## Financial Efficiency of Methyl Bromide Alternatives for Georgia's Bell Pepper Industries

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**Abstract**

Georgia vegetable farmers are pressed for time to make the transition to new fumigation methods as use of methyl bromide (MeBr) will be completely banned soon. This study focuses on alternative fumigation methods for Georgia's bell pepper production with production efficiency matching MeBr. Analyses of enterprise cost and return estimates indicate the comparable financial feasibility of certain technically efficient fumigant systems vis-à-vis the conventional production plan involving MeBr.

Methyl Bromide (MeBr) is used extensively as an agricultural fumigant in most U.S. climates to control weeds, nematodes, soil-borne pests, and diseases. This widespread adoption results from its affordability as well as its application and control effectiveness. Historically, the U.S., as a leader in agricultural production, is the major user of MeBr with an estimated annual rate of 21,000 tons (Haire, 2003a). A controversy surrounding this use of MeBr is its identification as a leading cause of ozone depletion. MeBr now faces an accelerated phase-out schedule, especially among developed nations that are expected to completely eliminate its agricultural use by end of 2004 (United Nations Environmental Program (UNEP)).

Within the U.S., the two largest users of MeBr, California and Florida, account for more than 75 percent of the total U.S. usage (Carpenter, Gianessi, and Lynch). These states employ MeBr on fruits and vegetables to fight microscopic parasitic roundworms known as root-knot nematodes, and major soil-borne diseases such as bacterial wilt, southern blight, fusarium wilt (fungus), and fusarium crown and root rot. Weeds are also effectively handled with repeated applications of MeBr (Carpenter, Gianessi, and Lynch).

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These pest control problems are also prevalent in Georgia agriculture. Georgia ranks third in the U.S. in acreage of fresh market vegetables planted, and vegetables are the second most valuable crop in Georgia with an approximate farm-gate value of $901.2 million (Boatright and McKissick). Vegetable growers in Georgia expect that eliminating MeBr will reduce yields and increase production costs as a result of adopting more expensive and less effective alternatives (Seabrook). A petition for a critical use exemption beyond December 2004 filed by the University of Georgia (UGA) Extension Service and the Georgia Fruit and Vegetable Growers Association was approved by the UNEP's Methyl Bromide Technical Options Committee. The approval allows Georgia producers of squash, cantaloupe, cucumber, eggplant, pepper, tomato, and strawberry to use MeBr for one extra year (Haire, 2003b).

This exemption allows Georgia producers time to assess alternative production methods incorporating possible pesticide substitutes for the efficacy of MeBr. As an aid for this assessment, the University of Georgia conducted field trials in 2002 and 2003 at the Rural Development Center in Tifton, Georgia for identifying technically efficient combinations of fumigant alternatives and herbicides to replace MeBr. The Center's scientists upon reviewing the literature identified a set of fumigants and herbicides for testing (Culpepper and Langston).

As an outgrowth of their testing, the present study focuses on alternative fumigation methods for Georgia's bell pepper production. Georgia's total harvested acreage for bell peppers in 2003 was 5,230 with an accompanying farm gate value estimated at $87.1 million (Boatright and McKissick). Although bell peppers rank 13th in terms of acres harvested among all Georgia vegetables, its farm gate value makes it the 3rd most valuable vegetable in the state (Boatright and McKissick).

The technically feasible alternatives determined by field trails are further assessed in this study with the objective of determining their financial efficiency. For this analysis, Georgia bell pepper enterprise cost and return estimates are developed for each alternative, technically feasible production systems. These cost and return estimates are then analyzed with conventional MeBr production system for determining their comparative financial feasibility.

## Previous Economic Impact Studies on the U.S. Vegetable Industry

Deepak, Spreen, and Van Sickle estimated the impact of the phase-out on winter markets for six fresh vegetables, green peppers, squash, cucumbers, tomatoes, eggplant, and watermelons. They focused on November through May, months in which Florida is a supplier of vegetables to the U.S. market. A winter fresh vegetable market model was constructed by disaggregating Florida into four regions of production and incorporating Texas and Mexico as dominant winter suppliers. Their empirical model was initially solved for a base-case scenario without accounting for the elimination or reduction of MeBr. The model generated results that conformed to past data with respect to shipping among supply regions, quantity of the crop produced, and the acreage employed for production of the six crops. However, the model did fail to produce realistic results concerning pepper production in Florida. Under the base case, Southwest Florida was expected to not grow any peppers although it has historically been the largest pepper producing region in the state. After modifying the model to account for the loss of MeBr, the solution indicated that the production of peppers, tomatoes, eggplant, and cucumbers would be eliminated in one of Florida's four regions. All other regions throughout Florida were expected to experience adverse effects from the ban due to a severe contraction in production.

The model predicted that Mexico and Texas, which are not affected by the ban, would offset most of the lost Florida production. Of the six crops analyzed in the study, peppers and tomatoes were subject to the greatest reduction in yields. The study estimated that the loss of MeBr would have a $1 billion impact on the U.S. winter vegetable industry, with Florida accounting for nearly all of this impact. However, they emphasized that technically efficient substitutes may invalidate these conclusions and reduce future impacts to Florida growers.

Van Sickle, Brewster, and Spreen considered the presence of such substitutes and extended the analysis by considering the whole vegetable market. Their model allocated production based on the cost of delivery across regional markets. They employed a similar system of inverse Rotterdam equations to estimate total U.S. demand. In their study, Florida pepper producers were assumed to replace MeBr with a combination of Telone C17 and Devrinol. The results on production costs varied depending on single or double cropping systems. For

single crops, costs ranged from a decrease of $41/acre for spring peppers produced in Central Florida to an increase of $397 when peppers were grown close to urban areas. For the double cropping system, costs were estimated to increase by $437/acre. Additionally, the associated yields for peppers were estimated to decline 15 to 25 percent for most areas of Florida.

Van Sickle, Brewster, and Spreen conducted comparative statics analysis under three scenarios (expected or baseline, optimistic, and pessimistic) for yield and production cost adjustments under the MeBr and its alternative production systems. They assumed a seamless transition from MeBr to the alternatives could occur if the largest impact on yield was 10 percent or less of the baseline MeBr scenario. When they tested this condition, it was determined that for tomato production to experience a seamless transition, while holding costs equal to those under the expected scenario, Florida growers would reduce yields by 55 to 60 percent. Their results also indicate that pepper producers must reduce yield losses by approximately 93 percent to make the transition. However, it was noted that future alternatives may reduce the economic impact to producers if they result in lower costs, enhanced yields, and/or new marketing windows.

### The UGA Field Trials

Subsequent to these studies, state-level efforts were directed toward identifying technically efficient alternatives for MeBr. In Georgia, crop scientists have explored various alternatives for MeBr including composts (Haire, 2000), brassica crops (Haire, 2003a), and commercial chemical products (Culpepper and Langston) that would produce optimal efficacy under the region's warm climate conditions and long growing season.

A set of technically viable fumigant alternatives to replace MeBr in bell pepper production were identified by crop scientists. Based on this set, the financial efficiency of alternative bell pepper systems can then analyzed. Pepper producers in Georgia face a variety of diseases and pests that cause severe economic damage to their crops. Certain fungi cause damage to the pepper plant through defoliation, and rotten fruit and stems. In addition to fungi, viruses, generally known as pepper mosaic virus, can lead to stunted plant growth that yields malformed and underdeveloped fruits (Brunt, et al.). Producers must also minimize the devastating effects of root-knot nematodes and implement effective weed control through seasonal applications of fumigants and herbicides.

The Georgia field trials, conducted in Tifton, Georgia, addressed these pest control concerns along with determining effective control of nutsedge, a weed that cannot be controlled even with black plastic mulching. The experiments encompassed two herbicide systems (no herbicides versus the Command-Devrinol-Dual prescription) and seven fumigant options on 6'x 35' experimental plots (Culpepper and Langston). Results of these field trials determined the fumigants' overall ability to control nutsedge growth. The herbicide system contributed to nutsedge control by increasing containment rate from 24 to 27 percent. Moreover, certain production systems were noted to produce better yield results than the MeBr production system (Culpepper and Langston).

From these trials, three fumigation systems that produced either comparable or higher yield levels than MeBr were identified for financial feasibility analysis. These systems include three fumigant alternatives (C35 + KPAM, Telone II + Chloropicrin, and C35 + Chloropicrin) separately combined with a commonly prescribed herbicide system consisting of Clomazone (Command), Napropamide (Devrinol), and s-metolachlor (Dual Magnum). Telone II is 1,3-Dichloropropene while KPAM is an abbreviated term for Metham potassium. C35 is a combination of Telone II and Chloropicrin.

Enterprise cost and return estimates were then developed for each of these production systems. A comparative statics assessment of these enterprise cost and return estimates relative to the base MeBr standard was then employed for identifying financially efficient options for Georgia's bell pepper producers.

### Developing the Enterprise Cost and Return Estimates

Four versions of a pepper enterprise cost and return estimates were developed representing production methods involving methyl bromide, alternative fumigants, and herbicides. These versions employed the format and base assumptions found in the 2003 University of Georgia enterprise cost and return estimates developed for Georgia's fresh bell pepper and growers market (Fonsah and Rucker). Three basic components, gross revenues, and variable and fixed costs, comprise the pepper enterprise cost and return estimates. Variables included in each component may differ among producers depending upon whether production concerns a new investment or whether capital costs are distributed over a multi-crop or mono-crop system.

## Gross Revenues

Table 1 lists a breakdown of the yield and price information used for calculating gross revenues for each production system. Each of the field trials generated peppers classified under one of two major grades: premium (Jumbo) pepper and the lower grades of U.S. 1 & 2 peppers. Jumbo peppers are consistently preferred to U.S. 1 & 2 peppers and thus command higher prices. Jumbo peppers are categorized according to size as extra-large, large, or medium with larger sizes commanding price premiums. In 2003, average spring and fall prices for Jumbo peppers were $16.24 and $10.09 per carton, respectively, while the comparative prices for U.S. 1 & 2 peppers were $12.31 and $8.08, respectively (Fonsah). The annual average prices for Jumbo and U.S. 1 & 2 peppers in 2003 were $13.16 and $10.20 per carton, respectively (Table 1). These 2003 prices were used in the cost and return analysis under the assumption that this year represented a normal or representative year for producers relative to the abnormally high market prices in 2004 resulting from production shrinkage from hurricanes.

The expected yields used in this study were calculated by separately summing the average yields for the Jumbo and U.S. 1 & 2 peppers under each production method and across trials. Plot yields were extrapolated to conform to the acre unit using measurements recorded by field scientists.

Average prices and yields for bell peppers were recorded using a bushel-carton as the standard unit of measurement. This unit is understood by producers to represent approximately twenty-five to thirty pounds of peppers. This study assumed an average bushel-carton weight of 28 pounds for all calculations (Gast).

The derivation of gross revenues in each production method considers the variable combinations of Jumbo and U.S. 1 & 2 pepper yields obtained from the experimental plots. The summary statistics in Table 1 indicate that the C35-KPAM method produced the highest proportion (41.29%) of Jumbo pepper yield to aggregate yield. The conventional Methyl Bromide method produced the lowest Jumbo yield proportion (31.28%) and the highest U.S. 1 & 2 yield proportion (68.72%). Allowing these variable proportions to influence the derivation of gross revenues will capture the relative strength of each production method in producing optimal returns for the pepper enterprise.

## Variable Costs

The variable costs section is divided into two main parts: pre-harvest and harvest/marketing costs. Total variable costs were calculated by summing these two components. The fumigant and herbicide costs associated with each of the final four production methods analyzed were addressed within the pre-harvest component of the variable costs section. Specifically, four separate enterprise cost and return estimates were created that differed, not only in terms of the yields, but also with respect to costs associated with the fumigants and herbicides employed for each unique production method. The marginal cost of fumigants and herbicides may vary according to the size of producers' operations. However, this study assumes that a producer's cost schedule for fumigants and herbicides applies to a 40-acre representative farm. Producers would generally not invest in all of the necessary equipment if only one acre is cultivated.

The prices for all chemicals used in this study were obtained from farm chemical suppliers located in Tifton, Georgia. Chemical prices for 2003 were used in order to ensure continuity with the wholesale prices received for 2003 peppers. Average chemical prices were calculated according to a range that is inherent to the pricing structure of many chemical dealers. All prices were based on typical application rates for Georgia pepper growers. Because growers purchase chemicals in bulk quantities, those growers with smaller operations will experience a greater loss of product through waste, thus resulting in a higher total cost, while large growers will benefit from an input-price discount. Additional costs within the pre-harvest section include seeds, fertilizer, insecticide, fungicide, plastic, drip tape, machinery, labor, land rent, irrigation, and interest on operating capital. Each acre required 174 pepper plants, costing $5.50 a plant, or $957 an acre. Lime was applied at a rate of one ton per acre with an associated cost of $26/acre. The combination of base and side dress fertilizers cost a total of approximately $214/acre. Low-density polyethylene plastic (LDPE), which is used to control for weeds and pests, is charged to growers by the roll, and when combined with the cost of its removal resulting in nearly $267/acre. Operations required 8,700 feet of drip tape per acre at a cost of $.02 / foot or $174/acre. Machinery costs are calculated at five hours per acre, $21/acre, for a total of $105/acre. The labor component is broken into two parts; transplant labor and non-

transplant labor. For this study the cost of both were calculated at $8.00/hour in accordance with prevailing regional prices. A total of 53 man-hours were required per acre resulting in a total cost of $424/acre. Land-rents were expected to cost the grower $105 per acre while total irrigation cost per acre was $65.

The harvesting costs component of the variable costs section includes picking and hauling, grading and packing, containers, and marketing. Marketing cost per unit was calculated as 8.5 percent of the expected price per carton. This value, when multiplied by the expected yield per acre for each method, resulted in the total marketing cost per acre. The cost per unit for all components remained the same for all methods. Picking and hauling ($1.25/ctn), grading and packing ($2.75/ctn), containers ($1.30/ctn), and marketing ($0.99/ctn) account for 20 percent, 44 percent, 20 percent, and 16 percent respectively, of the total harvesting and marketing costs.

The resulting total variable costs for the four production systems are summarized in Table 2. Based on this summary, farmers are able to save more on fumigation costs under the MeBr method which entails a cost of $405 per acre. The C-35 Chloropicrin method registered the highest fumigation cost of $1,007 per acre, which is more than twice the MeBr cost.

Yield and gross revenue differences account for a different trend in aggregate variable cost comparisons. C35-KPAM had the highest level of variable costs ($12,468/acre) while the MeBr method had the second to the lowest level ($11,247/acre).

**Fixed Costs**
The fixed costs section in the enterprise cost and return analysis includes machinery, irrigation, land, and overhead and management costs. The machinery complement includes tractors, herbicide applicators, cultivator, and sprayer. Machinery-related costs are calculated to account for depreciation, interest on investment, and taxes and insurance. A vegetable drip irrigation system is assumed in the enterprise cost and return estimates for which the same machinery-related costs were also calculated. Total overhead and management costs per acre were calculated by multiplying the total pre-harvest variable cost by 15 percent. The aggregate fixed costs for all production methods are presented in Table 2.

## Results of Enterprise Cost and Return Analyses
The financial efficiency of each production method was assessed by analyzing revenue-cost relationships and profit-generating capabilities under various operating conditions. Table 2 presents a summary of financial ratios and break-even measures to analyze the financial viability of the three alternative production methods relative to that of the conventional MeBr method. These results were obtained from cost and return estimates developed using the experimental yield results for Jumbo and U.S. 1 & 2 peppers reported in Table 1.

Among the four production systems, the C35-KPAM method generates the highest net income level at $1,438 per acre. The C35-Chloropicrin method is the least profitable option with a net income of $142 per acre. The MeBr method was outperformed by the C35-KPAM method in profitability in spite high savings on fumigation costs under the MeBr option. This can be attributed to the more favorable yield structure of the C35-KPAM method, which produced significantly more of the high-priced Jumbo peppers than the MeBr method.

The financial efficiency (net income ratio) rankings are similar to those of the net income levels. The combined effects of the varied yield and cost structures across production methods resulted in the C35-KPAM method generating the highest net profit margin of 9.7 percent among the four options. Expectedly, the C35-Chloropicrin method yielded the lowest net profit margin of 1.1 percent.

A comparison of the ratios of variable costs to gross revenues indicate that the C35-KPAM method, with a ratio of 0.8409, has the greatest cushion for absorbing unexpected fixed cost increases and/or reductions in the peppers' selling prices. This indicates if fixed cost increases and/or gross revenue reductions do not exceed 16 percent of current gross revenues, the farm stands to generate positive net returns from production. For both the MeBr and Telone II-Chloropicrin methods this cushion is approximately 13 percent while the C35-Chloropicirin method's cushion is only 8.5 percent.

Finally, break-even statistics were calculated for each method. Break-even analysis is traditionally a type of simulation analysis with the objective of determining what volume of

production, value of sales, or value of production inputs will result in the firm experiencing zero net revenue or breaking-even. Using experimental yields as a basis for revenues and production costs, the Telone II-Chloropicrin method will require the least revenues ($11,955 per acre) to break-even among the four methods. The C35-KPAM method, though the most profitable and financially efficient, will require the highest break-even revenue of $13,388 per acre.

Using the weighted prices (calculated with the average market prices and relative weights of yields of Jumbo and U.S. 1 & 2 peppers) in Table 1, the break-even revenues were converted into yield levels. These levels range from 1,050 (Telone II-Chloropicrin) to 1,172 (C35-KPAM) cartons per acre.

Equivalently, the break-even revenues were converted to break-even selling prices, which were derived using the relative yield weights of the Jumbo and U.S. 1 & 2 peppers. The resulting break-even prices ranged from $10.21 (C35-KPAM) to $11.04 (C35-Chloropicrin) per carton representing 90.3 percent and 98.9 percent of the weighted actual prices, respectively.

These results indicate that while the C35-KPAM method has the highest break-even revenue level, it remains the most preferred method as farmers can afford a price as low as 90.3 percent of the weighted actual price to break-even. The C35-Chloropicrin method has a much higher price threshold and least amount of leeway as producers cannot afford a price lower than 98.9 percent of their weighted actual price to break-even.

### Constant Yield Results

Further analysis is possible by ignoring yield structure differences, such as the composition and yield levels of the two grades of peppers (Jumbo and U.S. 1 & 2). In this analysis, we instead assume constant yields of 1,200 cartons per acre. This constant yield has been suggested in consultations with field scientists and producers in Georgia concerning realistic assumptions involving the expected yields generated by MeBr. The average price of $11.68 per carton used in this analysis was derived as the average of 2003 fall and spring prices of both Jumbo and U.S. 1 & 2 peppers. MeBr is the base-case for this study, so holding these expected yields constant allows producers to completely isolate costs within the cost and return analysis and determine the effects that these costs have on net revenues (Table 3).

Under a constant yield scheme, MeBr replaced C35-KPAM as the production method generating the largest net returns. Specifically, MeBr generated net income of $1,700/acre while C35-KPAM produced $1,242/acre, with a drop in ranking to third most profitable method. C35-Chloropicrin remains as the least profitable operation with net returns of only $976/acre. Net returns as a percent of gross returns increased, relative to experimental yields' net returns, by 5.9 percent for C35-Chlroropicrin, 5.4 percent for MeBr, and 4.9 percent for Telone II-Chloropicrin, but decreased by 0.8 percent for C35-KPAM.

C35-Chloropicrin will require the highest break-even revenue, consistent with its ranking as the most expensive fumigation method among the four alternative systems. MeBr, which incurs the least fumigation cost, has the lowest break-even sales, which requires the producers to produce at only 88 percent of the assumed yield of 1,200 cartons/acre (at the assumed selling price) or sell for a discount of 88 percent of the average selling price (at the assumed constant yield level). C35-Chloropicrin, on the other hand, will have higher yield and selling price thresholds to break-even at 93 percent of the assumed yield and average selling price.

### Sensitivity Analyses

The enterprise cost and return estimates are further analyzed to determine the sensitivity of return and break-even measures to sudden fluctuations in input costs and selling prices of the two grades of pepper. The original experimental yield data and gross revenue calculation method used in Table 2 are employed for this analysis.

Table 4 presents the results of the first sensitivity analysis involving a 5 percent overall increase in variable costs. The summary statistics indicate that producers will be able to sustain such cost increases in three of the four methods while a net loss of $448 per acre is estimated for the C35-Chloropicrin method. Net profit margins expectedly dropped by about 4 percent with C35-Chloropicrin experiencing a larger reduction of 4.6 percent compared to the others. An increase in break-even sales due to the assumed incremental variable costs will require farmers to sell from 95 to 98 percent of the actual weighted selling price in order for the three profitable operations to break-even.

The second financial durability test assumes a 5 percent reduction in the selling prices of Jumbo and U.S. 1 & 2 peppers.

The results of this sensitivity analysis, which are presented in Table 5, expose again the financial vulnerability of C35-Chloropicrin which will experience an estimated net loss of $503 per acre. The other three methods are able to sustain profitable operations despite the assumed price reduction. The drop in net margins ranges from 4.75 percent for C35-KPAM to 5.20 percent for C35-Chloropicrin. Break-even revenue levels, which remain unchanged from the levels reported in Table 2, are translated to break-even selling prices equivalent to 95 to 99 percent of the new weighted (reduced) selling prices for the three profitable operations.

The rankings of financial (net return) efficiency in the analysis remain unchanged. Whether inflationary pressures drive production costs higher or the farm sector experiences a plunge in commodity selling prices, the C35-KPAM maintains its dominance as the most profitable production system. The Telone II-Chloropicrin method is also able to endure these economic shocks and produce profitable operations, although the Telone II-Chloropicrin production system's return and break-even levels do not outperform the MeBr method.

## Summary and Conclusions

Georgia field trials have identified at least three production systems involving combinations of three fumigant chemicals and a commonly prescribed herbicide system that can be adopted by Georgia bell pepper producers to replace MeBr. Results of the two-year field experiments establish the production efficacy of these systems in controlling weeds (especially nutsedge), nematodes, soil-borne pests, and diseases, while at the same time producing yields that are better or closer to levels that farmers experience under the conventional MeBr fumigation method. Moreover, the propagation of such alternatives is guided by the more urgent priority that such methods will not increase environmental externalities, such as the depletion of the ozone layer which has led to the banning of MeBr.

This study extends the analysis of viable fumigant alternatives to MeBr by transforming yield and production cost information from the field trials into enterprise cost and return estimates to analyze the financial efficiency of Georgia pepper enterprises under the suggested new production methods. Results of our analyses indicate that C35-KPAM outperforms other production

systems, including MeBr, in terms of income generation and cost efficiency. Further analyses indicate that this method is most capable of sustaining sudden cost increments and selling price reductions. C35-Chloropicrin has consistently lagged behind the other production methods in all financial efficiency analyses. Under normal operating conditions, this method is only marginally profitable. Its financial vulnerability, which results in net losses, is exposed once price and cost fluctuations are factored into the analysis.

Much of the financial dominance of C35-KPAM can be attributed to its favorable yield structure characterized by its ability to produce a larger proportion of the highly-priced Jumbo peppers relative to regular U.S. 1 & 2 pepper grade. This is evident in an analysis of a simulated version of enterprise cost and return estimates that ignored variability of yield and pricing structures across methods. In this analysis, MeBr dominates the financial efficiency rankings while C35-KPAM ranks third only, outperformed by Telone II-Chloropicrin that has always ranked third in all analyses involving experimental yields.

Our results suggest that economically viable alternatives exist for Georgia pepper producers to replace MeBr. However, the successful adoption of these alternatives has yet to be determined and could depend on two critical factors. First, producers have relied on the MeBr's ability to eradicate diseases, weeds, and pests over a wide range of environmental conditions and growing conditions. Actual on-farm utilization of the suggested fumigants can only ascertain whether, like MeBr, the alternatives are equally flexible and adaptable to different farm conditions (such as irrigation levels, soil conditions, diseases, or pests not captured by the experiments). Moreover, producers have already established the consistency of yields under MeBr over time. Although alternatives have been found to be equally (at times even more) productive in experimental trials, there is not enough information that they can deliver consistent yields over the long-term.

Notwithstanding these concerns, Georgia bell pepper producers are pressed for time to make the transition to new fumigation methods as MeBr will be completely eliminated when the critical use exemption period expires. The adoption of new technologies, however, cannot be successfully implemented

overnight. Cooperative efforts among scientists should be well coordinated and complementary in order to effectively communicate educational tools to aid in technology adoption decisions. The enterprise cost and return estimates developed in this study can provide an important economic perspective for Georgia pepper producers deciding on the appropriate fumigation alternative for their farm operations. After all, whatever works both in field experiments and in actual farming situations is not necessarily economically sustainable and viable. At the end of the day, the farmer needs to know whether his/her farm business can thrive through the following day or through the next production season.

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**Table 1. Experimental Yield Results and Gross Revenues, Average of Three Planting Seasons**

| Measure and Product Type | Fumigation Method | | | |
| | Methyl Bromide | C35 – KPAM | C35- Chloropicrin | Telone II - Chloropicrin |
|---|---|---|---|---|
| Jumbo Peppers | | | | |
| Pounds per acre | 10,222 | 15,000 | 10,556 | 12,556 |
| Cartons per acre | 365 | 536 | 377 | 448 |
| % of Total Yield | 31.28 | 41.29 | 32.64 | 40.04 |
| Price ($) per carton | 13.16 | 13.16 | 13.16 | 13.16 |
| Dollar Value | 4,804 | 7,054 | 4,961 | 5,896 |
| U.S. 1 & 2 Peppers | | | | |
| Pounds per acre | 22,444 | 21,333 | 21,778 | 18,778 |
| Cartons per acre | 802 | 762 | 778 | 671 |
| % of Total Yield | 68.72 | 58.71 | 67.36 | 59.96 |
| Price ($) per carton | 10.20 | 10.20 | 10.20 | 10.20 |
| Dollar Value | 8,180 | 7,772 | 7,936 | 6,844 |
| Weighted Price ($)* | 11.13 | 11.42 | 11.17 | 11.39 |

*\* The weighted price is calculated by multiplying a variety's unit price by the proportion of the variety's yield to the sum of all varieties' yields.*

**Table 2. Cost, Return, and Break-even Analysis, Using Mean Experimental Yields**

| Measure and Product Type | Fumigation Method | | | |
| | Methyl Bromide | C35 – KPAM | C35- Chloropicrin | Telone II – Chloropicrin |
|---|---|---|---|---|
| Gross Revenues ($) | 12,984 | 14,826 | 12,897 | 12,740 |
| Fumigation Cost | 405 | 786 | 1,007 | 528 |
| Total Variable Cost | 11,247 | 12,468 | 11,801 | 11,076 |
| Total Fixed Cost | 860 | 920 | 954 | 879 |
| Net Income | 877 | 1,438 | 142 | 749 |
| Ratio and Break-Even Analysis | | | | |
| Net Income Ratio (%) | 6.75 | 9.70 | 1.10 | 6.16 |
| Variable Cost- Revenue Ratio (%) | 86.62 | 84.09 | 91.5 | 86.94 |
| Fumigant Cost – Revenue Ratio (%) | 3.12 | 5.30 | 7.81 | 4.14 |
| Break-Even (B/E) Sales ($) | 12,107 | 13,388 | 12,755 | 11,955 |
| B/E Yield (ctns/acre) | 1,088 | 1,172 | 1,142 | 1,050 |
| B/E Jumbo yield (ctns/acre) | 340 | 484 | 373 | 420 |
| B/E US 1&2 yield (ctns/acre) | 748 | 688 | 769 | 630 |
| B/E Price ($/ctn) | 10.37 | 10.31 | 11.04 | 10.68 |
| % of B/E to weighted actual price | 93.25 | 90.30 | 98.90 | 93.84 |

**Table 3. Cost, Return, and Break-even Analysis, Using Constant Yields across Production Methods**

| Measure and Product Type | Fumigation Method | | | |
| | Methyl Bromide | C35 – KPAM | C35- Chloropic | Telone II – Chloropicrin |
|---|---|---|---|---|
| Gross Revenues ($) | 14,016 | 14,016 | 14,016 | 14,016 |
| Fumigation Cost | 405 | 786 | 1,007 | 528 |
| Total Variable Cost | 11,247 | 11,068 | 11,078 | 11,057 |
| Total Fixed Cost | 860 | 920 | 954 | 879 |
| Net Income | 1,700 | 1,242 | 976 | 1,552 |
| Ratio and Break-Even Analysis | | | | |
| Net Income Ratio (%) | 12.13 | 8.86 | 6.96 | 11.07 |
| Variable Cost- Revenue Ratio (%) | 81.74 | 84.57 | 86.22 | 82.66 |
| Fumigant Cost – Revenue Ratio (%) | 2.89 | 5.61 | 7.18 | 3.77 |
| Break-Even (B/E) Sales ($) | 12,316 | 12,774 | 13,040 | 12,464 |
| B/E Yield (ctns/acre) | 1,054 | 1,094 | 1,116 | 1,067 |
| % of B/E to assumed yield | 87.83 | 91.17 | 93.00 | 88.92 |
| B/E Price ($/ctn) | 10.26 | 10.64 | 10.87 | 10.39 |
| % of B/E to actual average price | 87.84 | 91.10 | 93.07 | 88.96 |

**Table 4. Increased Variable Cost Scenario: Cost, Return, and Break-even Analysis**

| Measure and Product Type | Fumigation Method | | | |
| | Methyl Bromide | C35 – KPAM | C35- Chloropicrin | Telone II – Chloropicrin |
|---|---|---|---|---|
| Net Income | 314 | 815 | -448 | 231 |
| Net Income Ratio (%) | 2.42 | 5.50 | -3.47 | 1.81 |
| Variable Cost- Revenue Ratio (%) | 90.95 | 88.30 | 96.08 | 91.29 |
| Fumigant Cost – Revenue Ratio (%) | 3.28 | 5.57 | 8.20 | 4.35 |
| Break-Even (B/E) Sales ($) | 12,669 | 14,011 | 13,345 | 12,509 |
| B/E Yield (ctns/acre) | 1,139 | 1,227 | 1,195 | 1,099 |
| B/E Jumbo yield (ctns/acre) | 356 | 507 | 390 | 440 |
| B/E US 1&2 yield (ctns/acre) | 783 | 720 | 805 | 659 |
| B/E Price ($/ctn) | 10.86 | 10.79 | 11.55 | 11.18 |
| % of B/E to weighted actual price | 97.58 | 94.50 | 103.47 | 98.19 |

**Table 5. Selling Price Reduction Scenario: Cost, Return, and Break-even Analysis**

| Measure and Product Type | Fumigation Method | | | |
| | Methyl Bromide | C35 – KPAM | C35- Chloropicrin | Telone II – Chloropicrin |
|---|---|---|---|---|
| Net Income | 228 | 697 | -503 | 148 |
| Net Income Ratio (%) | 1.85 | 4.95 | -4.10 | 1.22 |
| Variable Cost- Revenue Ratio | 91.18 | 88.52 | 96.32 | 91.52 |
| Fumigant Cost – Revenue Ratio | 3.28 | 5.58 | 8.22 | 4.36 |
| Break-Even (B/E) Sales ($) | 12,107 | 13,388 | 12,755 | 11,955 |
| B/E Yield (ctns/acre) | 1,145 | 1,234 | 1,202 | 1,105 |
| B/E Jumbo yield (ctns/acre) | 358 | 509 | 392 | 443 |
| B/E US 1&2 yield (ctns/acre) | 787 | 724 | 810 | 663 |
| B/E Price ($/ctn) | 10.37 | 10.31 | 11.04 | 10.68 |
| % of B/E to weighted actual price | 98.15 | 95.05 | 104.10 | 98.78 |