Production Costs of Organic Vegetable Farms: Two Case Studies from Pennsylvania

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SUMMARY. **The market premiums that currently exist for many organic crops are an attractive incentive for conventional growers considering the transition to organic practices. Before making this decision, there is a need to better understand the production costs of these systems. While many factors, such as crop rotation, soil type, and marketing, influence cropping decisions, production costs are vital information for production and pricing decisions. This research evaluated crop budgets from two Pennsylvania organic farms as case studies. A critical component of these budgets was the calculation of costs related to cover cropping, rotations, and compost production or use. These farms were very different in their scale, management, and marketing strategies. The crops selected for study on each farm were also different, based upon economic value to the farm. Beech Grove Farm used horse traction and hired no production labor on about 4 acres of production; budgets for carrot (*Daucus carota*), onion (*Allium cepa*), and garlic (*Allium sativum*) are presented. The other, Spiral Path Farm, used machinery and a hired labor crew extensively on about 60 acres; their production costs for tomato (*Solanum lycopersicum*), lettuce (*Lactuca sativa*), and winter squash (*Cucurbita moschata*) are presented. While costs could not be compared between the farms, costs per acre varied widely among crops on a farm, but less so across years. Neither farm spent a great deal on pest control inputs, relying on soil fertility and other management practices to minimize infestations and grow healthy plants. While these single-crop budgets provided some realistic measures of costs of organic vegetable production, longer-term budgets measuring multiyear rotations would better capture the tradeoffs made by diversified organic farmers.**

Supply and demand for organically grown foods continues to increase in the United States. Analysts have credited the market with annual growth percentages of 20% (Dimitri and Greene, 2002). On the supply side, certified organic acreage for all agricultural products and vegetables in particular continues to increase. Specifically, between 1997 and 2002, certified organic crop acreage increased by 53% and organic vegetable acres by 45%, although organic acreage still comprises a small percentage of overall agricultural land (U.S. Department of Agriculture, 2008a, 2008b). The market premiums that currently exist for many organic crops are an attractive incentive for conventional growers considering the transition to organic practices. Before making this decision, there is a need to better understand the production costs of these systems. A group of university researchers, nonprofit agencies, and farmers from the northeastern United States [Northeast Organic Network (NEON)] used an intensive, multidisciplinary research approach to explore the management and economics of 11 "exemplary" organic farms in the northeastern United States. The farms were chosen by the project's team from a list of nominees solicited from the region's organic farming institutions. On each farm, data collection concentrated on a handful of "focal" crops selected by the farmers and researchers based primarily upon economic importance to that farm. Areas of study included farm development, crop production, pest and weed management, and enterprise budgets for the farm focal crops that reflect the two seasons of production (2002 and 2003).

The use of budgeting tools, including enterprise budgets, has been a staple of farm management education (Kay and Edwards, 1999; Osburn and Schneeberger, 1983). Kay and Edwards (1999) defined an enterprise budget as "an organization of revenue, expenses and profit for a single enterprise. Each crop…that can be grown is an enterprise…The base unit for enterprise budgets is typically one acre for crops. Using these common units permits an easy and fair comparison across different enterprises." An understanding of production costs is critical for farmers' production and pricing decisions. These analyses help farm managers understand the pros and cons of components of their businesses, identify profitable enterprises, and can contribute to break-even price/quantity analysis, partial budgeting, and price-sensitivity analysis (Frank, 1997). Several academic institutions have created budgets on a variety of vegetable crops. The University of California at Davis (2008) has perhaps the greatest number of such budgets, but these may be of limited value to growers outside of California. Budgets from North Carolina (Estes et al., 2003) and the northeastern United States (Grubinger, 1999) were constructed with on-farm–specific data. Organic vegetable budgets from New Jersey (Rutgers University, 1996) may be the most relevant to the northeastern United States.

While many factors, such as crop rotation, soil type, and marketing, influence cropping decisions, production costs are vital information for production and pricing decisions. This article presents components of crop budgets from two Pennsylvania organic farms. These farms maintained excellent records and therefore produced detailed and credible budgets. A critical part of their budgets was the calculation of costs related to

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
0.4536	lb	kg	2.2046
1.1209	lb/acre	$kg \cdot ha^{-1}$	0.8922
1.6093	mile(s)	km	0.6214
0.7646	$yard^3$	m^3	1.3080
1.8893	$yard^3$/acre	$m^3 \cdot ha^{-1}$	0.5293

cover cropping, fallow systems, and compost production or use. In some cases, budgets extended beyond the year of production to more accurately estimate the costs of the system. Three different crops were studied on each farm. Furthermore, these farms were very different in their scale, management, and marketing strategies, highlighting the diversity of successful organic vegetable farms in the northeastern United States.

Beech Grove Farm (BG), a 6-acre farm in Trout Run, PA, is operated by Anne and Eric Nordell. Their approach to organic farming is notable in at least four ways. First, they use only horse traction. Second, they employ no on-farm labor. They grow about 16 different cash crops (not counting different cultivars) for sales to consumers and to a handful of grocery and retail accounts in nearby Williamsport, PA. Third, they use no irrigation, relying on only rainfall for crop needs. Finally, one-half of the production acres are summer fallowed each year, to use cultivation to reduce weed populations and build soil quality with cover crops. Cash crops are rotated into fields every other year. A typical rotation cycle on the farm during the time of our study started with a winter-killed cover crop of oat (*Avena sativa*) and pea (*Pisum sativum*), followed by an early planted vegetable (e.g., onion or carrot) This cash crop was followed by a cover crop of winter rye (*Secale cereale*) that was mowed several times during the spring of year 2. This rye cover crop was then plowed in and followed by several weeks of summer fallow. In the fall, a winter rye and hairy vetch (*Vicia villosa*) mixed cover crop was planted. In year 3, this cover crop was plowed under for a later planted crop [e.g. broccoli (*Brassica oleracea* var. *italica*)]. After this late crop, rye was planted. In year 4, the rye was mowed several times, followed by a summer fallow for weed control and the field was then planted to an oat/pea cover crop. The Nordells have carefully honed their farming techniques over the years; their tillage and fallow practices conserve soil moisture and minimize weed seed banks.

The second farm, Spiral Path Farm (SP) in Loysville, PA, is operated by Mike and Terra Brownback. They grow at least 23 different cash crops (not counting different cultivars) on 60 acres. They are considered a large organic vegetable farm, by northeastern U.S. standards, but little of the land is out of production in any one year. They use retail and wholesale marketing channels, including a Community Supported Agriculture (CSA) program, an organic growers' cooperative, and farmers' markets. They have numerous tractors for various operations, use plasticulture and drip irrigation for several crops, and operate greenhouses to produce transplants and tomatoes. At the time of our study, they employed 14 seasonal Hispanic workers for the field operations plus another 10 employees for packing. They applied mushroom compost before every crop that was planted. This compost was sourced from off the farm. A typical 5-year rotation at this farm was: 1) tomato, 2) lettuce then spinach (*Spinacia oleracea*), 3) winter squash, 4) lettuce then pepper (*Capiscum annuum*), and 5) cabbage (*Brassica oleracea* var. *capitata*).

Materials and methods

The budget data were collected over the course of two distinct growing seasons, 2002 and 2003, on each farm. Using the basic framework of Kay and Edwards (1999), costs were divided into direct operating (variable) costs and indirect (fixed) costs. Variable costs were organized into marketing, inputs and labor needed to perform each task associated with growing, harvesting, and packing the produce. For each crop, this included costs of inputs and labor for tillage, fertility, seeding, transplanting, weed and pest control, irrigation, harvest, and packing. Marketing costs included, for example, mileage to markets, labor for loading/unloading, driving and selling at markets, and other costs, such as farmers market stall fees, signs, tables, etc. Fixed costs covered land, buildings, machinery, equipment (amortized by expected years of service), utilities, interest, taxes, office, and all other associated expenses.

Farmers were asked to record expenses and labor hours for different tasks on a standardized form. In the late fall of 2002 and 2003, researchers visited each farm, reviewed the forms, and estimated any missing data through recall. Data were used to calculate costs for actual area grown and projected costs per acre. For hired labor costs, actual wages were included; for farmer or family labor, an opportunity cost (Kay and Edwards, 1999) was used ($10 per hour). Various summaries, including input, labor, marketing and fixed costs, and various break-even analyses were shared with each farm for their review and minor corrections were made as needed. All budgets are presented on a per acre basis, scaled up (in the case of BG) or down (for SP) for consistency. Budgets at BG were compiled for the following three crops: 'Nelson' carrot, 'Stuttgart' yellow onion, and hardneck garlic (propagated vegetatively over many years, exact cultivar unknown). At SP, budgets were calculated for 'Mountain Fresh' tomato, a mix of 'Two Star' and 'New Red Fire' leaf lettuce, and 'Nicklow's Delight' butternut winter squash. Finally, these budgets were limited to production costs; due to confidentiality agreements between researchers and farmers within the project, revenue and price data were not reported for either year. Actual yield data from the farms were used for budget analysis.

It is important to note that these budgets reflect the selected production years (2002 and 2003) on these farms, rather than a "typical" year or farm. Their primary value lies in describing the production costs and practices of two very different farms and highlighting the range of possibilities that constitute a successful vegetable operation in the northeastern United States. The seasons varied, as 2002 was a very hot, dry year, while 2003 was wet and relatively cool.

Results and discussion

The term "exemplary organic farm" is far from a one-size fits all model. Farmers have a wide array of strategies available to successfully meet their individual goals. These two organic farms demonstrated a wide range of scale, management practice, and philosophies for input use, labor management, and marketing channels.

The project focused on three crops at BG: carrot, garlic, and onion. These budgets had two unique features. First, given the Nordells' method of alternating production and fallow years, the budgets began with fallow management activities of the previous year. Second, the purchases and labor associated with caring for the draft horses were included in an overall budget for compost, horse manure being its principal component. The Nordells produced about 70 yard^3 per year, and applied about 7.5 yard^3/acre onto their fields. We acknowledge that there are many potential ways of modeling this integrated system of animal traction and manure management. After consultation with the farmers, we chose to collapse these costs into a single compost-horse cost. In the end, this cost was certainly higher than commercially purchased compost. However, this value did capture the associated costs of the whole horse traction-compost production complex, including horse purchase and maintenance costs (feed, veterinary, and bedding) and compost inputs such as rock phosphate and peatmoss (Table 1).

The Nordells' unique fallow system is integral to the overall farm management plan, providing numerous services like nutrient, weed, and water management. An article by Holzhueter (2005) provides an in-depth description of their practices and philosophy. Planting fields to cover crops for a whole year incurred direct and opportunity costs. The direct costs of the fallow year were summarized for the rye-hairy vetch cover cropping regime (Table 2), detailing associated input and labor costs for fallow management. Ideally, the opportunity cost of fallow would be the difference between foregone revenue from potential cash crops sales and the value of the various services provided. We included only the forgone revenue because estimating the value of the ecological services provided by the fallow was beyond the available data and scope of this article.

Each focal crop had specialized input and labor production costs, which were summarized by year (Table 3). Fixed and marketing costs were allocated equally across the farm's 4 acres in production each year (Table 3). Fixed costs (including land, equipment, taxes, and utilities) were relatively low without the expense of tractors and other machinery. Marketing costs included supplies (tables and canopies), bags, farmers market stall fees, mileage to and from market ($0.365/mile), and paid sales labor.

For variable costs, fertility inputs ranged from $472 to $599 per acre (Table 3). The cost of field supplies comprised the highest input category. Seed costs, especially garlic, were quite high because the Nordells saved their own seed. The cost represented the market opportunity cost. Although it was possible to purchase seed garlic for less, commercial sources would not be as well adapted to the farm's soil, climate, and practices. Pest management costs were negligible for all crops, reflecting the Nordells' excellent management. For all three crops, harvest and packing hours exceeded all other tasks associated with production. Hand planting of garlic was another time-consuming task. The services provided by the horse traction and fallow management systems explain the fairly low costs of field preparation and maintenance (e.g., tillage and weeding).

Table 1. Average annual costs of producing compost [70 yard^3 (53.5 m^3) per year] using horse manure at Beech Grove Farm, Trout Run, PA, in 2002 and 2003. Costs included maintenance of horses, feed, and veterinary fees. These costs were grouped to calculate the value of compost used in vegetable production.

Items	Cost ($/acre)[z]	Amortization (yr)	Avg annual cost ($/acre)
Fertilizer	270	1	270
Straw	486	1	486
Oats	100	1	100
Minerals	75	1	75
Rock phosphate	95	1	195
Horses (3)	1,250	20	62
Summer chores	532	1	532
Winter chores	760	1	760
Year-round chores	1,040	1	1,040
Veterinary bills	25	1	25
Peat moss	120	1	120
Total annual cost			3,666
Compost cost ($/yard^3) [y]			52

[z]$1.00/acre = $2.4711/ha.
[y]$1/yard^3 = $1.3080/m^3.

Many of the production practices at SP were common to all crops, such as the use of inputs like plastic mulch, drip irrigation, and compost, and the tasks associated with preparing beds for planting, postharvest clean up, etc. Again, costs were divided into production inputs and labor, plus fixed and marketing costs (Table 4). Plastic ($126/acre), compost ($227/acre), and drip irrigation supplies ($284/acre) totaled more than $600/acre. Seed comprised a large portion on input costs. Harvest and packing supplies included a large quantity of boxes used to market produce to various accounts.

As with BG Farm, the most costly task at SP was harvesting and packing (Table 4). The labor costs for all tasks varied widely across crops. Tomato was especially labor intensive, requiring great cost to trellis and harvest/pack. Winter squash required the least labor (about $800/acre), half of which was for harvesting.

The large inventory of equipment at SP was reflected in the relatively high fixed cost budget (Table 4). These costs were also allocated on a per acre basis. Additionally, a flat cost of $800 for marketing was added, a sum Mike Brownback assigned to each acre of production, which reflected an average per acre cost of all marketing activities across the farm.

An important analysis conducted for both farms described minimum crop prices or break-even prices to meet all incurred costs, using actual farm yields (Table 5). BG Farm had relatively similar break-even prices for onion and carrot between years. The higher cost or break-even price for garlic was largely due to the high opportunity cost of seed garlic discussed earlier. SP had much higher per acre costs for tomato than for lettuce or squash. However, due to

Table 2. Costs of production and labor hours for fallow management using a rye-hairy vetch cover crop regime at Beech Grove Farm, Trout Run, PA, in 2002 and 2003. Input rate or labor hours and unit price were used to calculate the costs per acre of various inputs.

Item	Input rate or labor hours	Unit price ($)	Cost ($/acre)[z]
Inputs	Input rate		
Lime	400 lb/acre[y]	0.04/lb[x]	16.00
Gypsum	200 lb/acre	0.10/lb	20.00
Compost	7.5 $yard^3$/acre[w]	52.37/$yard^3$[v]	392.78
Rye seed	80 lb/acre	0.07/lb	5.60
Hairy vetch seed	40 lb/acre	0.90/lb	36.00
Subtotal			470.38
Labor	Hours		
Mow fallow (3×, 1 h each)	3	10.00/h	30.00
Plow	6	10.00/h	60.00
Harrow (2×, 1 h each)	2	10.00/h	20.00
Roll	0.5	10.00/h	5.00
Spread lime and gypsum	1	10.00/h	10.00
Harrow and roll	1	10.00/h	10.00
Clean rye seed	0.32	10.00/h	3.20
Seed rye and vetch	2	10.00/h	20.00
Subtotal			158.20
Total costs			628.58

[z]$1.00/acre = $2.4711/ha.
[y] lb/acre = 1.1209 $kg\cdot ha^{-1}$.
[x]$1.00/lb = $2.2046 $/kg.
[w]1 $yard^3$/acre = 1.8893 $m^3\cdot ha^{-1}$.
[v]$1.00/$yard^3$ = $1.3080/$m^3$.

Table 3. Summary of production costs for each crop, lettuce, tomato, and winter squash for 2002 and 2003 at Beech Grove Farm, Trout Run, PA. Total costs were categorized and detailed by fixed, marketing, and variable costs.

	Crop and year					
	Carrot 2002	Carrot 2003	Garlic 2002	Garlic 2003	Onion 2002	Onion 2003
Category	Production cost ($/acre)[z]					
Fixed costs	1,269	1,129	1,269	1,129	1,269	1,129
Marketing costs	1,633	1,633	1,633	1,633	1,633	1,633
Variable costs						
Labor costs	4,060	3,866	6,874	8,393	3,593	4,546
Input costs	739	839	3,550	3,638	864	805
Total variable costs	6,432	6,338	12,057	13,664	6,090	6,984
Total costs	7,701	7,467	13,326	14,793	7,359	8,113
Input costs detailed						
Soil inputs	472	599	480	578	503	503
Field supplies	194	130	3,070	3,060	361	302
Pest control	0	20	0	0	0	0
Harvest/packing supplies	73	90	0	0	0	0
Labor costs, detailed (reflects $10/h wage for farmers)						
Field preparation and clean-up	353	552	873	268	595	341
Plant establishment and maintenance	407	113	1,800	2,800	266	605
Harvest and packing	3,300	3,200	4,200	5,326	2,732	3,600

[z]$1.00/acre = $2.4711/ha.

tomato high yields, this crop had a similar break-even price to squash ($0.27/lb for tomato and $0.21/lb for squash) in 2002, and a much lower per pound break-even price than lettuce ($1.13/lb). In 2003, low squash yields resulted in a break-even price of more than $1.00/lb.

We also analyzed the minimum price that would provide the farms an annual income of $40,000 over out-of-pocket costs if only these three crops were grown (Table 6). We used $40,000, as it is roughly equal to the median household income for Pennsylvania in 2003. Cash, or out-of-pocket, costs were calculated as total costs minus labor costs at BG because they hired no labor, and was equal to total costs at SP. Based upon total annual farmed acreage (3 acres for BG, 60 acres for SP), the total profit required would be $13,333/acre for BG and $667/acre for SP, to achieve a $40,000 annual income. We added cash costs plus profit needed to achieve the target revenue. Target revenue divided by yield was the price per unit needed to reach the $40,000 income goal. When compared with the break-even prices calculated for these crops (Table 5), BG would need to increase prices, on average, by 87% and SP would need to increase prices by about 9%, to achieve this $40,000 income threshold with the crops profiled here.

The final analysis of these data compared observations across 6 crop-years of the ratios of fixed-to-total costs and labor-to-variable costs (Table 7). We limited the comparisons to the crops studied, which differed between farms: broad comparisons of the two farms' overall cost structures were not possible given the differences in crop portfolios. First, BG had a much higher ratio of labor costs than does SP. SP had higher fixed costs overall, reflecting some capital for labor substitution. Finally, given that SP used mostly hired labor, incurring high out-of-pocket costs, whereas BG had only owner-operator production labor and no out-of-pocket costs, SP likely had a greater sense of urgency for minimizing costs and raising productivity through capital and management.

While different crops were grown on each farm, each farm budget presented here included one high-cost crop plus two lower-cost crops at each farm (Tables 3 and 4). Looking at simple averages of total costs over the six crops (three crops per farm over 2 years), SP had lower average costs, at $7402/acre, compared with BG, at $9793/acre. After removing labor costs (which are out-of-pocket costs for SP, but opportunity costs for BG), the simple averages were very similar, with BG slightly lower at $4571/acre versus SP at $4917/acre. The simple averages of fixed plus marketing costs were also very similar between BG ($2832/acre) and SP ($2748/acre). This was only a 3% difference between the farms despite the different crops and acreages.

The management and decisions regarding labor was perhaps the key difference between these farms. BG placed great priority upon not having to hire and manage labor on the farm and they developed a farming system (e.g., fallow management and weed control) to permit this. In contrast, SP viewed its large labor crew as a vital part of the operation and planned activities throughout the season to retain skilled workers. Mike Brownback said it is important to "triage" their priorities, "crawling through windows of opportunity." Acting within these windows was always critical, but even more so during a wet year. For example, he tried to get early season planting done without tractor drivers (even though it may be more costly in the short run), so that tractor labor was available to prepare the ground for later plantings. Furthermore, Mike felt an implicit trust between him and his crew, that there was a reason they were asked to perform certain tasks. The crew understood that putting plants in the ground today ensured harvest work in the near future.

When comparing the NEON budgets with other published enterprise budgets for organic production in the northeastern United States from Rutgers University (1996), the costs incurred by these farms were higher, even after accounting for inflation. Total costs in these published budgets for lettuce, onion, and fresh tomato were $3225, $3647, and $4568, respectively, making the NEON budgets between 58% and 126% higher. On average, the BG and SP costs were roughly twice as high as the Rutgers University (1996) budgets, perhaps because the NEON data were based on the costs of actual farms, and not average costs used by field researchers.

Comparisons between the NEON and Rutgers University (1996) budgets were difficult, however, given the lack of detail and different standards of inclusion and categorization. Some costs were similar to the Rutgers University (1996) budgets, such as labor costs for lettuce production and

Table 4. Summary of production costs for each crop, lettuce, tomato, and winter squash for 2002 and 2003 at Spiral Path Farm, Loysville, PA. Total costs were categorized and detailed by fixed, marketing and variable costs.

	Crop and year					
	Lettuce 2002	Lettuce 2003	Tomato 2002	Tomato 2003	Winter squash 2002	Winter squash 2003
Category	Production cost ($/acre)[z]					
Fixed costs	1,745[z]	2,151	1,745	2,151	1,745	2,151
Marketing costs	800	800	800	800	800	800
Variable costs						
Labor	1,266	1,303	3,257	5,578	808	803
Inputs	1,491	1,715	4,215	4,300	1,717	1,468
Total variable costs	3,557	3,818	8,272	10,678	3,325	3,071
Total costs	5,302	5,969	10,017	12,829	5,070	5,222
Input costs, detailed						
Soil inputs and irrigation	637	532	464	532	498	485
Field supplies	103	235	717	766	219	228
Pest control sprays	0	0	28	56	159	50
Harvest/packing supplies	751	948	3,006	2,946	841	705
Labor costs, detailed (reflects a $7.50 per hour wage for most employees)						
Field preparation and clean-up	223	130	225	308	172	130
Plant establishment and maintenance	209	240	511	710	164	137
Harvest and packing	835	934	2,520	4,560	473	536

[z]$1.00/acre = $2.4711/ha.

Table 5. Break-even prices for vegetables grown at Beech Grove Farm (Trout Run, PA) and Spiral Path Farm (Loysville, PA) using 2002 and 2003 costs and yields.

Farm	Crop	2002 Yield (lb/acre)[z]	2002 Total cost ($/acre)[y]	2002 Break-even price ($/lb)[x]	2003 Yield (lb/acre)	2003 Total cost ($/acre)	2003 Break-even price ($/lb)
Beech Grove	Carrot	18,400	7,701	0.42	22,000	7,467	0.34
Beech Grove	Onion	11,400	7,359	0.65	19,000	8,113	0.43
Beech Grove	Garlic	3,947[w]	13,326	3.38	7,080	14,793	2.09
Spiral Path	Lettuce	4,680[v]	5,302	1.13	4,500	5,969	1.33
Spiral Path	Winter squash	24,498	5,070	0.21	5,146	5,222	1.01
Spiral Path	Tomato	37,400	10,017	0.27	46,200	12,829	0.28

[z]1 lb/acre = 1.1209 $kg \cdot ha^{-1}$.
[y]$1.00/acre = $2.4711/ha.
[x]$1.00/lb = $2.2046/kg.
[w]Assumes 6 bulbs/lb (13.2 bulbs/kg) of garlic.
[v]Assumes 0.5 lb (0.23 kg) per head of leaf lettuce.

Table 6. Prices needed to achieve a $40,000 annual income over costs at Beech Grove Farm (Trout Run, PA) and Spiral Path Farm (Loysville, PA), using 2002 and 2003 costs and yields.

Crop	2002 Cash costs ($/acre)[z]	2002 Target revenue ($)	2002 Price for target revenue ($/lb)[y]	2003 Cash costs ($/acre)	*2003 Target revenue ($)	2003 Price for target revenue ($/lb)
			Beech Grove Farm			
Carrot	3,641[x]	16,974[w]	0.92[v]	3,581	16,914	0.77
Onion	3,766	17,099	1.50	4,520	17,853	0.94
Garlic	6,452	19,785	5.01	6,400	19,733	2.79
			Spiral Path Farm			
Lettuce	5,302	5,969	1.28	5,969	6,636	1.47
Winter squash	5,070	5,737	0.23	5,222	5,889	1.14
Tomato	10,017	10,684	0.29	12,829	13,496	0.29

[z]$1.00/acre = $2.4711/ha.
[y]$1.00/lb = $2.2046/kg.
[x]Cash costs equal total costs minus labor costs at Beech Grove Farm because no expenditures were made for labor at this farm. Cash costs at Spiral Path Farm include labor expenses.
[w]Target Revenue equal cash costs plus revenue per acre needed to reach $40,000 annual income ($13,333/acre for Beech Grove Farm, $667/acre for Spiral Path Farm).
[v]Actual yields from Table 5 were used to calculate price.

Table 7. Selected ratios of total, fixed, variable, and labor costs of six crop-years at Beech Grove Farm (Trout Run, PA) and Spiral Path Farm (Loysville, PA).

Farm	Cost ratios	Mean of all six crop-years	Minimum observation from six crop-years	Maximum observation from six crop-years
Beech Grove	Fixed:total (ratio)	0.25	0.14	0.34
	Labor:variable (ratio)	0.61	0.57	0.63
Spiral Path	Fixed:total (ratio)	0.30	0.24	0.52
	Labor:variable (ratio)	0.25	0.17	0.41

SP's purchased compost. However, labor costs on the NEON farms were generally much higher. The Rutgers University (1996) budgets only included land and machinery/equipment, not taxes, utilities, office, coolers, greenhouses, etc., and have no marketing costs beyond materials like crates and boxes (listed as inputs in our study). While comparisons on similar items (seeds and compost) may be valuable, it is important to look carefully at what is being measured and how, and to consider how costs fit into overall labor, cash flow, weed, pest, fertility, and marketing management strategies.

Both farms spent relatively little on pest control sprays (less than 1% of total input costs), relying on soil fertility and other management practices to minimize infestations and grow healthy plants. At SP, tomato was sprayed to manage aphids (Aphidoidea) and plant diseases, and winter squash was sprayed to manage cucumber beetle (*Acalymma vittatum*) early in the spring. The Rutgers University (1996) budgets have much higher pest control costs (e.g., $550/acre for tomato) implying greater emphasis on input substitution rather than an agro-ecological approach to farming. SP spent about $56/acre on sprays. BG spent nothing on sprays for 5 of the 6 crop years described (Table 3).

Enterprise budgets have long been a staple output of agricultural economics departments. Understanding the costs of production can guide many vital decisions that farmers make, from land, labor, and machinery resource allocation to pricing. Traditionally, enterprise budgets use "typical" practices and costs, as defined by university experts, rather than working with farmers to measure actual costs. The latter approach is exceedingly more difficult for researchers. However, measuring real on-farm costs captures details and subtleties not available from traditional budgets. This is particularly true of diversified organic farms, given the relative paucity of organic budgets, the complexity of organic systems, and the smaller scale upon which each crop is grown. Allocating labor to various tasks on a farm growing up to 100 different crops and employing 25 people is challenging. Yet budgets are vital tools of farm management, guiding product mix and pricing decisions, as well as documenting the profitability of crops for insurance and credit access.

More research is needed to analyze more organic farm enterprise budgets. This would allow for greater comparisons among different systems and definition of common ranges of costs. One particular area of need is for more budgets for diversified small-acreage farms. This description fits many organic vegetable farmers, particularly those using direct markets like farmers' markets and CSAs. While a diverse product mix may be needed for the overall marketing and risk-management strategy, ranking the profitability of crops could guide farms to specialize in certain crops to supply other market channels.

Most enterprise budgets limit themselves to a single planting, which does not capture the complexities of multiyear rotations and fallows that organic farmers use. The BG budgets attempted to incorporate fallow year expenses to a crop, but do not represent the multiyear rotations of cash and cover crops needed to provide fertility, pest, and weed management on organic farms. Crop rotation strategy is a vital part of farm management, and economic data would certainly guide wise choices. One particularly promising direction would be to measure the production costs over the full multiyear rotation on these two organic farms. However, data were only gathered in 2 years, precluding this type of analysis.

Finally, the development and testing of a wide array of farmer-friendly budgeting tools, for single crops and multiyear rotations is critically needed. Several participating NEON farmers expressed that the effort to collect these costs, while substantial, taught them valuable lessons about their production and pricing practices, which in turn, led to profitable changes. Farmers vary greatly in their current record-keeping practices, attention to detail, and patience for data keeping. Development, testing, and comparison of an array of tools with varying detail (e.g., daily activity records, end of year recall, estimates, and shortcuts) would help farmers find tools suited to their goals, abilities, and preferences. This work would benefit from multidisciplinary collaborations, drawing expertise from production and social scientists, so as to capture farmer decision making in as rich and complete a manner as possible.

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