

6. Yields. Contrary to other broccoli growing regions in this series of cost studies, yields in Morris and Light (2010) are expressed in fourteen to sixteen pound boxes per acre with fourteen crowns per box (as opposed to twenty-one pound boxes). We converted the units into twenty-one pound boxes in order to allow comparison with other costs studies. Broccoli yield varies between 5.6 and 6.4 tons/acre (equivalently, between 533 and 610 twenty-one pound boxes). The typical yield of 6 tons/acre (570 twenty-two pound boxes per acre) is considered in the baseline case and other values of yields are considered in the ranging analysis.

7. Wages. Prevailing hourly wage for non-operating labor is $9.5/hr (including 30% payroll overhead). Operating and unpaid family labor is estimated at $15/hr.

8. Harvest. Harvesting variable costs amount to approximately $1,736/acre.

a. *Labor*: labor costs related to harvesting and packing 14-16 lb boxes amounts to approximately $1/box. Adding 2.5 hours/acre of miscellaneous labor for harvest makes harvest labor costs amount to approximately $824/acre.
b. *Boxes*: broccoli is packed in reusable plastic containers (RPCs) that cost $1.35 each.
c. *Machinery*: apart from 'hauling variable costs', which we include in the postharvest section below, Morris and Light (2010) do not report harvest-related machinery costs. We borrow from the South Carolina cost study to estimate harvest cost attributable to machinery at $ 0.25/box.

9. Postharvest. Broccoli crowns are hydro-cooled.

a. *Labor*: Morris and Light (2010) report labor costs in three categories: pre-harvest, harvest and operating and family labor costs. We assume that by default, postharvest labor is reflected in the latter category.
b. *Machinery, and ice*: hydro-cooling and ice cost approximately $1.5/box. Postharvest machinery fixed costs are included in the 'machinery and equipment' cost line. The hydro-cooler and ice generator fixed costs are those reported in the South Carolina broccoli cost study (approximately $50/acre).
c. *Cooling:* Cold storage costs are not included in Morris and Light (2010). Borrowing from the South Carolina study, we estimate those costs at $0.5/box.

10. Returns. Broccoli price paid for the grower is estimated at $14 per 15 lb box (14-16 lb). That price would be $19.6 per 21 lb box. The ranging analysis in Table 2 shows the net returns above operating costs, and total costs for a range of prices and yields.

11. Equipment Operating Costs. The description on the methodology on the pre-harvest equipment operating costs will requested from Morris and Light. The assumptions on harvest and postharvest equipment operating costs are explained in the respective sections.

12. Interest on Operating Capital. The reported interest on variable costs amounts to approximately $151/acre. This cost reflects a 6% interest rate when calculated on pre-harvest, harvest and postharvest variable costs for six months.

13. Land rent. Average cash rent per acre for vegetable production in 2010/11 in Virginia is $32.[15]

14. General Overhead. Morris and Light (2010) estimate insurance, taxes on land, irrigation system depreciation and machinery and equipment fixed costs at approximately $440/acre, which constitutes 7.7% of the total variable costs.

[15] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/cabbspr6.pdf

B. SUMMARY OF COSTS

The estimate of the total costs of broccoli production in Southwest Virginia is around $6,600/acre. Figure 1 represents the total cost breakdown: harvest and postharvest constitute 55% of total costs. Table 1 presents costs by type (variable costs, fixed costs, and overhead costs), stage of production (pre-harvest, harvest, and postharvest), and type of input (material/machinery and labor). A column titled 'Your Costs' is provided in Table 1 for comparison of case-specific figures with the sample costs of this study. Please note that, due to rounding, the totals given in Table 1 differ slightly from the sums of their constituent numbers.

Figure 1 Proportion of broccoli production costs, Southwest Virginia, 2010/11

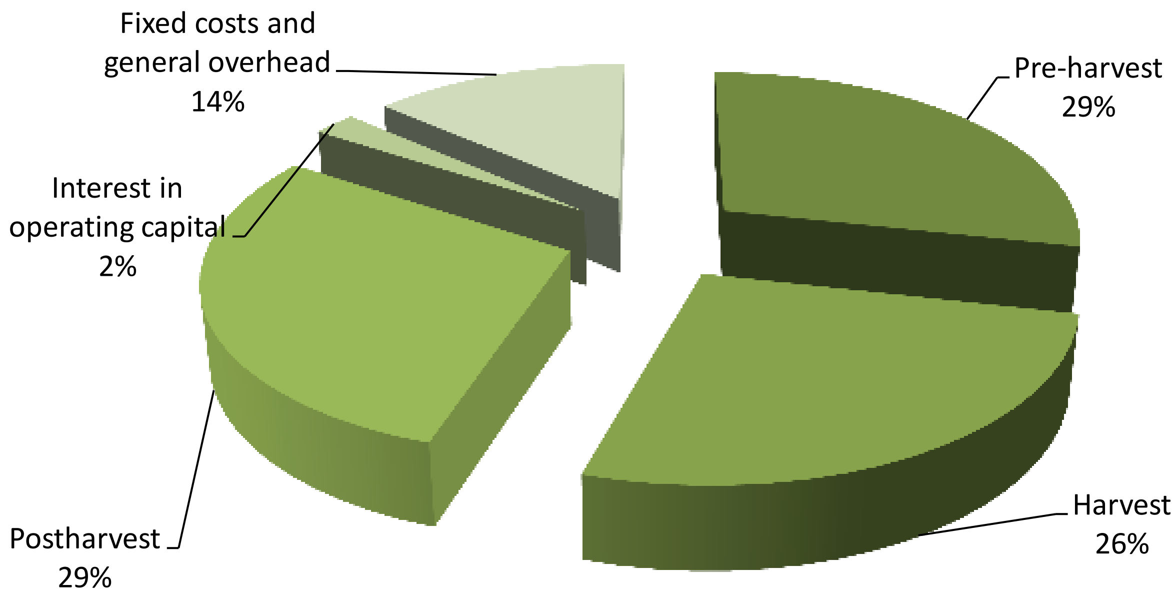

Table 1. Costs per acre to produce broccoli crowns, Southwest Virginia, 2010/2011

				MATERIAL/MACHINERY			LABOR			TOTAL	YOUR COSTS
			unit	quantity	$/unit	Total	hours	$/unit	Total		
1. VARIABLES COSTS											
PRE-HARVEST	Land preparation: ag. machinery		acre	1	$45	$45	-	-	-	$45	______
	Transplants		thousand	20	$25	$500	-	-	-	$500	______
	Fertilizer	starter	lb	20	$1	$28	-	-	-	$28	______
		10-20-20 (spread)	lb	600	$0	$132	-	-	-	$132	______
		calcium nitrate	lb	300	$1	$318	-	-	-	$318	______
		ammonium nitrate	lb	80	$0	$32	-	-	-	$32	______
		lime	ton	2	$40	$80	-	-	-	$80	______
	Herbicides		acre	1	$150	$150	-	-	-	$150	______
	Insecticides		acre	1	$170	$170	-	-	-	$170	______
	Fungicides		acre	1	$180	$180	-	-	-	$180	______
	Irrigation		hours	12	$8	$96	-	-	-	$96	______
	TOTAL pre-harvest					**$1,731**	16	$10	$152	**$1,883**	______
HARVEST	***TOTAL harvest***		box	570	$1.60	$912	87	$10	$824	$1,736	______
POSTHARVEST	Ice/ hydro-cooling		box	570	$1.50	$855	50	$15	$750	$1,605	______
	Hauling		box	570	$0.09	$51				$51	______
	Cold storage		box	570	$0.50	$285				$285	______
	TOTAL postharvest					**$1,191**			-	**$1,941**	______
	Interest on operating capital		USD	$2,780	6%	$151	-	-	-	$151	______
	Other labor		hours	$50	$15	$750	-	-	-	$750	______
	TOTAL VARIABLE COSTS									**$6,461**	______
2. FIXED COSTS											
	Tractor/machinery		acre	1	$77	$77	-	-	-	$77	______
	Irrigation		acre	1	$300	$300	-	-	-	$300	______
	Hydro-cooler & ice generator		acre	1	$49	$49	-	-	-	$49	______
	TOTAL FIXED COSTS									**$426**	______
3. OVERHEAD COSTS											
	Land rent		acre	1	$32		-	-	-	$32	______
	General overhead		USD	$5,711	7.7%		-	-	-	$440	______
4. TOTAL COSTS										**$7,359**	______

C. Profitability Analysis

For the baseline yield of 570 boxes/ acre, the break-even price is estimated at about $11.3 to cover variables costs and $12.9 to cover total costs (Table 2, part a). Break-even price is calculated as the cost of production per acre divided by the yield per acre. Net returns for the baseline yield and price ($19.6/box) are estimated at $4,711/acre when measured with respect to variable costs (Table 2, part b) and $3,813/acre when measured with respect to total costs (Table 2, part c). Profitability changes greatly depending on the prices received by growers and the realized crop yields. In order to illustrate scenarios with different yields and prices, Table 2 (parts a through c) considers yield increments of 50 boxes/ acre above and below the base yield, and price increments of $2/ box above and below the base price.

Table 2. Range analysis of broccoli production costs and returns, Southwest Virginia 2010-2011

a. Per acre costs at varying yields	Yield (boxes/acre)					
	470	**520**	**570**	**620**	**670**	**720**
Preharvest	1,883	1,883	1,883	1,883	1,883	1,883
Harvest	1,431	1,583	1,736	1,888	2,040	2,193
Postharvest	1,601	1,771	1,941	2,112	2,282	2,452
Interest on operating capital	134	142	151	160	169	177
TOTAL VARIABLE COSTS/ACRE	5,048	5,380	6,461	6,042	6,374	6,705
Total variable cost/box	10.7	10.3	11.3	9.7	9.5	9.3
TOTAL FIXED COSTS/ACRE	426	426	426	426	426	426
OVERHEAD COSTS/ACRE	376	398	472	443	466	489
TOTAL COSTS/ACRE	5,850	6,204	7,359	6,912	7,266	7,620
Total costs/box	12.4	11.9	12.9	11.1	10.8	10.6
b. Per acre net returns above variable costs						
Price ($/box)						
13.6	1,344	1,692	1,291	2,390	2,738	3,087
15.6	2,284	2,732	2,431	3,630	4,078	4,527
17.6	3,224	3,772	3,571	4,870	5,418	5,967
19.6	4,164	4,812	4,711	6,110	6,758	7,407
21.6	5,104	5,852	5,851	7,350	8,098	8,847
23.6	6,044	6,892	6,991	8,590	9,438	10,287
25.6	6,984	7,932	8,131	9,830	10,778	11,727
c. Per acre net returns above total costs						
Price ($/box)						
13.6	542	868	393	1,520	1,846	2,172
15.6	1,482	1,908	1,533	2,760	3,186	3,612
17.6	2,422	2,948	2,673	4,000	4,526	5,052
19.6	3,362	3,988	3,813	5,240	5,866	6,492
21.6	4,302	5,028	4,953	6,480	7,206	7,932
23.6	5,242	6,068	6,093	7,720	8,546	9,372
25.6	6,182	7,108	7,233	8,960	9,886	10,812

CHAPTER 3

BROCCOLI PRODUCTION IN NORTH CAROLINA: SAMPLE COSTS AND PROFITABILITY ANALYSIS

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The sample broccoli production costs in this study are based on a North Carolina broccoli cost study by Estes et al (2002)[16]. The assumptions below pertain to the agricultural practices of producing, harvesting and cooling fresh market broccoli crowns in North Carolina and their associated costs. In the cost estimates below, broccoli is transplanted on plastic, drip irrigated and slurry ice-cooled.

A. Assumptions

There are two broccoli crops per year, spring and fall. The costs in this study are for one spring broccoli crop. Fall crop is generally seeded and requires more pest management.

1. Land Preparation. We employ the BLS's PPI industry data for the category of 'diesel' to update 2002 cost data into 2010 dollar terms through multiplication by a factor of 2.55. Machinery fuel, lube, and repair costs amount to approximately $74/acre. Using BLS' Employment Cost Index for the 'Construction, extraction, farming, fishing, and forestry occupations', we use a factor of 1.29 to update machinery labor costs to approximately $30/acre. Land preparation total costs amount then to roughly $105/acre.

2. Plastic mulch and drip irrigation system. Using PPI data for the category of 'hose' we use a factor of 1.34 to update the costs of plastic mulch (fig. 1 and 2) and drip irrigation. Similarly, we use the above mentioned BLS Employment Cost Index to update labor costs. The costs of fumigation, irrigation system, and plastic mulch installation and disposal amount to approximately $1,740/acre. Assuming broccoli is rotated with another crop, we account for half of these costs, i.e. $870/acre (the sum of $756 and $114 in table 1). (Figures 1 and 2 are taken in South Carolina and used here to illustrate the plastic mulch cropping system).

3. Stand Establishment. Broccoli is transplanted at an approximate planting density of 30-40,000 transplants per acre[17] with a plant material cost of approximately $277/acre. The figure is obtained using PPI data for the category of 'nursery' (factor of 1.15). Planting starts in mid-

[16] http://www.ag-econ.ncsu.edu/AgBudgets/veg/broc901a.pdf
[17] http://www.ces.ncsu.edu/depts/hort/hil/hil-5.html

February in the coastal plain, early March in Piedmont and mid-August in the mountains for the spring crop. The fall crop starts in mid-July in Piedmont and in August in the coastal plain[18].

Figure 1 Broccoli field

Figure 2 Plastic mulch

4. **Irrigation.** Broccoli is drip irrigated in March, April and May. Irrigation fuel, lube, repair and labor costs amount to approximately $615/acre. Updating of the figures from their 2002 to their 2009 values is done as described in paragraph 1 for machinery fuel, lube and repair and machinery labor.

5. **Fertility management.** Nitrogen, phosphorous and potassium and boron are used in the fertility program. Fertilizer costs amount to approximately $93/acre. Cost figures are updated from 2002 to 2010 using a factor of 1.39 obtained from the BLS' PPI data for the category of 'agricultural chemicals'.

6. **Pest Management**. Pre and post emergence herbicides, three types of contact insecticides and a fungicide constitute the pest management program. The cost is around $27/acre. Cost updating from 2002 to 2009 follows description in paragraph 1.

7. **Yields**. Yields are expressed in twenty-one pound boxes per acre. The typical yield is 450 twenty-one pound boxes and other values of yields are considered in the ranging analysis.

8. **Wages**. Hourly wages reported in Estes et al. (2002) are $7.5/hr for non-operating labor and $8.5/hr for operating labor. Using the NC Department of Labor minimum wage rate history[19], we approximate the increase in wage rate between 2002 and 2010 to be 28% and use this figure to update hourly wages from 2002 to 2010 terms: $9.6/hr for non-operating labor and $11/hr for operating labor.

9. **Harvest**. The harvesting window is April through June for the spring crop and late August through October for the fall crop[20]. Broccoli is custom harvested. Using the same

[18] http://www.ces.ncsu.edu/depts/hort/hil/hil-5.html

[19] http://www.nclabor.com/wh/fact%20sheets/minimum_wage_rate_history_072407.pdf

[20] Harvesting window based on planting windows in http://www.ces.ncsu.edu/depts/hort/hil/hil-5.html

percentage increase from section 7, custom harvest costs excluding the boxes amount to approximately $420/acre for the baseline yield of 440 twenty-one-pound boxes/acre. In order to approximate the number of hours needed to harvest broccoli, we use the per box figure in the SC broccoli budget. Based on that, 110 person-hours employed. Total harvest costs amount to approximately $1,684/acre.

10. Postharvest. Broccoli is pre-cooled using slurry ice injection at a rate of 10 lb of ice for a 21 lb broccoli box. We use data collected in Lexington County SC in 2010 in a broccoli crown slurry ice cooling facility as an approximation to postharvest costs in NC. The costs are approximated at $1/box made from $0.25/box for the slurry ice injection, $0.25/box for ice generation and $0.5/box for cold storage. Fifteen person-hours are employed during pre-cooling. Total postharvest costs are approximately $584/acre or $1.32/box.

11. Returns. The ranging analysis in Table 2 shows the net returns above operating costs, and total costs for a range of prices below and above a baseline price of $12/box.

12. Equipment Operating Costs. The description on the methodology on the pre-harvest operating costs was requested from Estes et al (2002). The assumptions on harvest and postharvest equipment operating costs are explained in the respective sections.

13. Interest on Operating Capital. Estes et al (2002) compute interest at a rate of 8% on machinery, irrigation and equipment and include it in the fixed costs.

14. Land rent. Average cash rent per acre for vegetable production in 2010/11 in North Carolina is $63.[21]

15. General Overhead and fixed costs. We include a general farm overhead cost of 9% of total variable costs; it amounts to approximately $400/acre and reflects "catch-all" costs including telephone, utilities and contingencies.[22] Fixed costs are composed of an 8% interest machinery, irrigation and equipment in addition to depreciation, taxes and insurance and amount to approximately $735/acre (Estes et al, 2002).

B. Summary of Costs

The estimate of the total costs of broccoli production in North Carolina is around $5,645/acre. Figure 3 represents the total cost breakdown: harvest and postharvest constitute 40% of total costs. Table 1 presents costs by type (variable costs, fixed costs, and overhead costs), stage of production (pre-harvest, harvest, and postharvest), and type of input (material/machinery and labor). A column titled ‘Your Costs’ is provided in Table 1 for comparison of case-specific figures with the sample costs of this study. Please note that, due to rounding, the totals given in Table 1 differ slightly from the sums of their constituent numbers.

[21] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/cabbspr6.pdf
[22] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf

Figure 3 Proportion of broccoli production costs, North Carolina, 2010/11

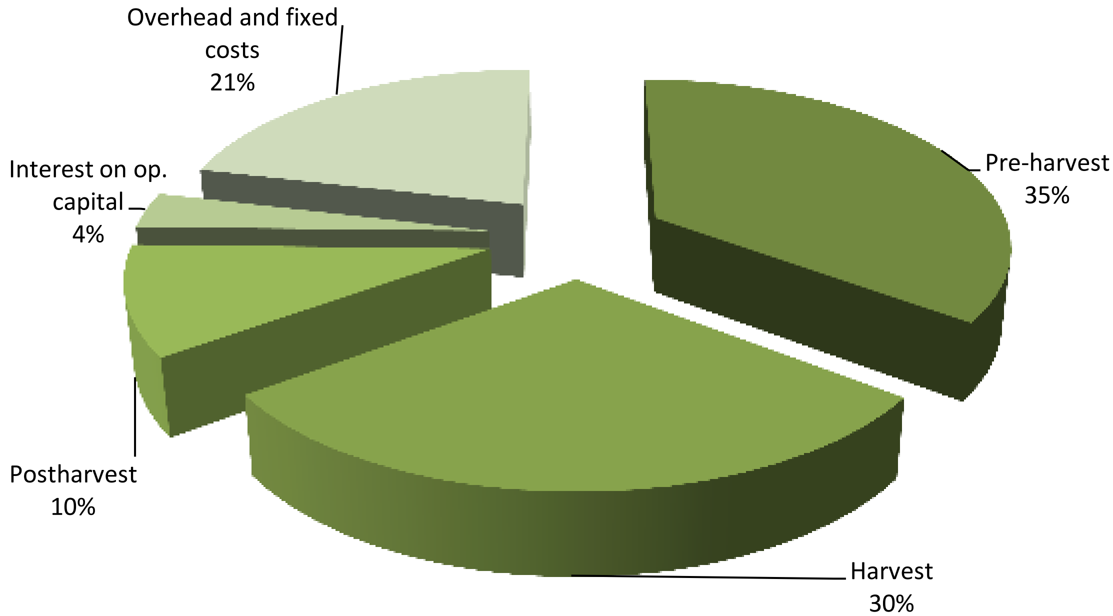

Table 1. Costs per acre to produce broccoli crowns, North Carolina, 2010/11

			MATERIAL/MACHINERY			LABOR			TOTAL	YOUR COSTS
1. VARIABLE COSTS		unit	quantity	$/unit	Total	hrs	$/unit	Total		
PREHARVEST	Land preparation: ag. machinery	acre	1	$74	$74	3	$11	$31	$105	
	Fumigation, Plastic, drip	acre	1	$641	$641	12	$10	$115	$756	
	Plastic disposal	acre				1	$114	$114	$114	
	Transplants	hundred	120	$2	$277	-	-	-	$277	
	Fertility management	acre	1	$93	$93	-	-	-	$93	
	Pest management	acre	1	$27	$27	-	-	-	$27	
	Irrigation	acre	1	$543	$543	8	$10	$72	$615	
	TOTAL pre-harvest				**$1,654**	23		**$333**	**$1,987**	
HARVEST	***TOTAL harvest***	box	440	$1.4	$616	110	$10	$1,068	**$1,684**	
POSTHARVEST	Slurry ice	box	440	$1.0	$440	15	$10	$144	$584	
	TOTAL postharvest				**$440**				**$584**	
	Interest on operating capital	USD	$1,820	9%		-	-	-	**$191**	
	TOTAL VARIABLE COSTS								**$4,447**	
2. FIXED COSTS										
	Tractor/machinery	acre	1	$34	$34	-	-	-	$34	
	Irrigation	acre	1	$632	$632	-	-	-	$632	
	Equipment	acre	1	$69	$69	-	-	-	$69	
	TOTAL FIXED COSTS								**$735**	
3.OTHER OVERHEAD COSTS										
	Land rent	acre	1.00	$63		-	-	-	$63	
	General overhead	USD	$4,447	9%		-	-	-	$400	
	TOTAL OVERHEAD COSTS								**$463**	
5. TOTAL COSTS									**$5,645**	

C. Profitability Analysis

For the baseline yield of 440 boxes/ acre, the break-even price is estimated at about $10 to cover variables costs and $12.8 to cover total costs (Table 2, part a). Break-even price is calculated as the cost of production per acre divided by the yield per acre. Net returns for the baseline yield and price ($12/box) are estimated at $833/acre when measured with respect to variable costs (Table 2, part b) and $ -365/acre when measured with respect to total costs (Table 2, part c). Profitability changes greatly depending on the prices received by growers and the realized crop yields. In order to illustrate scenarios with different yields and prices, Table 2 (parts a through c) considers yield increments of 50 boxes/ acre above and below the base yield, and price increments of $2/ box above and below the base price.

Table 2. Range analysis of broccoli production costs and returns, North Carolina, 2010-2011

a. Per acre costs at varying yields	Yield (boxes/acre)					
	340	**390**	**440**	**490**	**540**	**590**
Pre-harvest	1,987	1,987	1,987	1,987	1,987	1,987
Harvest	1,301	1,492	1,684	1,875	2,067	2,258
Postharvest (cooling)	452	518	584	651	717	784
TOTAL VARIABLE COSTS/ACRE	3,740	3,998	4,447	4,513	4,771	5,029
Total variable cost/box	11.0	10.3	10.1	9.2	8.8	8.5
TOTAL FIXED COSTS/ACRE	735	735	735	735	735	735
OVERHEAD COSTS/ACRE	400	423	463	469	492	516
TOTAL COSTS/ACRE	4,874	5,155	5,645	5,717	5,998	6,279
Total costs/box	14.3	13.2	12.8	11.7	11.1	10.6
b. Per acre net returns above variable costs						
Price ($/box)	**340**	**390**	**440**	**490**	**540**	**590**
6	-1,700	-1,658	-1,807	-1,573	-1,531	-1,489
8	-1,020	-878	-927	-593	-451	-309
10	-340	-98	-47	387	629	871
12	340	682	833	1,367	1,709	2,051
14	1,020	1,462	1,713	2,347	2,789	3,231
16	1,700	2,242	2,593	3,327	3,869	4,411
18	2,380	3,022	3,473	4,307	4,949	5,591
c. Per acre net returns above total costs						
Price ($/box)	**340**	**390**	**440**	**490**	**540**	**590**
6	-2,834	-2,815	-3,005	-2,777	-2,758	-2,739
8	-2,154	-2,035	-2,125	-1,797	-1,678	-1,559
10	-1,474	-1,255	-1,245	-817	-598	-379
12	-794	-475	-365	163	482	801
14	-114	305	515	1,143	1,562	1,981
16	566	1,085	1,395	2,123	2,642	3,161
18	1,246	1,865	2,275	3,103	3,722	4,341

CHAPTER 4

BROCCOLI PRODUCTION IN SOUTH CAROLINA: SAMPLE COSTS AND PROFITABILITY ANALYSIS

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The sample broccoli production costs in this study are based on primary data collected in 2011 and secondary data available from vegetable cost studies for South Carolina, in which case a link to the document is provided in a footnote. The assumptions below pertain to the agricultural practices of producing, harvesting and cooling fresh market broccoli crowns in Lexington County, South Carolina and their associated costs. In the cost estimates below, broccoli is transplanted, overhead irrigated, hydro-cooled and top-iced.

A. Assumptions

The hypothetical farm in this study has a 100 contiguous acre operation dedicated to fresh market broccoli crowns. Other crops grown are onions, turnips, collard, kale, sweet corn, green beans, eggplant, parsley, strawberry, green pepper and peanut. There are two broccoli crops per year, spring (75 acres) and fall (100 acres). The costs are for one fall broccoli crop.

1. Land Preparation. The machinery used in land preparation and its related costs are the ones described in Clemson University's collard crop budget[23], except for the planter, given that transplanting is manual in the system considered here. Land preparation variable costs amount to approximately $135/acre.

2. Stand Establishment. Transplants of a hybrid broccoli variety (Diplomat, Imperial, Green Magic or Castle Dome) are bought for a price of $19-25 per thousand transplants. Planting happens in early February (spring crop) and early August (fall crop). In some instances, broccoli is direct seeded for the fall crop to save on transplants ($3.5-5 per thousand seeds, with a germination success rate of 90%) and labor. This study considers the more general case of

[23] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/cabbspr6.pdf

transplanting. It is done on a riding transplanter called a sled transplanter that has no moving parts. The transplanter shoe slides across the ground making a furrow in the row. The workers place the transplants into the furrow and a 'closer' follows the shoe firming the soil around the transplant. Spacing comes out close to 10 inches resulting in a planting density of 17,000 – 18,000 plants per acre (Fig. 1). Planting one acre requires 30 person-hours composed of 8 non-operating workers and one operating worker. Stand establishment variable costs amount to approximately $730/acre.

Figure 1 Broccoli transplanted on 36-inch rows

Figure 2 Center pivot irrigation system

3. Irrigation. Broccoli is irrigated using a center pivot system (Fig. 2). Due to the sandy soils, broccoli is irrigated daily or multiple times daily in late summer for the fall crop during establishment. Small amounts of water are used to keep the foliage wet as well provide water to the root zone). Fixed costs are estimated at $300[24] and variable costs are $100 per acre (includes aggregated machinery maintenance, energy and labor irrigation costs).

4. Fertility management. Fertilizer costs and quantities are those reported in the irrigated spring cabbage budget for South Carolina.[25] Application of 5-10-10 fertilizers, calcium nitrate side and lime costs approximately $390/acre.

5. Pest Management. Chemicals' costs and quantities are those reported in the irrigated spring cabbage budget for South Carolina[26]. Application of herbicides, insecticides and fungicides costs approximately $320/acre.

6. Yields. Yields are expressed in twenty-one to twenty-two pound boxes per acre. Broccoli yield varies between 400 and 600 boxes per acre[27]. The typical yield of 400 twenty-two pound boxes or 4.4 tons per acre is considered in the baseline case and other values of yields are considered in the ranging analysis.

[24] See crop budget for South West Virginia

[25] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/cabbspr6.pdf

[26] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/cabbspr6.pdf

[27] A box consists of 34 to 38 bulk-packed crowns and weighs a minimum of 20 pounds

7. Wages. Prevailing hourly wage is $7.25/hr for non-operating labor and $9.5/hr for operating labor (including 30% payroll overhead). In the crop budgets, labor cost figures are averages of the two wage categories weighted by the number of workers in each category.

8. Harvest. Broccoli is hand harvested in late April-Mid May and mid-to-late October using a harvest aid. Harvesting variable costs amount to approximately $1,440/acre.

d. *Labor*: harvesting, grading and field packing requires 80 person-hours per acre for the baseline yield of 400 boxes per acre. Given the above mentioned operating and non-operating labor, harvest labor costs are approximately $ 0.5/box (out of 30 harvesters, 28 are non-operating labor).

e. *Boxes*: broccoli is packed in waxed non-recyclable boxes that cost $1.5 /box. Broccoli is packed in RPC boxes when retailers require iceless broccoli. In this study, we consider the more general case of top-iced broccoli.

f. *Machinery*: harvest cost attributable to machinery is estimated at $ 0.25/box.

9. Postharvest. Transporting broccoli boxes from field to shed costs 10 cents/box. Broccoli crowns are hydro-cooled by submersion in cold water (water and ice) in a 'dipper' system (custom made by Price's Machine Shop.; Fig 5 below). Broccoli boxes are then top-iced at a rate of 10 lb of ice per box, palletized and stored up to 2 weeks and then top-iced a second time before shipping. Postharvest variable costs amount to approximately $500/acre or $1.25/box.

d. *Labor*: 10 person-hours are needed in the postharvest phase (10 people, including 2 operating labor at a rate of 400 boxes per hour). Postharvest labor costs are then approximately $0.24/box.

e. *Machinery*: The hydro-cooling unit costs $ 50,000 ($ 30,000 for the steel infrastructure and $ 20,000 for the belts and controls) and is used to cool other leafy greens, such as collard. Therefore, cooling fixed costs are allocated to broccoli and collard proportionally to their values as measured by the gross receipts per acre for the benchmark price and yield ($4,800/acre for broccoli and $5,100/acre for spring cabbage).[28] Accordingly, 48% of the cooling fixed cost is attributed to broccoli.

f. *Ice*: Generating ice costs $0.25/box for ice (10 lb of ice per box for 21lb of broccoli). Broccoli boxes are top-iced after harvesting and may be top-iced a second time before shipping.

g. *Room cooling:* Broccoli is stored up to 2 weeks at 34-35° and a relative humidity above 70%. Cooled room storage costs are estimated at $0.5/box.

[28] http://www.clemson.edu/extension/aes/budgets/index.html

Figure 3 Hand harvesting, grading and field packing

Figure 4 Broccoli field packing

Figure 5 Immersion hydro-cooling (‘Dipper’): broccoli boxes are placed on conveyor belts that circulate them in troughs filled with cold water (water and crushed ice)

10. Returns. Broccoli price paid for the grower varies between $6 and $28 per box. The lower bound is a sure price paid by contracting brokers who truckload ship broccoli. The ranging analysis in Table 2 shows the net returns above operating costs, and total costs for a range of prices and yields.

11. Equipment Operating Costs. The methodology on this section is explained in the Vegetable Enterprise Budgets of Clemson University (computed using the University of Georgia’s interactive enterprise budgets). [29,30]

12. Interest on Operating Capital. This interest is calculated on pre-harvest, harvest and postharvest variable costs at a rate of 9% [31] and amounts to approximately $163/acre.

13. Land rent. Reported cash rent per acre in Lexington County is $40/acre (although the average cash rent per acre for vegetable production in 2010/11 in SC is $32.5[32]).

14. General Overhead. We include a general farm overhead cost of 9% of total variable costs; it amounts to approximately $340/acre and reflects "catch-all" costs including telephone, utilities and contingencies.[33]

B. Summary of Costs

The estimate of the total costs of broccoli production in South Carolina is around $4,565/acre. Figure 6 represents the total cost breakdown: harvest and postharvest constitute 42% of total costs. Table 1 presents costs by type (variable costs, fixed costs, and overhead costs), stage of

[29] http://www.ces.uga.edu/Agriculture/agecon/interactive/squash/general.html
[30] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf
[31] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf
[32] http://usda.mannlib.cornell.edu/usda/nass/AgriLandVa//2010s/2010/AgriLandVa-08-04-2010.pdf
[33] http://www.clemson.edu/extension/aes/budgets/melons_vegetables/1veg_intro.pdf

production (pre-harvest, harvest, and postharvest), and type of input (material/machinery and labor). A column titled 'Your Costs' is provided in Table 1 for comparison of case-specific figures with the sample costs of this study. Please note that, due to rounding, the totals given in Table 1 differ slightly from the sums of their constituent numbers.

Figure 6 Proportion of broccoli production costs, Lexington County, SC, 2010/11

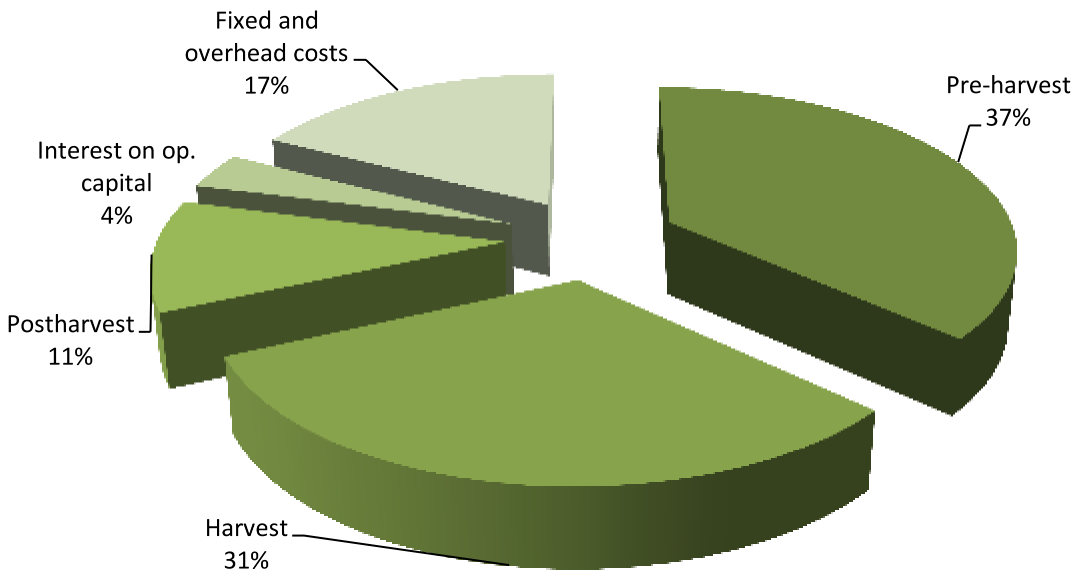

Table 1. Costs per acre to produce broccoli crowns, Lexington County, SC, 2010/2011

			MATERIAL/MACHINERY			LABOR			TOTAL	YOUR
		unit	quantity	$/unit	Total	hours	$/unit	Total	/ ACRE	COSTS
1. VARIABLE COSTS										
PRE-HARVEST	Land preparation	acre	1	$83	$83	5.50	$9.50	$52	$135	______
	Stand establishment (transplants)	thousand	23	$22	$506	30.00	$7.50	$225	$731	______
	Fertilizer 5-10-10 (spread)	cwt	12	$20	$240	-	-	-	$240	______
	side dressing-calcium nitrate	cwt	4	$24	$96	-	-	-	$96	______
	lime	ton	1	$53	$53	-	-	-	$53	______
	Herbicides	acre	1	$4	$4	-	-	-	$4	______
	Insecticides	acre	1	$171	$171	-	-	-	$171	______
	Fungicides	acre	1	$146	$146	-	-	-	$146	______
	Irrigation	acre	1	$100	$100	-	-	-	$100	______
	TOTAL pre-harvest				**$1,400**			**$277**	**$1,676**	______
HARVEST	***TOTAL harvest***	box	400	$1.75	**$700**	100.00	$7.40	**$740**	**$1,440**	______
POSTHARVEST	'Dipper' hydro-cooling	box	400	$0.25	$100	12.50	$7.70	$96	$196	______
	Ice	box	400	$0.25	$100	-	-	-	$100	______
	Cold storage	box	400	$0.50	$200	-	-	-	$200	______
	TOTAL postharvest				**$400**	-	-	**$96**	**$496**	______
	Interest on operating capital	USD	$1,806	9%	-	-	-	-	$163	______
	TOTAL VARIABLE COSTS				**$2,498**			**$1,113**	**$3,775**	______
2. FIXED COSTS										
	Tractor/machinery	acre	1.00	$61	$61	-	-	-	$61	______
	Irrigation	acre	1.00	$300	$300	-	-	-	$300	______
	Hydro-cooler & ice-maker	acre	1.00	$50	$50	-	-	-	$50	______
	TOTAL FIXED COSTS:								**$410**	______
3. OVERHEAD COSTS										
	Land rent	acre	1.00	$40		-	-	-	$40	______
	General overhead	USD	$3,775	9%		-	-	-	$340	______
	TOTAL OVERHEAD COSTS								**$380**	______
4. TOTAL COSTS									**$4,565**	______

C. Profitability Analysis

For the baseline yield of 400 boxes/ acre, the break-even price is estimated at about $9.4 to cover variables costs and $11.4 to cover total costs (Table 2, part a). Break-even price is calculated as the cost of production per acre divided by the yield per acre. Net returns for the baseline yield and price ($12/box) are estimated at $1,025/acre when measured with respect to variable costs (Table 2, part b) and $250/acre when measured with respect to total costs (Table 2, part c). Profitability changes greatly depending on the prices received by growers and the realized crop yields. In order to illustrate scenarios with different yields and prices, Table 2 (parts a through c) considers yield increments of 50 boxes/ acre above and below the base yield, and price increments of $2/ box above and below the base price.

Table 2. Range analysis of broccoli production costs and returns, Lexington County, SC, 2010-2011

	Yield (boxes/acre)					
a. Per acre costs at varying yields	**300**	**350**	**400**	**450**	**500**	**550**
Pre-harvest	1,676	1,676	1,676	1,676	1,676	1,676
Harvest	1,080	1,260	1,440	1,620	1,800	1,980
Postharvest	372	434	496	558	620	682
Interest on operating capital	141	152	163	173	184	195
TOTAL VARIABLE COSTS/ACRE	3,269	3,522	3,775	4,027	4,280	4,533
Total variable cost/box	10.9	10.1	9.4	8.9	8.6	8.2
TOTAL FIXED COSTS/ACRE	410	410	410	410	410	410
OVERHEAD COSTS/ACRE	334	357	380	402	425	448
TOTAL COSTS/ACRE	4,013	4,289	4,565	4,840	5,116	5,392
Total costs/box	13.4	12.3	11.4	10.8	10.2	9.8
b. Per acre net returns above variable costs						
Price ($/box)						
6.00	-1,469	-1,422	-1,375	-1,327	-1,280	-1,233
8.00	-869	-722	-575	-427	-280	-133
10.00	-269	-22	225	473	720	967
12.00	331	678	1,025	1,373	1,720	2,067
14.00	931	1,378	1,825	2,273	2,720	3,167
16.00	1,531	2,078	2,625	3,173	3,720	4,267
18.00	2,131	2,778	3,425	4,073	4,720	5,367
c. Per acre net returns above total costs						
Price ($/box)						
6.00	-2,213	-2,189	-2,165	-2,140	-2,116	-2,092
8.00	-1,613	-1,489	-1,365	-1,240	-1,116	-992
10.00	-1,013	-789	-565	-340	-116	108
12.00	-413	-89	235	560	884	1,208
14.00	187	611	1,035	1,460	1,884	2,308
16.00	787	1,311	1,835	2,360	2,884	3,408
18.00	1,387	2,011	2,635	3,260	3,884	4,508

CHAPTER 5

BROCCOLI PRODUCTION IN CALIFORNIA: SAMPLE COSTS AND PROFITABILITY ANALYSIS

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The sample broccoli production costs in this study are based on secondary data from the work of Smith et al (2004).[34] In order to update 2004 broccoli costs to 2010, we used other available crop budget cost items when the cultural practice is similar, as determined by comparing the crop budget narratives between Smith et al (2004) and Tourte and Smith (2010) and/or Bolda et al (2010). [35,36] The assumptions below pertain to the agricultural practices of producing, harvesting and cooling fresh market broccoli crowns in Monterey County, California and their associated costs. In the cost estimates below, broccoli is direct seeded, irrigated using sprinklers until germination then flood irrigated and cooled using package liquid-icing.

A. Assumptions

The hypothetical farm in this study has a 1,200 non-contiguous acre vegetable crop operation of which 400 acres are planted to fresh market broccoli. Other crops grown are cauliflower, lettuce and celery. The farm will normally produce two to two and one-half crops per year on each field. In this study, the costs are for one broccoli crop.

For the description of the production practices, and inputs used in each of the following categories, we refer the reader to the Monterrey broccoli cost study of Smith et al (2004)[37]. The sections below refer to the methods used to update cost data from the 2004 study into 2010 dollar terms. Where a 2010 crop budget is available for the Monterrey County, we use the cost figures associated with a particular production practice whenever it is similar to the one described for broccoli in Smith et al (2004). Where no such information is available, cost data is updated using

[34] http://coststudies.ucdavis.edu/files/broccolicc2004.pdf
[35] http://coststudies.ucdavis.edu/files/2010Lettuce_Wrap_CC.pdf
[36] http://coststudies.ucdavis.edu/files/StrawberryCC2010.pdf
[37] http://coststudies.ucdavis.edu/files/broccolicc2004.pdf

the Bureau of Labor Statistics' (BLS) published producer price indices (PPI) for the appropriate input category[38]. Costs in Smith et al (2004) that are not included in the cost studies of other regions are omitted in order to allow comparison among the regions.

1. **Land preparation and stand establishment.** Broccoli is direct seeded using a four-bed planter on 40-inch beds (Fig. 1). Plant density is 69,700 plants per acre and plant spacing is 4 1/2-inch (Smith et al 2004). Other planting configurations can be found in Monterey County, such as planting on two rows per bed (Fig 2); we do not consider them in this study and consider the configuration described in Smith et al (2004) to be more typical. Given the similarity between the land preparation and planting operations for broccoli and lettuce, we use the cost figures of Tourte and Smith (2010) in order to have the costs in 2010 dollar terms. Land preparation and stand establishment variable costs amount to approximately $750/acre.

2. **Irrigation.** Irrigation is described in Smith et al (2004): water is applied through sprinklers during stand establishment (Fig. 2) and in the furrow during the growing season. Although drip irrigation is also common in broccoli fields in Monterey County (Fig 3), we focus in this study on the sprinkler irrigation system reported in Smith et al (2004). The labor proportion of the cost is the one reported in Smith et al (2004) (see reason in the labor section below). The machinery proportion of the cost is obtained using a factor of 1.22 to update 2004 cost data into 2010 dollar terms. That factor is obtained by computing the change in BLS's PPI industry data from 2004 to 2010 for the category of 'agricultural machinery'.[39] Irrigation variable costs amount approximately to $243/acre.

Figure 1 Broccoli direct seeded on 4-row beds

Figure 3 Sprinkler irrigation system

[38] http://www.bls.gov/ppi/

[39] 'Water Supply and Irrigation Systems' are currently not covered the PPI system. We used the 'plastics industrial' as an approximation

Figure 2 Broccoli on 2-row beds

Figure 4 Drip irrigation system

3. Fertility management. We use the fertilization cost figures of Tourte and Smith (2010); costs associated with cover crops are omitted in order to comply with practices described in Smith et al (2004). Fertility management variable costs amount to approximately $530/acre.

4. Pest management. Employing BLS's PPI industry data for the category of 'pesticide, fertilizer, and other agricultural chemical manufacturing', 2004 cost data are updated into 2010 dollar terms through multiplying by a factor of 1.287. Application of herbicides, insecticides and fungicides costs approximately $700/acre.

5. Yields. Average fresh market broccoli yields in the Central Coast are about 800 cartons per acre. Lower and higher yields are considered in the ranging analysis.

6. Wages. Reported labor rates are similar in the 2004 ($11.8/hr including 35% payroll overhead) and 2010[40] ($11.4/hr including 34% payroll overhead) cost studies for Monterrey County. We therefore use the labor related costs reported in Smith et al. (2004).

7. Harvest. Broccoli is hand harvested 90 to 120 days after planting using a harvest aid (Fig 3). Harvesting is done under contract. Harvesting variable costs amount to approximately $3,600/acre.

a. *Labor*: Field labor cost $2.6 per box plus $0.18 per box for field overhead (supervision).
b. *Boxes*: containers cost $1.75 each.

We do not include selling costs reported in Smith et al. (2004) to allow comparison with other broccoli cost studies.

[40] http://coststudies.ucdavis.edu/files/2010Lettuce_Wrap_CC.pdf

Figure 3 Hand harvesting with a harvest aid

8. Postharvest. Broccoli is cooled through package liquid-icing using a pallet ice injector (Figures 4a and 4b). The service is provided by a cooling company. Employing BLS's PPI industry data for the category of 'ice manufacturing', the 2004 cooling custom rent and hire figure of Smith et al. (2004) is updated into 2010 dollar terms through multiplying by a factor of 1.152. Postharvest variable costs are approximated at $2.19/box or $1,750/acre.

Figure 4a Ice injector (back view)

Figure 4b Pallet leaving ice injector (side view)

9. Returns. Between 9/27/2010 and 9/27/2011, shipping point prices in CA ranged from $5 to $30/box with a daily average of around $13/box[41]. The ranging analysis considers a baseline price of $13/box. Table 3 shows per acre net returns above variable costs and per acre total costs for a range of prices ($5-30/box) and yields (700-900 boxes/acre).

10. Equipment Operating Costs. The methodology on this section is explained in Smith et al (2004).

[41] http://www.marketnews.usda.gov/portal/ data from daily prices for broccoli crowns from 9/2010 to 9/2011

11. Interest on Operating Capital. Interest on operating capital is based on cash operating costs and is calculated monthly until harvest at a nominal rate of 5.75%[42] per year. This interest is calculated on pre-harvest, harvest and postharvest variable costs and amounts to approximately $200/acre.

12. Land rent. The land rented includes developed wells and irrigation system. The irrigation system is maintained by the owner and included in the land rental cost. A 2010 sample land rent for one vegetable crop in Monterey Country is $1,200.[43]

13. General Overhead. The 2004 total cash overhead cost for broccoli production in Monterey is around $62/acre (Smith et al., 2004). In order to update that figure to 2010/11, we use the value of $250/acre reported for lettuce production overhead (that includes interest in operating capital[44]) in 2010 (Tourte and Smith, 2010) and subtract from it the interest on operating capital at the rate of 5.75% (see section 11). The general overhead amounts then to $100/acre or 4% of the total variable costs ($2,557/acre).

B. Summary of Costs

The estimate of the total costs of broccoli production in Monterey County is around $8,400/acre. Figure 5 represents the total cost breakdown: harvest and postharvest constitute 54% of total costs. Table 1 presents costs by type (variable costs, fixed costs, and overhead costs), stage of production (pre-harvest, harvest, and postharvest), and type of input (material/machinery and labor). A column titled 'Your Costs' is provided in Table 1 for comparison of case-specific figures with the sample costs of this study. Please note that, due to rounding, the totals given in Table 1 differ slightly from the sums of their constituent numbers.

[42] http://coststudies.ucdavis.edu/files/StrawberryCC2010.pdf
[43] http://coststudies.ucdavis.edu/files/2010Lettuce_Wrap_CC.pdf
[44] It is not clear whether this figure from Tourte and Smith (2010) includes noncash overhead or not; this is however unlikely to constitute an underestimation since noncash overhead costs constitute less than 0.8% of total costs in Smith (2004).

Figure 5 Proportion of broccoli production costs, Monterey County, CA, 2010/11

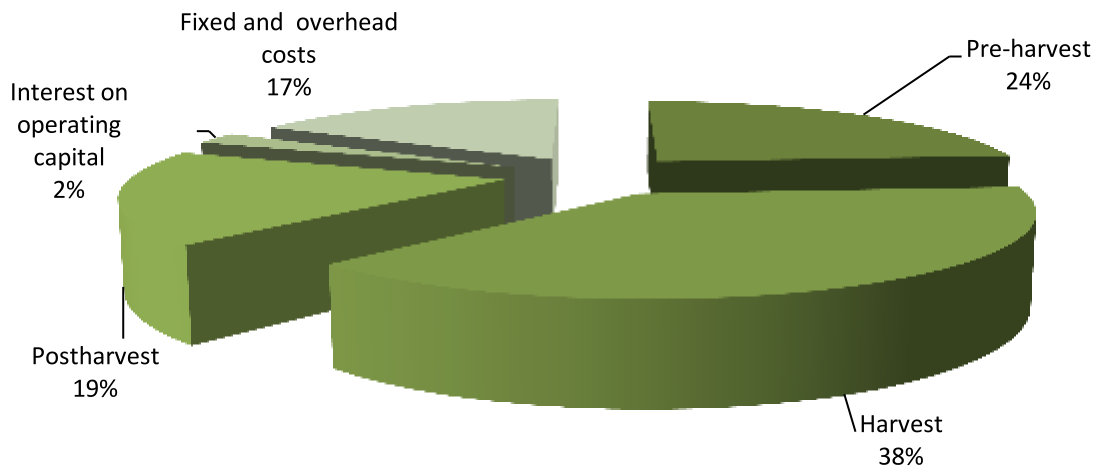


Table 1. Costs per acre to produce broccoli crowns, Monterey County, CA, 2010/2011

			MATERIAL/MACHINERY			LABOR				
		unit	quantity	$/unit	Total	box	$/unit	Total	TOTAL	YOUR COSTS
1. VARIABLE COSTS										
	Land preparation and stand establishment	acre	-	-	-	-	-	-	$751	______
	Fertility management	acre	-	-	-	-	-	-	$534	______
PREHARVEST	Pest management	acre	-	-	$588.64	-	-	$108.00	$697	______
	Irrigation	acre	-	-	$169.19	-	-	$74.00	$243	______
	TOTAL pre-harvest		-	-		-	-	-	**$2,225**	______
HARVEST	***TOTAL harvest***	box	800	$1.75	$1,400	800.00	$2.78	$2,224	**$3,624**	______
POSTHARVEST	***TOTAL postharvest***	box	800	$2.19	$1,752				**$1,752**	______
	Interest on operating capital	USD	$3,800	5.75%	$219				$219	______
	TOTAL VARIABLE COSTS								**$7,819**	______
2. FIXED COSTS										
	Tractor/Machinery	acre	1.00	60.57					$61	______
	TOTAL FIXED COSTS:								**$61**	______
3. OVERHEAD COSTS										
	Land rent	acre	1200.00						$1,200	______
	General overhead	USD	$7,819	4%					$313	______
	TOTAL OVERHEAD COSTS								**$1,513**	______
4. TOTAL COSTS									**$9,393**	______

Profitability Analysis

For the baseline yield of 800 boxes/ acre, the break-even price is estimated at about $9.8 to cover variables costs and $11.7 to cover total costs (Table 3, part a). Break-even price is calculated as the cost of production per acre divided by the yield per acre. Net returns for the baseline yield and price ($13/box) are estimated at $2,581/acre when measured with respect to variable costs (Table 3, part b) and $1,007/acre when measured with respect to total costs (Table 3, part c). Profitability changes greatly depending on the prices received by growers and the realized crop yields. In order to illustrate scenarios with different yields and prices, Table 3 (parts a through c) considers yields ranging from $700 to $950/acre, and prices ranging from $5 to $30/acre.

Table 2. Range analysis of broccoli production costs and returns, Monterey County CA, 2010/11

a. Costs per acre at varying yields						
Yield (boxes/acre)	**700**	**750**	**800**	**850**	**900**	**950**
Preharvest	2,225	2,225	2,225	2,225	2,225	2,225
Harvest	3,171	3,398	3,624	3,851	4,077	4,304
Postharvest	1,533	1,643	1,752	1,862	1,971	2,081
Interest on operating capital	199	209	219	228	238	248
TOTAL VARIABLE COSTS/ACRE	7,128	7,474	7,819	8,165	8,511	8,856
Total variable cost/box	10.2	10.0	9.8	9.6	9.5	9.3
TOTAL FIXED COSTS/ACRE	61	61	61	61	61	61
OVERHEAD COSTS/ACRE	1,485	1,499	1,513	1,527	1,540	1,554
TOTAL COSTS/ACRE	8,674	9,033	9,393	9,752	10,112	10,471
Total costs/box	12.4	12.0	11.7	11.5	11.2	11.0
b. Net returns per acre above variable costs						
Price ($/box)						
5	-3,628	-3,724	-3,819	-3,915	-4,011	-4,106
9	-828	-724	-619	-515	-411	-306
13	1,972	2,276	2,581	2,885	3,189	3,494
22	8,272	9,026	9,781	10,535	11,289	12,044
30	13,872	15,026	16,181	17,335	18,489	19,644
c. Net returns per acre above total costs						
Price ($/box)						
5	-5,174	-5,283	-5,393	-5,502	-5,612	-5,721
9	-2,374	-2,283	-2,193	-2,102	-2,012	-1,921
13	426	717	1,007	1,298	1,588	1,879
22	6,726	7,467	8,207	8,948	9,688	10,429
30	12,326	13,467	14,607	15,748	16,888	18,029

CHAPTER 6

EASTERN BROCCOLI CROP BUDGETS: SYNTHESIS

This section synthesizes the findings of cost studies of fresh broccoli crown production in South Carolina (SC), North Carolina (NC), New York (NY), Virginia (VA) and California (VA) in 2010-2011. As shorthand, the abbreviations of the states are used to indicate the surveyed production system in that particular state. Some remarks are outlined for each production phase/cost item in order to help interpret the cost results summarized in Table 1 and figures 1 to 3. The results are currently being validated as more field visits take place and more information becomes available.

1. Pre-harvest costs

NY has the lowest per box pre-harvest cost and SC the highest. SC production system surveyed is more intensive in its use of fertilizers, insecticide and fungicide due to sandy soils and warmer weather. SC has the highest per box pre-harvest cost of production ($4.2/box) and the highest share of pre-harvest costs (37%).

2. Harvest costs

Among the eastern production regions, VA has the lowest per box harvest cost ($3.3/box) and NC the highest ($3.8/box). This compares with a per box harvest cost of $4.5 in CA. Harvest operations constitute the highest cost shares in NY (37 %).

3. Postharvest costs

NY and SC spend the least on postharvest operations both in absolute terms ($1 and $1.2/box, respectively) and in terms of cost shares (12 and 11%, respectively). NC, VA and CA have the highest postharvest costs. In the systems sampled, NY and SC cool broccoli through hydro-cooling and/or top-icing whereas NC, VA and CA employ slush ice cooling. One would expect this higher investment in postharvest technology in NC, VA and CA to be reflected in the farm gate prices for broccoli crowns in those states.

4. Total costs

Among the eastern production regions, VA has the highest total cost of production ($11.6/box). This figure compares with $11.7/box in Dillard et al[45] (their estimated includes transportation costs of $0.73/box). VA is followed by NC and SC. NY has the lowest total costs of production ($8.4/box). Those figures are contrasted with a cost of $11.7/box in CA (Table 1 and figure 1). Total costs look different among Eastern production regions, however, once divided by the respective yields, per box costs become more or less similar for SC, NC and VA ($11.2, $11.5 and $11.6/box respectively). Despite this similarity in the per box costs, the different regions seem to have very different production processes as evidenced by the pre-harvest, harvest and postharvest shares of total costs are different between states. The production process can be described as “pre-harvest” intensive in SC, “harvest intensive” in NY and NC. In VA however, costs are more or less equally allocated to pre-harvest, harvest and postharvest operations (Fig. 3).

[45] http://ageconsearch.umn.edu/bitstream/8553/1/37010052.pdf

Table 1. Per box costs, cost shares and total costs of broccoli crown production per production stage and growing region

Yield	South Carolina 440 boxes/acre			North Carolina 440 boxes/acre			New York 450 boxes/acre			Virginia 570 boxes/acre			California 800 boxes/acre		
	$/ box	Cost share [a]	Total costs	$/ box	Cost share	Total costs	$/ box	Cost share	Total costs	$/ box	Cost share	Total costs	$/ box	Cost share	Total costs
Pre-harvest	$4.2	37%	1,676	$3.1	28%	$1,372	$2.6	31%	$1,168	$3.3	28%	1,883	$2.8	24%	$2,225
Harvest	$3.6	32%	1,440	$3.8	34%	$1,684	$3.1	37%	$1,395	$3.0	26%	1,736	$4.5	39%	$3,624
Postharvest	$1.2	11%	496	$1.3	12%	$584	$1.0	12%	$451	$3.4	29%	1,941	$2.2	19%	$1,752
Other	$2.4	21%	953	$3.0	26%	$1,304	$1.7	20%	$768	$1.8	16%	1,049	$2.2	19%	$1,792
Total	$11.4	100%	4,565	$11.2	100%	$4,944	$8.4	100%	$3,781	$11.6	100%	6,609	$11.7	100%	$9,393

[a] Proportion of total costs

Figure 1 Broccoli crown production per box costs for Eastern states and California

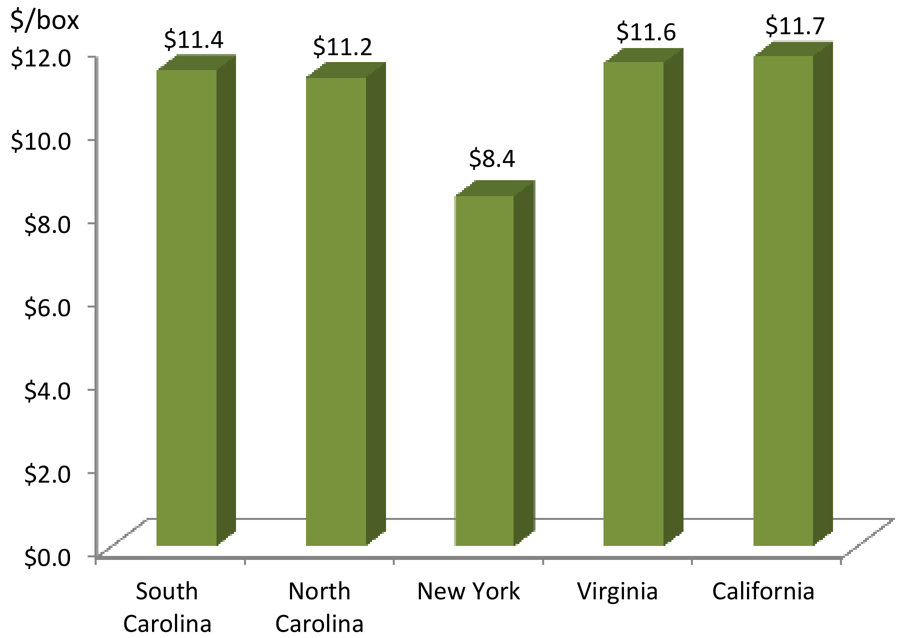


Figure 2 Breakdown of broccoli crown production per box costs for Eastern states and California

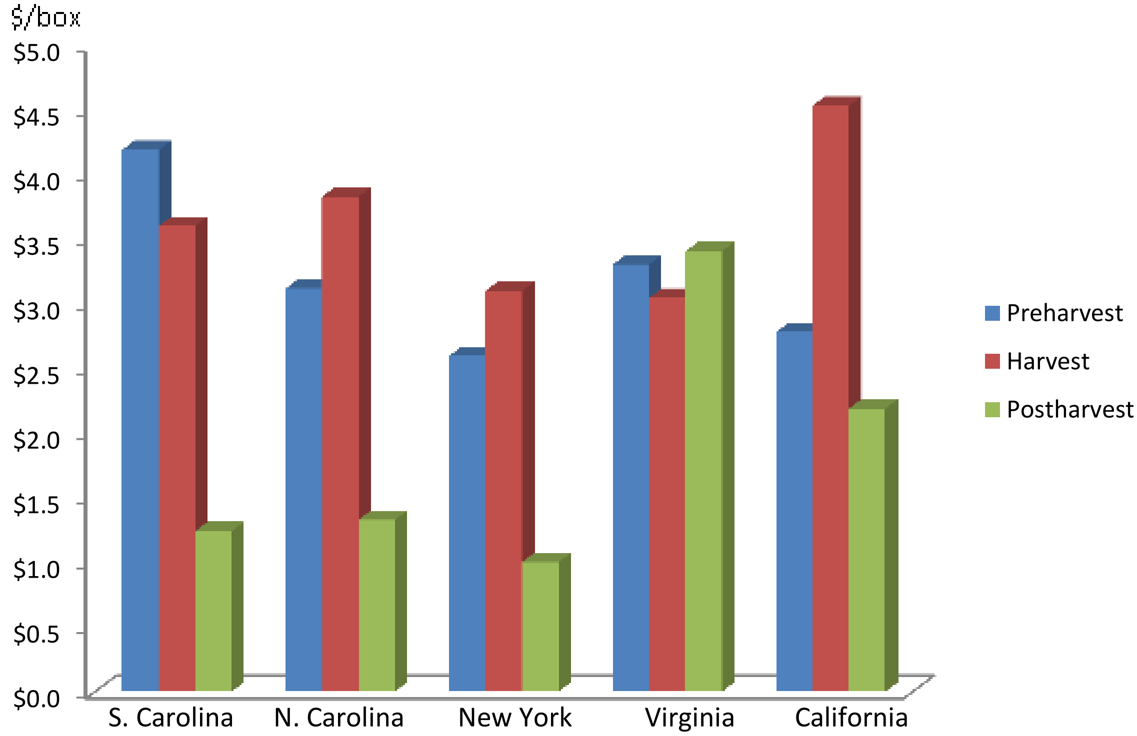
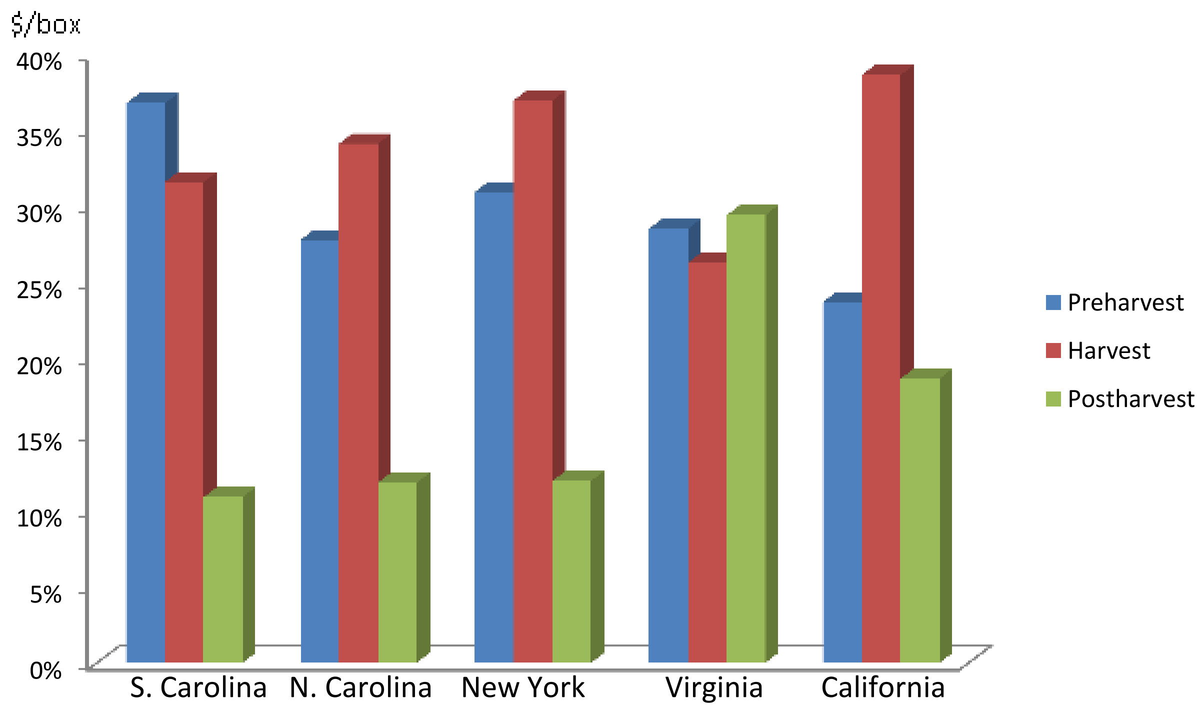


Figure 3 Broccoli pre-harvest, harvest and postharvest shares of total costs for the East coast and California



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2013-12	Dairy Farm Business Summary, Western New York Region, 2012	($12.00)	Knoblauch, W., Dymond, C., Karszes, J., Hanchar, J., Grace, J., Carlberg, V. and J. Petzen
2013-11	Dairy Farm Business Summary, New York Large Herd Farms, 300 Cows or Larger, 2012	($16.00)	Karszes, J., Knoblauch, W. and C. Dymond
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