Production & Marketing Reports

Comparative Cost Analyses of Conventional, Integrated Crop Management, and Organic Methods

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The authors wish to acknowledge the Rutgers Experiment Station SARE funding for their participation in bringing together the resources to construct the comprehensive set of production budget information for this project. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulation, this paper therefore must be here by marked *advertisement* solely to indicate this fact.

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ADDITIONAL INDEX WORDS. economics, vegetables, budgeting, tomatoes, corn, pumpkins

SUMMARY. Production costs have been analyzed in several studies using such normative approaches as budgeting and mathematical programming, and positive approaches as estimation of production, cost, or profit functions. This study used budgeting methods to analyze the costs and benefits of adopting integrated crop management (ICM) or organic methods versus conventional agriculture for tomatoes (*Lycopersicon esculentum* Mill.), sweet corn (*Zea mays* L. var. *saccharada*), and pumpkins (*Cucurbita pepo* L.). Data were collected using field studies conducted at the Rutgers University Snyder Research and Extension Farm, Pittstown, N.J. Time and motion study techniques were used to record machinery use and labor quantities. Records of production inputs and yields were also collected. These records were then converted to a 1.0-acre (0.4-ha) basis to constructed crop budgets. Results show that ICM systems are more profitable than conventional and organic systems. Organic systems had the lowest net returns. However, because of the organic price premium, the net returns were fairly close to those for conventional and ICM systems.

The 1990s witnessed a considerable expansion in the use of organic products. In many of the large-scale supermarkets in metropolitan areas, fresh and/or processed organic products became common. The total market value of organic products was estimated to be $1 billion in 1990, which grew to $3.5 billion in 1996 (Raterman, 1997). In another study (Glaser and Thompson, 1999), the organic food sales in natural-product stores was valued at $1.96 billion in 1997 with organic produce and frozen food accounting for 16% and 10% of the total, respectively. Organic production has been practiced in the United States since the late 1940s. From that time, the industry has grown from experimental garden plots to commercial farms, which sell under a special "organic" label. Growth in the organic produce market is driven by a growing demand for healthy food and a clean environment (Thompson, 1998).

Two production systems that farmers use to attempt to be more sustainable than conventional agriculture are integrated crop management and organic agriculture. A conventional farming system relies primarily on conventional tillage, commercial fertilizers, and agricultural chemicals. ICM includes management practices such as minimum tillage, nutrient balancing, and integrated pest management (IPM). Organic agriculture includes management practices such as no-till and cover cropping to minimize erosion, reduction of pests through rotation, the use of manure and natural fertilizers, and biological methods of pest control.

With alternative farming programs such as ICM and organic farming, a farmer can reconcile between short-term risks and long-term benefits. However, before farmers adopt an alternative system, they must be convinced that the economic benefits from the alternative farming program clearly surpass the costs incurred. Methods for measuring the aggregate economic impacts of alternative farming programs at the farm level can involve several techniques, but at the heart of these techniques is a basic benefit–cost analysis. This paper evaluates the economic costs and benefits of ICM, conventional, and organic methods of farming for three vegetable crops in New Jersey using the partial budgeting technique as a subcomponent of cost–benefit analyses (Kay and Edwards, 1999).

The costs of adopting an ICM program may include reduced revenues and added expenses, both of which are usually borne solely by producers. However, scouting costs may be borne by the state government if such a program is available. Farmers' budgets and records of sale should be able to provide the necessary cost and revenue data. Farmers may reap the benefits of added revenues and reduced expenses. In addition, they may benefit from the avoidance of chemical resistance, a more favorable image for their industry, and a reduction in environmental problems (Rojotte, 1993). Lower exposure to pesticides may increase the health of producers and their workers, thus improving productivity, yet another benefit. Some of these benefits accrue to society at a whole, and others

Table 1. Chemicals and rates (lb a.i./acre) used in three production systems for three crops.

	Cropping system		
Crop	**O**[z]	**ICM**[y]	**C**[x]
Tomato			
Herbicide	Potash soap 3.5 lb[w]	Paraquat 0.24 lb Metribuzin 0.13 lb	Paraquat 0.47 lb Napropamide 1.0 lb Metribuzin 0.25 lb
Fungicide	Fixed copper 4.7 lb Elemental sulfur 2.0 lb	Chlorothalonil 11.4 lb	Chlorothalonil 17.1 lb
Insecticide	Pyrethrum 1.0 lb	Esfenvalerate 0.18 lb Azinphos-methyl 0.38 lb	Esfenvalerate 0.22 lb Azinphos-methyl 0.76 lb Piperonyl butoxide 0.75 lb
Sweet corn			
Herbicide	Potash soap 3.5 lb	Paraquat 0.47 lb Alachlor 0.25 lb Atrazine 0.17 lb	Paraquat 0.47 lb Alachlor 0.75 lb Atrazine 0.45 lb
Fungicide	None	None	None
Insecticide	B.t. var *kurstaki* 5.0 lb Pyrethrum 0.5 lb	Methomyl 2.4 lb B.t. var *kurstaki* 2.0 lb	Methomyl 4.2 lb
Pumpkin			
Herbicide	Potash soap 3.5 lb	Paraquat 0.47 lb Bensulide 0.84 lb	Paraquat 0.47 lb Bensulide 6 lb
Fungicide	Fixed copper 3.7 lb	Chlorothalonil 13.7 lb Fixed copper 3.15 lb	Chlorothalonil 2.28 lb Fixed copper 1.6 lb Benomyl 0.75 lb Triadimefon 0.12 lb
Insecticide	Pyrethrum 0.375 lb	Esfenvalerate 0.12 lb	Esfenvalerate 0.12 lb

[z]C = conventional.
[y]ICM = integrated crop management.
[x]O = organic.
[w]1 lb / acre = 1.12 $kg \cdot ha^{-1}$.

do not lend themselves to easy measurement of dollar values.

Demand for organic and ICM grown food has been increasing in the last decade (Khan, 1998). In a recent survey of 1200 households in New Jersey, respondents ranked the absence of pesticides third in a list of qualities they look for in produce with price ranked as fourth (Govindasamy et al., 1997). Consumers are willing to pay premium prices for organic and ICM products (Govindasamy et al., 1998). Glaser and Thompson (1999) report a considerable price differential between conventional and organic frozen vegetables at the supermarkets. Organic frozen vegetables were appreciably more expensive than their conventional counterparts. For several years, the price premium ranged between 100% to 250% of conventional vegetables. In recent years, however, the price premium has declined slightly (Glaser and Thompson, 1999). This price differential, thus, shows that consumers are concerned about human health and the environmental effects of excessive chemical use and are willing to pay a premium price for food that they perceive to have no pesticide residues and to thus be safer than conventional produce (Jolly, 1991; Misra et al., 1991). Studies indicate that environmental protection may be as important to consumers as food safety as a motivation for purchasing organic products (Raterman, 1997; Bruhn et al., 1992; Cuperus et al., 1996; Goldman and Clancy, 1991; Morgan et al., 1990; and Weaver et al., 1992).

The primary method used for farm level cost–benefit analysis is to budget the effects of changes in input and output quantities and prices as a result of adopting more sustainable farming practices. Budgets can be constructed as enterprise budgets, partial budgets, or whole-farm budgets (Kay and Edwards, 1999). Enterprise budgets list all income and expenses (variable and fixed) associated with a particular enterprise. Partial budgets may include several enterprises but only include benefit and cost items expected to change significantly as a result of changes in production practices. A whole farm budget includes all enterprises on a farm. The costs and benefits that may incur among the enterprises due to changes in any activity in one of the enterprises can be considered as a result of introducing more sustainable farming practices. The most common types of budgets used for assessing impacts of adopting sustainable farming practices are enterprise and partial budgets (Kay and Edwards, 1999).

It is often difficult to gather all the information necessary to undertake a complete cost–benefit analysis (Rimal et al., 1998). A partial budget analysis is a tool often utilized when information for the economic analyses is limited. As the name implies, a partial budget is limited to a subset or particular category of expenses and activities for a given enterprise. This approach is appropriate when the area of concern is focused on a specific type of production activity or input that can be evaluated separately from other categories of activities or inputs. Such an analysis is often used to compare the costs and / or benefits of alternative inputs or production techniques. It has the advantages of simplicity, economy, and reduced information requirements. A partial budget provides a formal and consistent method of analyzing many of the common, everyday problems and opportunities that confront the farm and ranch manager (Kay and Edwards, 1999). Partial budgets are intended to analyze the profitability of proposed changes in the operation of the business where the change affects only part of the farm plan or organization. The current situation is com-

Table 2. Average price per unit of selected vegetables under three cropping systems.

Commodity	Cropping system C[z]	ICM[y]	O[x]
Fresh tomatoes ($ / box)[w]	11.40	11.40	14.82
Pumpkins ($ / cwt)[v]	10.00	10.00	13.00
Sweet corn ($ / cwt)	16.60	16.60	21.58

[z]C = conventional.
[y]ICM = integrated crop management.
[x]O = organic.
[w]25 lb = 11.3 kg.
[v]$1.00 / cwt = $0.02 / kg.

Table 3. Average marketable yield per acre for three vegetables under the three cropping systems.

Commodity	Cropping system C[z]	ICM[y]	O[x]
Fresh tomatoes (25-lb boxes)[w]	1,475	1,846	1,200
Pumpkins (cwt)[v]	475	500	400
Sweet corn (cwt)	311	296	265

[z]C = conventional.
[y]ICM = integrated crop management.
[x]O = organic.
[w]25 lb = 11.3 kg.
[v]$1.00 / cwt = $0.02 / kg.

pared to the expected situation after implementing a proposed change.

Materials, methods, experiments

Data were collected for three vegetables—tomatoes, sweet corn, and pumpkins—from 3 years (1991 to 1993) of field studies conducted at the Rutgers University Snyder Research and Extension Farm, Pittstown, N.J. Each of the three crops was grown using ICM, conventional and organic systems on approximately 0.25 acre (0.1 ha) using completely randomized design (CRD). The varieties used were 'Mountain Pride' fresh tomatoes, 'Sweet Sue' sweet corn, and 'Howden' pumpkins. Time and motion study techniques were used to record machinery use and labor quantities. Records of production inputs and yields were also collected. These records were the converted to a 1.0 acre (0.4 ha) basis. As shown in Table 1, there were differences in all aspects of production. For example, tomatoes in the conventional plots were grown on bare ground while plastic mulch was used on the ICM and organic plots. Commercial fertilizers were used on both the conventional and ICM plots. Compost and green manures were used on the organic plots. Scouting to determine insect populations was used on the ICM plots only. Fertilizer was applied based on soil test recommendations. The recommendations included both organic and conventional fertilizers. The systems were modified each year. Production inputs were changed to make the systems better as we learned from our research. For example, we switched from compost to green manure on the organic plot because the cost of transporting the compost was too costly.

The materials were divided into fertilizers, pesticides and others to highlight the differences in the use of chemicals under three farming systems. A management fee of 7% of gross sales for managing inputs other than labor, packaging materials, and land was added to the cost of production based on recommendations of a workshop on estimating agricultural costs (USDA, 1992). A selling charge of 3% of gross sales was added to cover marketing costs. These are the costs charged by the Vineland Cooperative Auction Association, the largest pro-

Table 4. Average number of labor hours per acre for three vegetables under three cropping systems.

Task	Tomatoes C[z]	Tomatoes ICM[y]	Tomatoes O[x]	Pumpkins C	Pumpkins ICM	Pumpkins O	Sweet corn C	Sweet corn ICM	Sweet corn O
					h / acre[w]				
Disk	1.2	1.2	1.2	1.1	1.1	1.1	1	1	1
Compost	---	---	0.7	---	---	1.43	---	---	1.5
Fertilize	1.4	1.39	---	1.3	1.3	---	1	1	---
Lay plastic	---	1.6	1.6	---	---	---	---	---	---
Plant	1.9	1.9	1.9	0.4	0.4	0.4	0.6	0.6	0.6
Top dress	2.8	---	---	3.1	---	---	2.03	---	---
Replace plants	3.2	3.2	3.2	---	---	---	---	---	---
Stake, prune, and tie	---	---	62.9	---	---	---	---	---	---
Plant rye and clover	---	---	21.8	---	---	---	---	---	---
Spray	31.2	25.5	37.3	20.6	15.3	30.3	17	13.5	24.9
Mow and trim	---	---	28.8	---	---	---	---	---	---
Pull stakes and strings	---	---	13.7	---	---	---	---	---	---
Harvest	98.5	153.1	80.7	9.1	13.1	7.2	11	16.8	10.1
Grade	92.3	100.1	49.1	---	---	---	3	5.4	2.1
Remove plastic mulch	---	7.8	7.8	---	---	---	---	---	---
Total hours	232.4	295.8	310.7	35.6	31.2	40.4	37.4	38.3	40.2

[z]C = conventional.
[y]ICM = integrated crop management.
[x]O = organic.
[w]1.0 h / acre = 2.47 $h \cdot ha^{-1}$.

Table 5. Average cost per acre of producing fresh market tomatoes under three cropping systems.

Item	Cropping system ($/acre)[z]		
	C[y]	ICM[x]	O[w]
Cost of materials			
Fertilizers	80.00	53.40	209.20
Pesticides	256.10	159.50	573.60
Seeds	21.90	21.90	21.90
Packaging	1,401.20	1,753.70	1,140.00
Plastic mulch	---	175.10	175.10
Stakes and twine	---	---	107.10
Picking baskets	33.40	33.40	33.40
Subtotal	1,792.60	2,197.00	2,260.30
Cost of labor			
Regular	186.60	237.20	249.80
Seasonal	1,369.20	1,743.30	1,831.80
Subtotal	1,555.80	1,980.50	2,081.60
Other expenses			
Cost of machinery and equipment	540.40	561.80	1,025.50
Cost of land	100.00	100.00	100.00
Management fee	1,177.05	1,473.11	1,244.88
Selling charge	504.45	631.33	533.52
Scouting cost[v]	---	10.90	---
Operational interest expense	193.40	182.50	191.20
Subtotal	2,515.30	2,959.64	3,095.10
Total costs	5,863.70	7,137.14	7,437.00
Gross returns	16,815.00	21,044.40	17,784.00
Net returns	10,951.30	13,907.26	10,347.00

[z]$1.00 / acre = $2.47 / ha.
[y]C = conventional.
[x]ICM = integrated crop management.
[w]O = organic.
[v]Estimated scouting costs are based on conversations with extension workers in New Jersey.

Table 6. Average cost per acre of producing pumpkins under three growing systems.

Item	Cropping system ($/acre)[z]		
	C[y]	ICM[x]	O[w]
Cost of materials			
Fertilizers	109.00	40.00	226.00
Pesticides	619.00	378.00	734.00
Seeds	88.00	88.00	88.00
Picking baskets	33.40	33.40	33.40
Subtotal	849.40	539.40	1,081.40
Cost of labor			
Regular	47.00	105.00	129.00
Seasonal	216.00	218.00	296.00
Subtotal	263.00	323.00	425.00
Other expenses			
Cost of machinery and equipment	201.00	253.00	267.00
Cost of land	100.00	100.00	100.00
Management fee	336.00	295.40	354.48
Selling charge	144.00	126.60	151.92
Scouting cost	---	10.90	---
Operational interest expense	193.40	182.50	191.20
Subtotal	974.40	968.40	1,064.60
Total costs	2,086.80	1,830.80	2,571.00
Gross returns	4,750.00	5,000.00	5,200.00
Net returns	2,663.20	3,169.20	2,629.00

[z]$1.00 / acre = $2.47 / ha.
[y]C = conventional.
[x]ICM = integrated crop management.
[w]O = organic.

duce auction in New Jersey.

Table 2 shows average prices for the three crops under three cropping systems. Prices for 25-lb (11.3-kg) boxes of tomatoes and per hundred weight (45.4 kg) of pumpkins and sweet corn were based primarily on the prices received at the Vineland Corporation Produce Auction Association, Vineland, N.J. Monthly price data from USDA were also used to compute average, maximum and minimum prices used in the sensitivity analyses. It is assumed that prices for organic vegetables command a 20 to 30% premium over the conventional and ICM. Following Brumfield et al. (1995), a 30% premium was added to the prices of organic vegetables. There are other studies supporting the assumed price premiums of 30%. A recent industry article cites a grocery chain owner's estimates of organic produce price premiums, which are estimated to average between 20% to 30%. Dairy and frozen food products are at the high end of the price differential, while price differentials for organic produce, grains and cereals are at the lower end (Richman, 1999).

The average labor hour and machine hour for three years were then computed on a per acre basis. Table 4 shows average number of labor hours for the farm activities. The type of labor was assumed to be 10% regular and 90% seasonal based on interviews with commercial farmers. The number of hours required for all three organic vegetables was higher than that for the ICM and conventional systems. Labor costs were obtained by multiplying the number of labor hours by the wage rate per hour. Wage rates for seasonal and regular labor were estimated at $6.50 per hour and $8.40 per hour respectively (Dhillon and Thatch, 1992). These wages included base wages, social security, workers' compensation, unemployment and disability insurance, and seasonal housing. The total labor costs (Table 5 to 7) are highest for organic systems.

In estimating machinery costs, we used methodology adopted by Dhillon (1979) with minor modifications. First, on the basis of interviews with commercial farmers, we established the size of the model farm as 25 acres (10.1 ha). Subsequently, we determined types and sizes of fixed machinery and equipment. Next, we calculated annual overhead costs of

Table 7. Average cost of producing sweet corn under three growing systems per acre.

Item	Cropping system ($/acre)[z] C[y]	ICM[x]	O[w]
Cost of materials			
Fertilizers	111.08	46.90	386.43
Pesticides	432.88	215.71	533.37
Seeds	53.75	53.75	53.75
Subtotal	597.71	316.36	973.55
Cost of labor			
Regular	88.48	96.60	117.80
Seasonal	224.90	239.85	309.40
Subtotal	313.38	336.45	427.20
Other expenses			
Cost of machinery and equipment	231.15	290.95	307.05
Cost of land	100.00	100.00	100.00
Management fees	361.38	343.95	400.31
Selling charge	154.88	147.41	171.56
Scouting cost	---	10.90	---
Interest expenses	335.77	301.08	344.95
Subtotal	1,183.18	1,194.29	1,323.87
Total costs	2,094.27	1,847.10	2,724.62
Gross returns	5,162.60	4,913.60	5,718.70
Net returns	3,068.33	3,066.50	2,994.08

[z]$1.00 / acre = $2.47 / ha.
[y]C = conventional.
[x]ICM = integrated crop management.
[w]O = organic.

depreciation, interest, housing, and insurance for each piece. We based depreciation on the replacement costs of machinery in 1997 because current replacement costs better reflect the long-run opportunity costs of capital than do the original costs. The annual depreciation cost of each item was calculated by dividing the purchase price by the estimated years or hours of useful life (Richey et al., 1991). No salvage value was considered, on the assumption that the machines will be completely depreciated on the farm. Annual interest cost was estimated at 10% charged on the average investment. Annual equipment storage cost was estimated on the basis of space required for each piece of machinery and equipment, valued at $0.30 / ft^2$ ($3.23 / m^2$). Annual insurance cost was estimated at 6% for farm equipment and 13% for delivery vehicles based on information provided by insurance companies. By dividing total annual overhead cost of each machine by annual hours of its use, we calculated overhead per operating hour. Factors for the lifetime repairs and maintenance costs were obtained from secondary sources to determine operating costs of repair and maintenance, fuel, and lubrication (Richey et al., 1991).

Results

Marketable yields for tomatoes, pumpkins, and sweet corn showed variation during the study period mainly due to dry and wet weather conditions. However, there were no differences due to dry or wet seasons between systems. Average yields were computed as simple averages for three years for three cropping systems. The marketable yield was highest under ICM for fresh tomatoes and pumpkins, while the average sweet corn yield per acre was highest under the conventional system. Yield per acre for all three crops under the organic system was lower by 15% to 19% compared to that under the conventional system (Table 3).

Tables 5 to 7 are the partial budgets for the three crops under three cropping systems. The budgets include average costs of materials for each vegetable under conventional, ICM, and organic farming practices. The cost of production per unit of vegetable was compared for three types of production systems (Table 8). The organic system of production incurred 28% to 34% higher cost per unit compared to conventional system, while ICM incurred 3% to 9% lower cost per unit than the conventional systems. The costs of machinery and equipment for organic tomatoes was almost twice those for conventional and ICM because of the use of machinery to plant cover crops, apply compost, and mow the cover crops. Thus mechanical means were used to control weeds and add nutrients in the organic systems whereas chemicals were used for these tasks in the conventional and ICM systems.

At the farm level the increase in net return per unit was 1% to 8% under ICM systems and 5% to 16% under organic systems compared to conventional systems. It was important to notice that change in net returns for ICM and organic after switching from conventional systems was positive for all three crops. For ICM systems this positive change is attributed to a decrease in costs, and for organic systems it is attributed to an expected price premium.

Sensitivity analysis

Although farm budgets may project positive net profits, unexpected

Table 8. Summary of per unit cost of production and per unit net return.

Item	Cropping system ($/unit) C[z]	ICM[y]	O[x]
Cost of materials			
Average cost per unit			
Fresh tomatoes ($ / box)[w]	3.98	3.87	6.20
Pumpkins ($ / cwt)[v]	4.39	3.66	6.43
Sweet corn ($ / cwt)	6.73	6.24	10.28
Net return / unit			
Fresh Tomatoes ($ / box)	7.42	7.53	8.62
Pumpkins ($ / cwt)	5.61	6.34	6.57
Sweet corn ($ / cwt)	9.87	10.36	10.12

[z]C = conventional.
[y]ICM = integrated crop management.
[x]O = organic.
[w]1 box = 25 lb = 11.3 kg.
[v]$1.00 / cwt = $0.02 / kg.

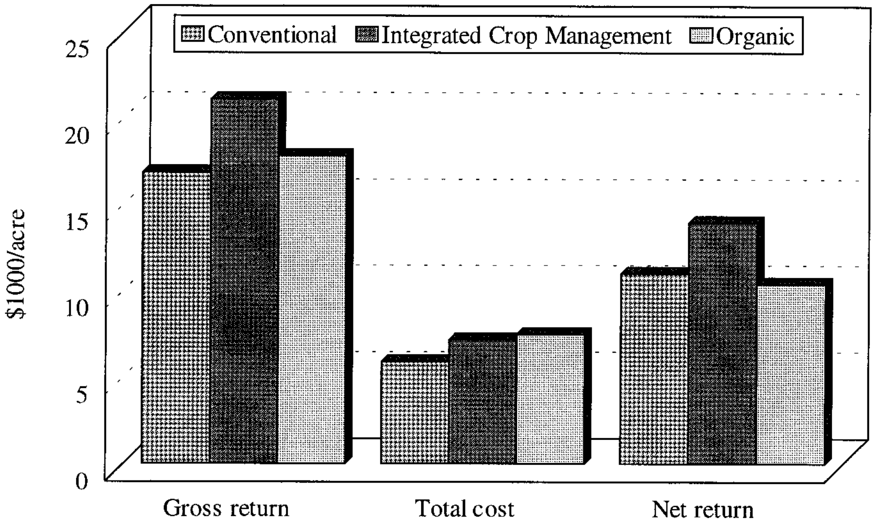

Fig. 1. Gross return, total costs, and net returns for fresh tomatoes grown under three cropping systems; $1000/acre = $2471/ha.

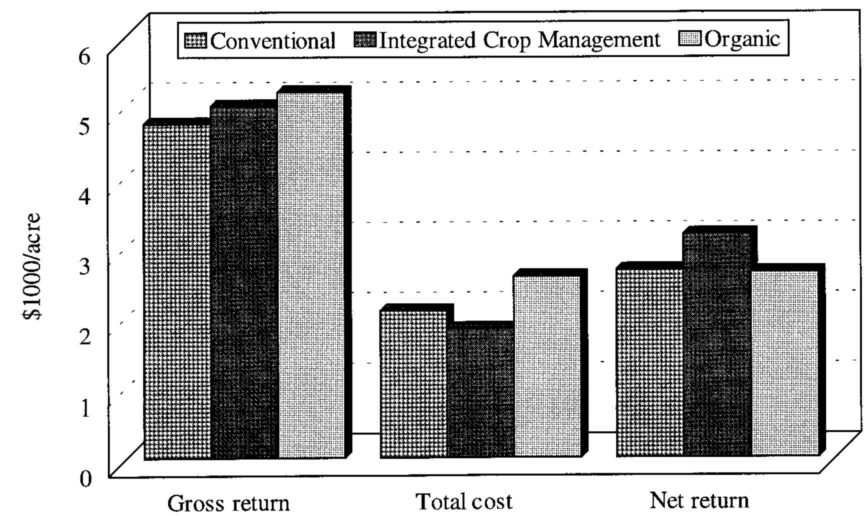

Fig. 2. Gross returns, total costs, and net returns for pumpkins grown under three cropping systems; $1000/acre = $2471/ha.

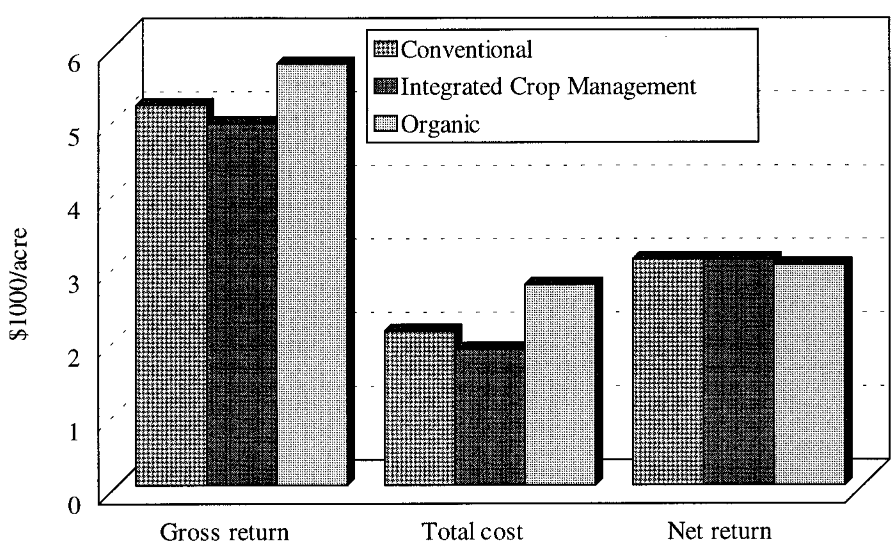

Fig. 3. Gross returns, total costs, and net returns for sweet corn grown under three cropping systems; $1000/acre = $2471/ha.

changes in prices or production costs can quickly turn that into a loss. Analyzing how changes in key budgeting assumptions affect income and cost projections is called sensitivity analysis. A sensitivity analysis was conducted to evaluate the impact of changes in economic parameters such as prices and costs of inputs on the net returns per acre for each of the vegetables. They are reported with the help of bar diagrams (Fig. 1 to 9). Two main scenarios were assumed in the analysis. The first scenario included increases in prices and costs from the average figures used in the budget analysis. The issues are clear under this scenario. First, the price of each of the vegetables was increased by 20% from the average prices without any change in the input costs. Second, the prices remained the same, but total costs increased by 20% from the base costs. Finally, both prices and costs increased by 20%. The second scenario included decreases in prices and costs from the average. Following that, first, the prices of each of the vegetables were decreased by 20% from the average prices without any change in the input costs; second, prices remained the same but total costs decreased by 20% from the base costs; and finally, both prices and costs decreased by 20%.

Figures 1 to 3 graphically represent the baseline scenarios for tomatoes, pumpkins, and sweet corn respectively. The organic system of producing fresh tomatoes had the highest total costs per acre but second highest gross return and lowest net return. The net return for organic tomatoes was only slightly lower than for the conventional system and was thus nearly comparable with the conventional system. While the conventional system had the least total costs, it had the second lowest gross return. Interestingly, for pumpkins and sweet corn, the organic system was competitive with the conventional and ICM systems. For all three crops, ICM systems had the highest net returns. In this study, organic vegetables were competitive due to the assumption of price premiums. If the price premiums were removed and all types of vegetables commanded the same price, then organic vegetables do not perform as well as they do under the price premium regime. Organically grown fresh tomatoes, sweet corn, and pumpkins generated the lowest net returns when

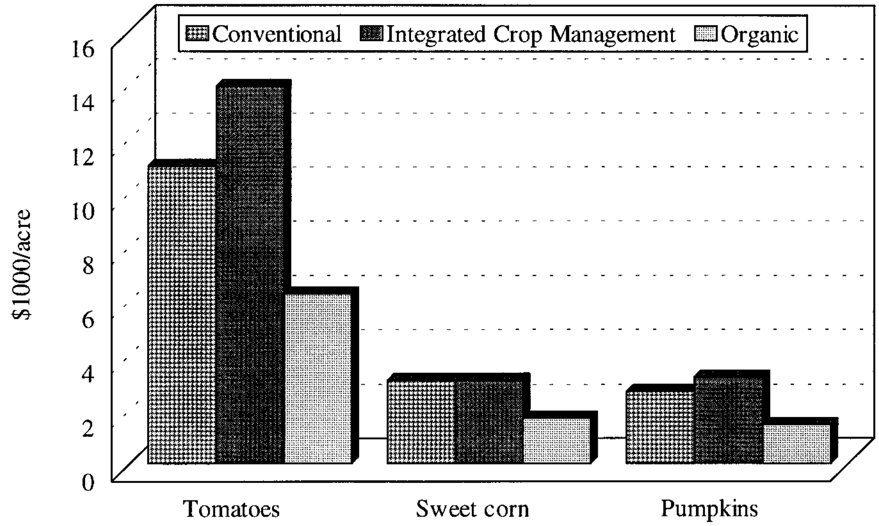

Fig. 4. Net returns per acre for tomatoes, sweet corn, and pumpkins under the single price regime; $1000/acre = $2471/ha.

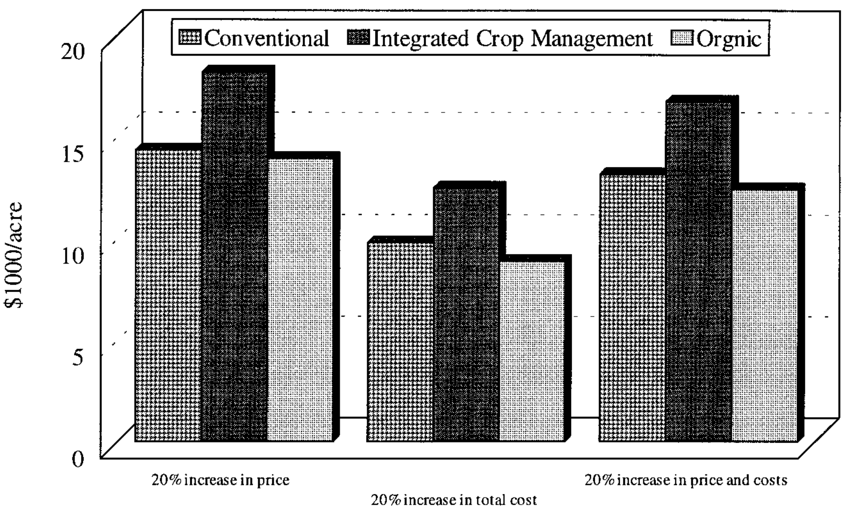

Fig. 5. Net returns for fresh tomatoes after 20% increase in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

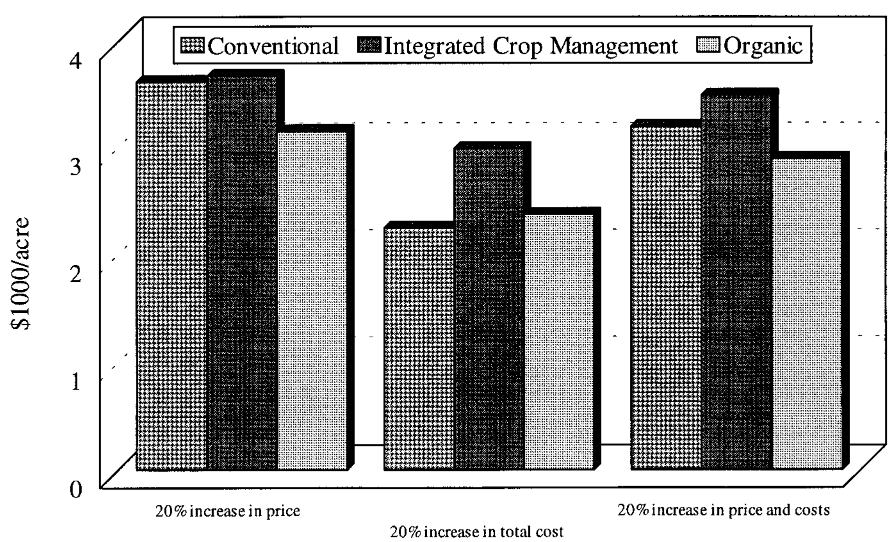

Fig. 6. Net returns for fresh pumpkins after 20% increase in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

all three types of vegetables, including organically grown, were sold at the same prices (Fig. 4). For example, net returns per acre for organic tomatoes were $6,243 compared to nearly $13,000 for conventional tomatoes and $14,000 for tomatoes grown under ICM system.

Under the scenarios with a 20% increase in prices and costs from the baseline costs and prices, the ICM system earned the highest net returns per acre for fresh tomatoes. The organic system of producing fresh tomatoes fared lower than conventional systems in all three situations (Fig. 5). For pumpkins, the organic system fell in to third place when prices were raised by 20%, and prices and costs were both raised by 20% (Fig. 6). When only total costs were raised by 20%, the organic system surpassed the conventional system. For sweet corn, a 20% increase in prices alone, costs alone, and prices and costs together did not result in considerable difference in net returns among three cropping system (Fig. 7).

A decrease in prices alone, costs alone, and prices and costs together (Figs. 8–10) by 20% decreased net returns for all three vegetables from base line levels. However, ICM still commanded the highest net returns among the three systems for tomatoes and pumpkins. In the case of sweet corn, however, a substantial difference did not exist among the three cropping systems. For all three vegetables, a 20% increase in prices had much more favorable effect on the net returns than 20% decrease in costs.

Conclusions

The results of this study show that organic systems for tomatoes, corn, and pumpkins required more labor and had lower marketable yields than conventional or ICM systems. Results also showed that organic systems had the lowest net returns. However, because of the organic price premium, the net returns were fairly close to those for conventional and ICM systems. Were it not for price premiums for organic produce, only ICM and conventional would compete from a profitability standpoint. As more producers start to grow organic vegetables, this price premium may be reduced, and organic producers will have to find a way to decrease costs and / or increase yields. In our own research, we

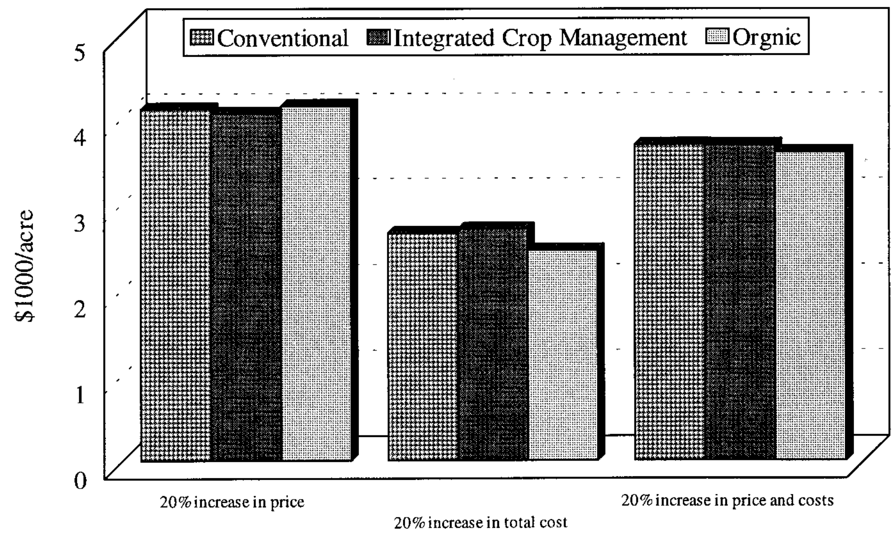

Fig. 7. Net returns for fresh sweet corn after 20% increase in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

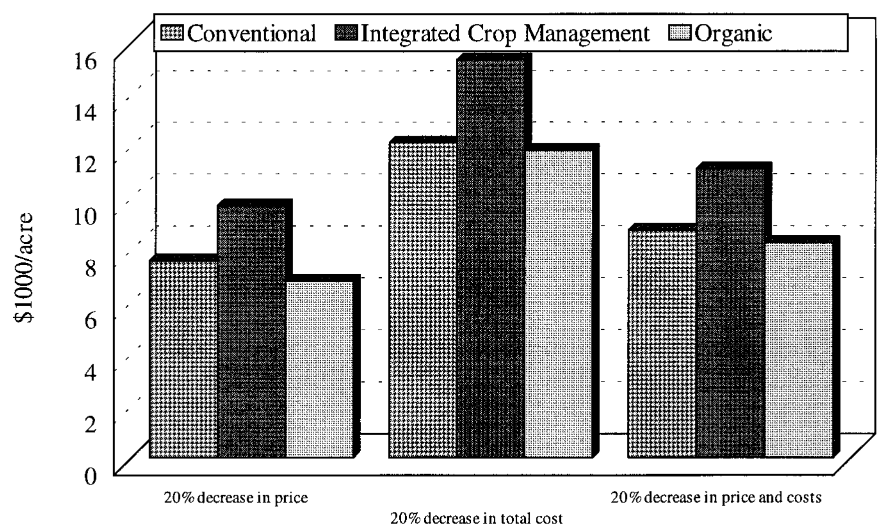

Fig. 8. Net returns for fresh tomatoes after 20% decrease in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

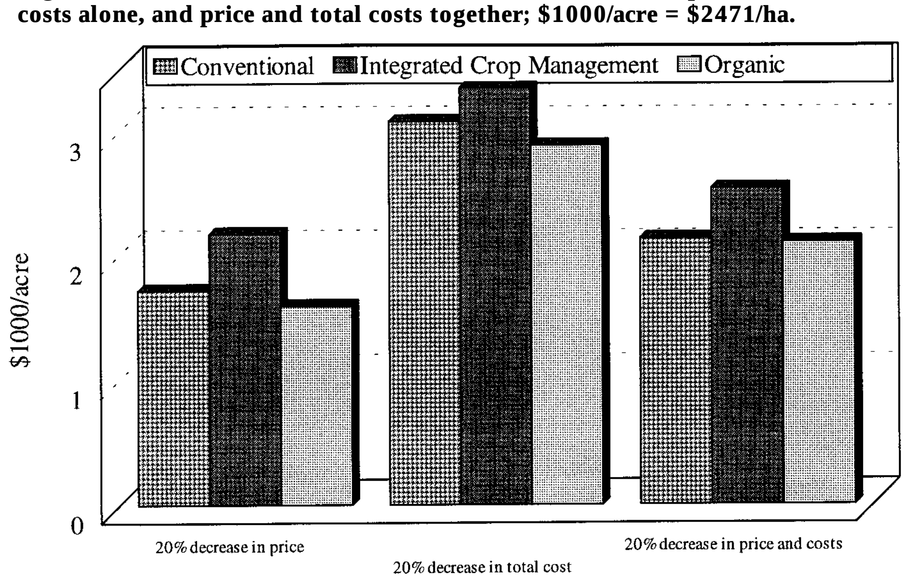

Fig. 9. Net returns for fresh pumpkins after 20% decrease in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

were learning the organic system as we went. Most producers are in the same situation. As commercial organic production matures, and as university researchers and others help modify commercial organic systems to make them more economically efficient, the costs should decline. It remains to be seen whether the decline in costs will compensate for the decline in the price premium. Niche markets will no doubt continue to play a role in organic production. Community assisted agriculture, which shifts some of the price and production and price risks from producers to consumers, is one way organic producers are able to collect the price premium they need to remain competitive.

Since World War II, the focus of land grant university research and chemical companies has been on conventional agriculture. Such research relied heavily on petrochemical based pesticides and fertilizers. However, the decade of the 1970s introduced a gradual shift toward university research on sustainable agriculture. Only since the 1970s have organic and sustainable agriculture started to receive some attention in university research programs. Organic agriculture requires systems approaches, which are much more complicated to develop and will take more time to do so profitably.

ICM systems compare favorably with conventional systems for tomatoes and pumpkins, but have slightly lower returns for sweet corn. Producers may be reluctant to switch from conventional production systems to ICM systems because it requires more intensive management, or hiring scouts. Because ICM systems should have less negative impacts on the environment, policy makers may want to consider continuing to subsidize the costs of the scouts to encourage conventional producers to switch to ICM systems. This can be justified since the costs currently accrue only to producers, but the benefits of a better environment accrue to society as a whole.

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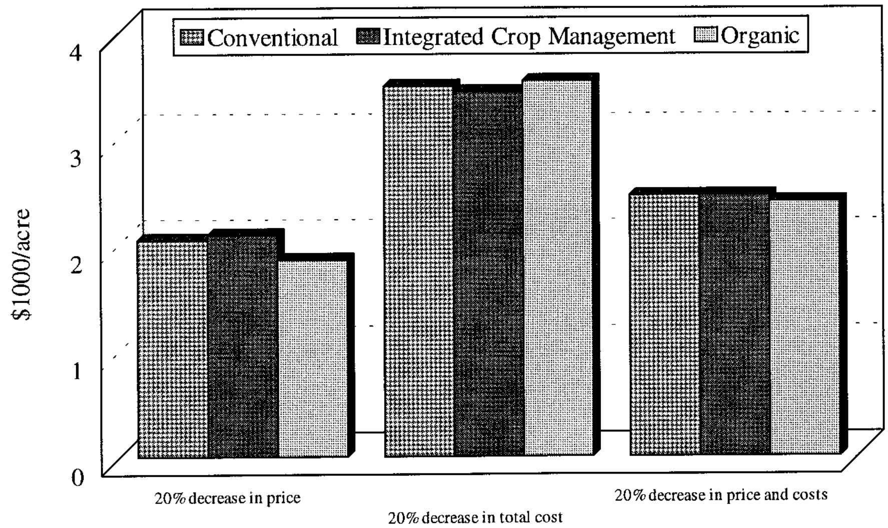

Fig. 10. Net returns for pumpkins after 20% decrease in price alone, total costs alone, and price and total costs together; $1000/acre = $2471/ha.

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