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ALTERNATIVES TO MANUAL SORTING USING SELECTED ELECTRONIC GRADERS IN ASPARAGUS FRESH PACKING SHEDS: A COST-BENEFIT ANALYSIS

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Alternatives to Manual Sorting Using Selected Electronic Graders in Asparagus Fresh Packing Sheds: A Cost-Benefit Analysis

by

Trent Ball and Raymond J. Folwell[1]

Introduction

In the United States (U.S.), nearly 80% of asparagus consumption is fresh product. To optimize the shelf-life of fresh asparagus for the consumer, the grading, sorting, packing, and cooling in an asparagus fresh packing firm must be done rapidly and efficiently. Asparagus is a highly perishable crop, with a shelf life of 3 weeks after harvest under optimum conditions (Robinson et al., 1975). The current method of handling asparagus in most domestic fresh packing firms is unchanged from the methods used in the 1950s. The methods include extensive hand labor, which is required to visually sort, grade, and orient spears that are bundled and marketed. If this is to be done efficiently, it requires a high-speed evaluation of approximately 0.5 second for each spear (Rigney et al., 1992). The fast inspection of a large number of spears becomes demanding on a manual grader's consistency. Further, the intense concentration by manual graders and long hours in a fresh packing firm can cause fatigue and reduce performance (Yang, 1992). Quality of the final product deteriorates as defects are missed, and the precision of bunching by size is reduced. The use of automated systems for grading asparagus could increase productivity along with improved quality in the grading.

In this study, selected electronic graders are evaluated based on a cost-benefit analysis compared with the current system. The objective is to evaluate the substitution of asparagus grading technology for manually grading asparagus spears in a typical domestic fresh packing

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firm. Individual packing firms must analyze such technologies to determine if the machines can be inserted into their respective facilities based on size requirements. This study will focus on comparisons from an economic perspective among the current method of packing fresh asparagus in the U.S. with electronic grading.

Past Technology Research

In the late 1960s and early 1970s, several studies were done with devices that orient spears (Singh et al., 1971; Gradwohl, 1971). Studies also focused on developing methods of grading asparagus spears by length. A prototype machine that graded pre-aligned spears by length was developed by Srivastava (1969). Later, Mears et al. (1974) developed a mechanized vibratory length grader/long spear orienter from a commercial vibratory frozen french fry grader. Results indicated that it could successfully grade based on size and orient spears from a jumbled mass. Further, estimates showed that using the machine compared with sorting by hand reduced overall labor costs. However, the machine was never used commercially.

More recent research focused on using machine vision technology to detect asparagus defects in addition to diameter and length measurements. A study by Rigney et al. (1992) examined using machine vision to assess spreading tips, broken tips, and scars or cracks on the basal portion of a spear. Analysis found that the machine vision algorithms correctly identified spreading tips with an error rate of 8%, while the detection of broken tips, and scarred or cracked spears had higher error rates. Results from the study indicate that machine vision has the capability for automated grading and inspection of asparagus spears, with improvement needed for cracks, scars and broken tips. Electronic color sorters and vision systems are already used extensively for grading other commodities, such as seeds, peanuts, coffee beans, and apples.

Asparagus Industry Costs

Half of the current costs of production, packing, processing, and distribution are composed of labor costs. With the North American Free Trade Act and the Andean Trade Pact in place, the asparagus industry in the U.S. is attempting to compete with countries where the labor costs are $0.40 to $0.60 per hour. High wage rates in California and Washington, which produce more than 90% of domestic fresh asparagus, can be upwards of $9.00 per hour. Mears et al. (1977) noted that if hand harvesting costs increased relative to the selling price of asparagus, then mechanization of the current processes was necessary. In a specialty crop industry such as asparagus, there are major barriers to developing innovative technologies because the market or number of potential users (firms) is small. For the U.S. asparagus industry to insure a competitive position, it will have to substitute technology for labor in an attempt to lower costs.

Improving the Asparagus Grading/Sorting Process

This study evaluates technology that can be substituted for human labor for grading asparagus in domestic fresh packing firms. The technology, electronic graders, are used to sort and grade asparagus based upon several criteria, such as length, color, flower, and diameter. Several different machines are evaluated. The general configuration of the mechanisms and process is similar among the various electronic graders. A schematic of the process flow with an electronic grader is shown in Figure 1. Product is conveyed on a belting system that uses v-shaped cups that carry individual asparagus spears. The spears move past a camera that electronically scans a picture of the individual spears, which is then transferred to the computer system. In the unloading area, cups are overturned in the appropriate exits, or chutes, based upon the set specifications of grading criteria (color, flower, diameter, etc.).

The electronic graders significantly reduce or eliminate the manual grading normally required in the packing of fresh asparagus. Manual labor is still required to do minimal sorting and aligning of asparagus spears, in addition to the bunching and packaging that occur after the grading process. The principal function of the electronic grader is to improve the quality and consistency of the graded product, in addition to reducing the number of employees needed for grading.

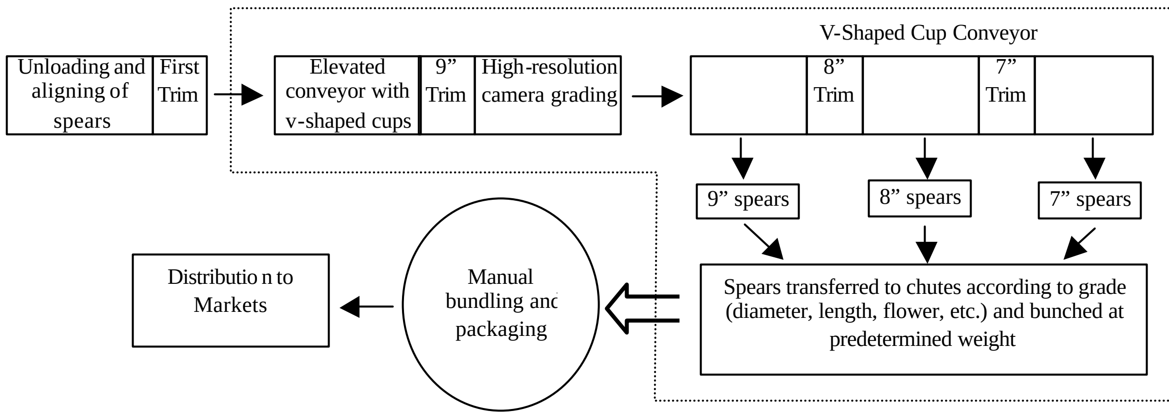

Figure 1. Typical Process Flow of an Electronic Asparagus Grader

Materials and Methods

The current manual method of grading in domestic fresh packing firms could potentially be replaced by electronic graders, while bunching and packaging would remain the same. Four electronic graders were evaluated over a 10-year period based on the additional costs incurred by purchasing and using the machines and potential savings, such as labor reduction and the tax benefit from equipment depreciation. Machine capacity and requirements used in developing the cost-benefit analysis, such as throughput capabilities and typical repair and maintenance costs, were provided by the companies of the selected electronic graders. Repairs were increased annually by 5% to reflect additional costs as the machine ages.

Assumptions for Cost Analysis

Several assumptions were used to conduct an analysis of the costs and savings that occur from using the electronic graders in a domestic firm. Manual labor was provided by minimum wage employees. In California and Washington, fresh packing firms can experience employer costs of $8.75 and $8.25 per hour, respectively. These figures were based on minimum wage rates and the associated taxes. A value of $8.50 per hour was used as the labor cost per employee for the first year. The labor cost was increased annually by 2.5%, which was the average increase in the Consumer Price Index for the urban wager earner and clerical worker over the past 10 years.

It was assumed the electronic graders were purchased using a loan to finance 75% of the total acquisition value of the machines, paid over the course of five years at a rate of 8.1%; there was a 1% initial loan fee associated. The remaining 25% was financed by the individual firm. The acquisition value included the purchase price, a sales or use tax rate of 7.6%, and $1,000 to cover other expenses required for installation. A transportation cost of $600 accounted for the delivery expense of an electronic grader from a major port of entry to the fresh packing firm.

The depreciation schedule used by the fresh packing firm was assumed to be the Modified Accelerated Cost Recovery System (MACRS). According to tax code, the manufacturing machinery was treated as a 7-year property, with the depreciation taken over 8 years with no salvage value (Table 1). MACRS is a form of double declining balance depreciation with the half-year convention and a switch to straight line halfway through the asset's life. The fresh packing firm was assumed to generate a taxable income of over $100,000 and less than $335,000, for a variable tax rate of 39%. A tax savings is generated since depreciation is a noncash expense used in calculating income tax.

Table 1. MACRS 7-Year Property Depreciation Schedule Using the Half-Year Convention*(%)

Year	Depreciation
1	14.29
2	24.49
3	17.49
4	12.49
5	8.93
6	8.92
7	8.93
8	4.46
9	-
10	-

*Under the half-year convention it is assumed the property is placed in service in the middle of the first year. The effect is that it extends the depreciation schedule out one more year; therefore, a 7-year life property is depreciated over eight years.

Most fresh packing firms have several processing lines for manual sorting and grading. However, analysis in this study compares replacing one manual line with an electronic grader(s). Two scenarios were created (Table 2). Under both scenarios, the packing firms were assumed to run the packing lines eight hours per day for five days a week over a nine-week season. It was further assumed that additional activities required to package fresh asparagus, such as hydrocooling, bundling, and packaging the spears, remain constant regardless whether using an electronic grader or manual sorting and grading.

Table 2. Fresh Packing Firm Assumptions of Throughput and Capabilities for the Alternative Scenarios

Item	Scenario One	Scenario Two
Throughput (lbs/hr/line)	1,500	2,000
People to process throughput	25	25
Pounds per person per hour	60	80
Packing season (weeks)	9	9

The four electronic graders (Grader A, Grader B, Grader C, Grader D) have different purchase prices and varying capabilities (Table 3). Prices for the electronic graders range from $95,000 to $164,000 per machine; each grader has the capability to process over 110 pounds of asparagus per person per hour. The throughput and the number of people required to process the throughput are based on the graders running at full capacity.

The electronic graders were evaluated based on the two alternative scenarios. Under the scenarios, the requirements for the graders to process the throughput differed (Table 4). Purchase of additional machines was financed under the earlier assumptions. If the packing season was extended beyond 40-hour workweeks, an overtime expense of 1.5 times the wage rate was subtracted from the labor savings.

Table 3. Purchase Price, Throughput, and Capabilities of the Selected Electronic Graders at Full Capacity

Item	Grader A	Grader B	Grader C	Grader D
Price ($)	95,000	113,000	150,000	164,300
Maximum throughput capacity (lbs/hr)	1,800	1,525	2,000	1,200
People to process throughput	16	10	16	10
Pounds per person per hour	113	153	125	120

Table 4. Throughput and Requirements of the Selected Electronic Graders under the Alternative Scenarios

Item	Grader A	Grader B	Grader C	Grader D
		--Scenario One--		
Number of machines	1	1	1	1
Estimated throughput (lbs/hr)	1,500	1,500	1,500	1,200*
People to process throughput	14	10	12	10
Total hours of overtime (season)	0	0	0	90
		--Scenario Two--		
Number of machines	1	1	1	2
Estimated throughput (lbs/hr)	1,800*	1,525*	2,000	2,000
People to process throughput	16	10	16	16
Total hours of overtime (season)	40	112	0	0

*The maximum throughput capabilities for these graders are less than the defined hourly throughput requirements in the corresponding scenarios; therefore, to meet the throughput, overtime hours are necessary.

Three methods were used in evaluating the electronic graders. First, the costs of implementing the electronic graders were subtracted from the savings from labor reduction and tax savings over a 10-year period. The future benefits were discounted at an 8% interest rate to arrive at the present value of the cost savings in year one. From the present values, the discounted payback period was computed. The payback period indicates the number of years necessary to recover the investment, or break even. Second, the net present value (NPV) for each grader was computed as the sum of discounted cash flows. A positive NPV indicates sufficient cash flow to repay the investment, provide an 8% return, and generate extra cash for the firm. Third, a modified internal rate of return (MIRR) of the savings was determined over the life of the project (10 years). The MIRR measures profitability and was reported as a percentage return on the investment; it was assumed the cash flows were reinvested at an 8% return. The 10-year MIRR was used to identify the long-term returns from the selective graders. For a project to be deemed as viable, it was assumed it must generate at least an 8% return.

Results

The detailed costs and savings for the electronic graders under the two scenarios are presented in the Appendix. The tables provide the annual expenses (repairs, loan payment, etc.) in addition to the savings (labor, tax benefit, etc.) over the duration of 10 years. The present values of the future returns are also included. A discussion of the results follows.

Grader A

Scenario One

Relative to the investment, Grader A provides a high degree of cost effectiveness for replacing a line with a throughput of 1,500 pounds per hour. The payback period for the electronic grader was only 1.37 years (Table 5). In the first year, the total costs exceed the total savings, for an $8,040.88 net cost. Years two through ten provided positive returns. In scenario one, 25 people are necessary to process 1,500 pounds per hour. However, using Grader A requires only 14 people, thus eliminating 11 employees and providing a labor savings of nearly $34,000 in the first year. The largest costs over the 10 years were the loan payments. In the final year of the loan (year five), a present value of $14,522.91 was achieved at a discount rate of 8%. The following year, the present value increases nearly $13,000 to $27,334.50. Over 10 years, the MIRR was 53%, a result of the large savings from the years six through ten.

Scenario Two

For Grader A to pack the equivalent of a throughput of 2,000 pounds per hour per line over a nine-week season it was necessary to work overtime for 40 hours, or almost five hours of overtime per week (Table 4). Sixteen employees were used for Grader A in the second scenario compared with the 25 employees who would be required for manual sorting. Therefore, nine employees were reduced using Grader A. Overtime and additional working hours reduce the labor savings from the nine eliminated employees below the savings achieved in the first scenario. In year one, there was a $22,320.88 net cost. Expenses incurred from overtime reduced the overall labor savings, as the employees were paid at 1.5 times normal wage for hours worked over 40 per week. Consequently, the investment payback period more than doubled (5.12 years) compared with scenario one (Table 5). By the sixth year, the savings increased due to repayment of the loan. Savings continue to outweigh costs, as seen by the 10-year MIRR (26%). Substantial savings in the sixth through tenth years cover the minimal returns in the earlier years. Although returns were received using Grader A, time was required to see them actualize.

Table 5. Projected Payback and Returns Per Line from Adopting Electronic Graders under the Alternative Scenarios

	Grader A	Grader B	Grader C	Grader D
		--Scenario One--		
Net Present Value (NPV)	$180,904.91	$266,045.31	$187,387.93	$133,089.91
Payback Period (years)	1.37	1.10	2.11	3.92
10-Year Modified Internal Rate of Return	53.4%	77.0%	37.1%	28.2%
		--Scenario Two--		
Net Present Value (NPV)	$66,213.65	$107,940.29	$89,548.26	-$10,111.39
Payback Period (years)	5.12	5.40	5.50	>10
10-Year Modified Internal Rate of Return	25.9%	31.8%	23.6%	6.9%

Grader B

Scenario One

Grader B had a higher purchase price than Grader A, but required less labor to handle additional product (Table 4). By the end of the second year, Grader B had covered the expenses and provided a positive return. A labor savings of nearly $46,000 was attained from the first year of implementation. The repair expense was $1,000. There was a $924 loan fee and the individual firm funded nearly $31,000 and financed the remaining value of the machine with a five-year loan and a $23,200.94 annual payment. After expenses, there was a net cost of $3,156.46 in year one. By the second year, a present value of $32,002.19 was returned, which results in a discounted payback of 1.10 years (Table 5). The 10-year MIRR was 77%. The high percentage return was a result of the large savings, provided by labor reduction. Over half of the manual employees, 15, were eliminated using Grader B compared with the requirements for manual sorting. The economic returns from Grader B make it a viable option for substituting manual labor with an electronic grader.

Scenario Two

The per hour throughput capacity of Grader B was 1,525 pounds per line (Table 4). Therefore, Grader B alone does not have the capacity to run the volume in scenario two. To compensate, 112 hours of overtime were necessary during the season to handle the throughput. Ten people were required to run the Grader B machine, a labor savings of over 50% compared to sorting and grading manually. Despite the significant labor reduction the discounted payback period was over 5 years primarily because of the overtime expense (Table 5). Labor savings in year one were $14,280 less than what was received under the first scenario due to the excess hours used to process the throughput. Negative returns were received in the fourth and fifth years, but the remaining years all provided positive inflows. Even though a significant amount of overtime was required for operation, labor savings from the grader were still generated, which led to a 32% 10-year MIRR.

Grader C

Scenario One

Grader C has the capability to handle 2,000 pounds per hour of product using 16 people (Table 4). In scenario one, only 12 people were required to handle the 1,500 pounds per hour throughput, a reduction of 13 employees. The resulting labor savings generated a payback period of just over two years. The annual repair cost was $1,000 and the loan fee was $1,222.50 in the first year. Starting in the second year, positive returns were incurred. In the sixth year, after the loan expired, nearly $34,000 of savings was generated, based on a discount rate of 8%. A 37% MIRR was achieved over the 10-year life of the project (Table 5). Despite being the second most expensive machine, a positive net present value was attained ($187,387.93).

Scenario Two

Under the second scenario, the grader was able to pack a throughput of 2,000 pounds per hour without incurring overtime (Table 4). Despite the higher throughput in scenario two, the labor force was still reduced by nine people. In year one, a labor savings of $27,540 was generated, which was slightly below the nearly $31,000 loan payment. Although the first year had a $37,047.39 net cost, positive inflows were generated in each of the remaining years. After 5.5 years, the investment expenses were recovered and a positive return on the investment was achieved (Table 5). More than $21,000 in annual returns was reached in year six from year five. Completion of the loan payment was the largest factor toward increasing the returns in years six through ten. In fact, the MIRR was 24%, providing a return above our expected 8% rate. The project had an $89,548.26 NPV.

Grader D

Scenario One

Using the electronic grader instead of the manual line eliminated fifteen people, but the five-year loan ($33,596.96) necessary to fund Grader D limited the benefits of the reduced labor. Further, 90 hours of overtime was needed to process the 1,500 pounds per hour of throughput under the scenario (Table 4). The firm financed nearly $45,000 (25% of acquisition cost). A combination of the large acquisition costs and overtime expenses resulted in a payback period of 3.92 years (Table 5). The labor reduction of 15 people minus the overtime expense led to a $34,425 labor savings for year one. The labor savings generated a NPV of $133,089.91 over the 10-year life of the project. In addition, a 28% MIRR was achieved, exceeding the expected return of 8%, making this project a viable alternative to manual sorting.

Scenario Two

The suppliers for Grader D offer a reduced purchase price for a second machine, which was necessary to process the 2,000 pounds per hour throughput for the second scenario (Table 4). A total acquisition cost of over $290,000 was required to purchase the two-machine setup. The acquisition cost resulted in a nearly $55,000 loan payment, which exceeded the savings produced from using the electronic grader. A labor savings of $27,540 was received in year one by eliminating nine people from grading. However, due to a lag of positive inflow in the early years, a negative NPV of $10,111.39 was generated. It was not until after the loan payment was complete (year 5) that a positive return was achieved. The 7% MIRR was less than the return required (8%) to classify the project as acceptable (Table 5).

Summary and Conclusions

The results for the electronic graders are specific to the assumptions and procedures used in this study; the results of this study should not be generalized outside of the assumptions used. Nonetheless, the results do provide a basis for fresh packers to evaluate the economics of implementing electronic graders as a substitution for manual sorting.

In scenario one, Grader B provides the quickest discounted payback period, and the largest 10-year return. Grader A has the lowest purchase price, and the second quickest payback period. Even though Grader A has a faster payback period, over 10 years Grader C provides almost a $6,500 higher NPV. Under the scenario, Grader C provides higher returns in the years after the loan is complete than Grader A, based on present values. Compared with Grader C, Grader A has a higher MIRR due largely to the returns in the early years that are reinvested at 8%. Early returns in the life of a project tend to lead to a higher MIRR. A firm choosing between the graders needs to determine if short-term or long-term returns are most important.

Overall, Grader D provides the least amount of economic returns, as it requires a large purchase price and minimal return over 10 years. Yet, each grader covers the investment in less than four years, before providing a return to the firm. Projects that provide returns to the investment in less than five years are typically viewed as safe investments. Each electronic grader reduces employees compared to manual sorting, and provides savings that otherwise may not be achieved.

The best investment under the second scenario considering the discounted payback period is Grader A. However, both Grader B and C have higher NPV's, and Grader B has a higher MIRR. Despite the overtime used for Grader B, it still generates a NPV over $18,000 more than the next closest electronic grader. From a financial perspective, it is significantly more profitable. Even considering the large NPV associated with Grader B, a firm could possibly be deterred by the amount of overtime required (120 hours) to process the throughput. A fresh packer might prefer not to work 11-hour days, five days per week over a 9-week season, the assumption used to determine the costs and savings for Grader C. Further, additional costs with the overtime are not accounted for in this study, which could reduce the economic benefits of Grader B.

As in the first scenario, Grader C has a higher NPV than Grader A, but a longer discounted payback period in the second scenario. However, in this scenario the NPV for Grader C is greater by $23,334.61. The payback periods and MIRR's are comparable, yet Grader A displays slightly better results. One potential drawback of Grader A is the 40 hours of overtime. As mentioned with Grader B, the overtime may incur additional expenses beyond 1.5 times the wage rate, not included in this study. Graders C and D are the only two electronic graders not requiring additional hours to achieve the packouts. However, a significant purchase price and minimal savings force Grader D not to be economically viable under this study's assumption.

Even though a specific grader may provide a larger return or faster payback, it might not be the best electronic grader for a firm. A firm that has limited space and a large throughput for each line might not be able to have two machines replace one line. Firms with larger throughputs need to examine if overtime labor costs are a viable option; otherwise, a grader that can handle the specific volume of a firm may be more appropriate. Therefore, individual firms must examine all aspects of the machines, besides just the economic benefits.

References

Gradwohl, D. R. 1971. Developing an orienter for mechanically harvested asparagus. Agricultural Engineering. 52(6): 312,313.

Mears, D.R., Carpenter, H.E., and Stammer, R.W. 1974. Sorting and packing machine – harvested asparagus for the fresh market. TRANSACTIONS of the ASAE 17(5): 876-881.

Mears, D.R., Shiao, L., and Singley, M.E. 1977. Simulation of a fresh market asparagus packing line. Transactions of the ASAE. 20(1): 189-192.

Rigney, M.P., Brusewitz, G.H. and Kranzler, G.A. 1992. Asparagus defect inspection with machine vision. Transactions of the ASAE. 35(6): 1873-1878.

Robinson, J.E., Browne, K.M. and Burton, W.G. 1975. Storage characteristics of some vegetables and soft fruits. Annals of Applied Biology. 81: 399-408.

Singh, G., Moore, M.J. and Mears, D.R. 1971. Mechanical orientation of asparagus spears and related physical properties. Transactions of the ASAE 14(5): 985-986.

Srivastava, A. 1969. Mechanical length sorting of asparagus spears and development of a computer simulation model of a theoretical asparagus processing plant. Unpublished M.S. Thesis, Rutgers University.

Yang, Q. 1992. The potential for applying machine vision to defect detection in fruit and vegetable grading. Agricultural Engineer 47(3): 74-79

APPENDIX

APPENDIX TABLE 1A. GRADER A ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO ONE

Price	$95,000.00
Sales Tax (7.6%)	$7,220.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$103,820.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$25,955.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$778.65	-	-	-	-	-	-	-	-	-
Repairs**	-$1,200.00	-$1,260.00	-$1,323.00	-$1,389.15	-$1,458.61	-$1,531.54	-$1,608.11	-$1,688.52	-$1,772.95	-$1,861.59
Loan Payment	-$19,553.22	-$19,553.22	-$19,553.22	-$19,553.22	-$19,553.22	-	-	-	-	-
Tax Savings (39%)	$5,785.99	$9,915.95	$7,081.67	$5,057.18	$3,615.74	$3,611.69	$3,615.74	$1,805.85	-	-
Labor Savings	$33,660.00	$34,501.50	$35,364.04	$36,248.14	$37,154.34	$38,083.20	$39,035.28	$40,011.16	$41,011.44	$42,036.73
Net return/loss	-$8,040.88	$23,604.23	$21,569.49	$20,362.95	$19,758.26	$40,163.35	$41,042.90	$40,128.49	$39,238.49	$40,175.13
Present Value (8%)	-$8,040.88	$21,855.77	$18,492.36	$16,164.76	$14,522.91	$27,334.50	$25,863.99	$23,414.59	$21,199.34	$20,097.57

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 1B. GRADER A ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO TWO

Price	$95,000.00
Sales Tax (7.6%)	$7,220.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$103,820.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$25,955.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$778.65	-	-	-	-	-	-	-	-	-
Repairs**	-$1,200.00	-$1,260.00	-$1,323.00	-$1,389.15	-$1,458.61	-$1,531.54	-$1,608.11	-$1,688.52	-$1,772.95	-$1,861.59
Loan Payment	-$19,553.22	-$19,553.22	-$19,553.22	-$19,553.22	-$19,553.22	-	-	-	-	-
Tax Savings (39%)	$5,785.99	$9,915.95	$7,081.67	$5,057.18	$3,615.74	$3,611.69	$3,615.74	$1,805.85	-	-
Labor Savings	$19,380.00	$19,864.50	$20,361.11	$20,870.14	$20,650.45	$21,926.69	$22,474.86	$23,036.73	$23,612.65	$24,202.96
Net return/loss	-$22,320.88	$8,967.23	$6,566.56	$4,984.95	$3,254.37	$24,006.84	$24,482.48	$23,154.05	$21,839.70	$22,341.37
Present Value (8%)	-$22,320.88	$8,302.99	$5,629.77	$3,957.21	$2,392.06	$16,338.65	$15,428.12	$13,510.17	$11,799.31	$11,176.25

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 2A. GRADER B ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO ONE

Price	$113,000.00
Sales Tax (7.6%)	$8,588.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$123,188.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$30,797.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$923.91	-	-	-	-	-	-	-	-	-
Repairs**	-$1,000.00	-$1,050.00	-$1,102.50	-$1,157.63	-$1,215.51	-$1,276.28	-$1,340.10	-$1,407.10	-$1,477.46	-$1,551.33
Loan Payment	-$23,200.94	-$23,200.94	-$23,200.94	-$23,200.94	-$23,200.94	-	-	-	-	-
Tax Savings (39%)	$6,865.39	$11,765.81	$8,402.78	$6,000.61	$4,290.27	$4,285.46	$4,290.27	$2,142.73	-	-
Labor Savings	$45,900.00	$47,047.50	$48,223.69	$49,429.28	$50,665.01	$51,931.64	$53,229.93	$54,560.68	$55,924.69	$57,322.81
Net return/loss	-$3,156.46	$34,562.37	$32,323.02	$31,071.32	$30,538.83	$54,940.82	$56,180.10	$55,296.31	$54,447.24	$55,771.48
Present Value (8%)	-$3,156.46	$32,002.19	$27,711.78	$24,665.42	$22,446.95	$37,391.80	$35,402.99	$32,264.86	$29,416.15	$27,899.63

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 2B. GRADER B ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO TWO

Price	$113,000.00
Sales Tax (7.6%)	$8,588.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$123,188.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$30,797.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$923.91	-	-	-	-	-	-	-	-	-
Repairs**	-$1,000.00	-$1,050.00	-$1,102.50	-$1,157.63	-$1,215.51	-$1,276.28	-$1,340.10	-$1,407.10	-$1,477.46	-$1,551.33
Loan Payment	-$23,200.94	-$46,401.89	-$46,401.89	-$46,401.89	-$46,401.89	-	-	-	-	-
Tax Savings (39%)	$6,865.39	$23,531.62	$16,805.55	$12,001.22	$8,580.54	$8,570.93	$8,580.54	$4,285.46	-	-
Labor Savings	$31,620.00	$32,410.50	$33,220.76	$34,051.28	$34,902.56	$35,775.13	$36,669.51	$37,586.24	$38,525.90	$39,489.05
Net return/loss	-$17,436.46	$8,490.23	$2,521.93	-$1,507.01	-$4,134.29	$43,069.77	$43,909.95	$40,464.61	$37,048.44	$37,937.72
Present Value (8%)	-$17,436.46	$7,861.33	$2,162.15	-$1,196.31	-$3,038.83	$29,312.56	$27,670.72	$23,610.71	$20,016.12	$18,978.30

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 3A. GRADER C ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO ONE

Price	$150,000.00
Sales Tax (7.6%)	$11,400.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$163,000.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$40,750.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$1,222.50	-	-	-	-	-	-	-	-	-
Repairs**	-$1,000.00	-$1,050.00	-$1,102.50	-$1,157.63	-$1,215.51	-$1,276.28	-$1,340.10	-$1,407.10	-$1,477.46	-$1,551.33
Loan Payment	-$30,699.04	-$30,699.04	-$30,699.04	-$30,699.04	-$30,699.04	-	-	-	-	-
Tax Savings (39%)	$9,084.15	$15,568.29	$11,118.39	$7,939.89	$5,676.80	$5,670.44	$5,676.80	$2,835.22	-	-
Labor Savings	$39,780.00	$40,774.50	$41,793.86	$42,838.71	$43,909.68	$45,007.42	$46,132.60	$47,285.92	$48,468.07	$49,679.77
Net return/loss	-$24,807.39	$24,593.75	$21,110.71	$18,921.93	$17,671.93	$49,401.58	$50,469.31	$48,714.04	$46,990.61	$48,128.44
Present Value (8%)	-$24,807.39	$22,771.99	$18,099.03	$15,020.84	$12,989.40	$33,621.89	$31,804.23	$28,424.17	$25,387.57	$24,076.20

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 3B. GRADER C ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO TWO

Price	$150,000.00
Sales Tax (7.6%)	$11,400.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$163,000.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$40,750.00	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$1,222.50	-	-	-	-	-	-	-	-	-
Repairs**	-$1,000.00	-$1,050.00	-$1,102.50	-$1,157.63	-$1,215.51	-$1,276.28	-$1,340.10	-$1,407.10	-$1,477.46	-$1,551.33
Loan Payment	-$30,699.04	-$30,699.04	-$30,699.04	-$30,699.04	-$30,699.04	-	-	-	-	-
Tax Savings (39%)	$9,084.15	$15,568.29	$11,118.39	$7,939.89	$5,676.80	$5,670.44	$5,676.80	$2,835.22	-	-
Labor Savings	$27,540.00	$28,228.50	$28,934.21	$29,657.57	$30,399.01	$31,158.98	$31,937.96	$32,736.41	$33,554.82	$34,393.69
Net return/loss	-$37,047.39	$12,047.75	$8,251.06	$5,740.79	$4,161.26	$35,553.14	$36,274.66	$34,164.53	$32,077.36	$32,842.36
Present Value (8%)	-$37,047.39	$11,155.32	$7,073.96	$4,557.23	$3,058.65	$24,196.87	$22,859.19	$19,934.67	$17,330.40	$16,429.36

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 4A. GRADER D ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO ONE

Price	$164,300.00
Sales Tax (7.6%)	$12,486.80
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$178,386.80

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$44,596.70	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$1,337.90	-	-	-	-	-	-	-	-	-
Repairs**	-$1,000.00	-$1,050.00	-$1,102.50	-$1,157.63	-$1,215.51	-$1,276.28	-$1,340.10	-$1,407.10	-$1,477.46	-$1,551.33
Loan Payment	-$33,596.96	-$33,596.96	-$33,596.96	-$33,596.96	-$33,596.96	-	-	-	-	-
Tax Savings (39%)	$9,941.67	$17,037.90	$12,167.94	$8,689.40	$6,212.68	$6,205.72	$6,212.68	$3,102.86	-	-
Labor Savings	$34,425.00	$35,285.63	$36,167.77	$37,071.96	$37,998.76	$38,948.73	$39,922.45	$40,920.51	$41,943.52	$42,992.11
Net return/loss	-$36,164.88	$17,676.57	$13,636.25	$11,006.78	$9,398.97	$43,878.17	$44,795.03	$42,616.27	$40,466.06	$41,440.78
Present Value (8%)	-$36,164.88	$16,367.19	$11,690.89	$8,737.53	$6,908.53	$29,862.74	$28,228.47	$24,866.18	$21,862.56	$20,730.71

* 25% of acquisition cost

** 5% annual increase

APPENDIX TABLE 4B. GRADER D ANNUAL COSTS, SAVINGS AND PRESENT VALUES UNDER SCENARIO TWO

Price	$268,500.00
Sales Tax (7.6%)	$20,406.00
Transportation Cost	$600.00
Installation Cost	$1,000.00
Total Acquisition Cost	$290,506.00

	Year									
Items	1	2	3	4	5	6	7	8	9	10
Equity financing*	-$72,626.50	-	-	-	-	-	-	-	-	-
Loan Fee (1%)	-$2,178.80	-	-	-	-	-	-	-	-	-
Repairs**	-$1,500.00	-$1,575.00	-$1,653.75	-$1,736.44	-$1,823.26	-$1,914.42	-$2,010.14	-$2,110.65	-$2,216.18	-$2,326.99
Loan Payment	-$54,713.23	-$54,713.23	-$54,713.23	-$54,713.23	-$54,713.23	-	-	-	-	-
Tax Savings (39%)	$16,190.19	$27,746.52	$19,815.70	$14,150.84	$10,117.45	$10,106.12	$10,117.45	$5,053.06	-	-
Labor Savings	$27,540.00	$28,228.50	$28,934.21	$29,657.57	$30,399.01	$31,158.98	$31,937.96	$32,736.41	$33,554.82	$34,393.69
Net return/loss	-$87,288.33	-$313.21	-$7,617.06	-$12,641.26	-$16,020.03	$39,350.68	$40,045.27	$35,678.82	$31,338.63	$32,066.69
Present Value (8%)	-$87,288.33	-$290.01	-$6,530.40	-$10,035.04	-$11,775.20	$26,781.41	$25,235.31	$20,818.25	$16,931.29	$16,041.33

* 25% of acquisition cost

** 5% annual increase

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is violation of law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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