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Financial Analysis of Methyl Bromide and Mulch Alternatives for Bell Pepper in Georgia

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Foreword

This report is aimed at providing necessary planning data to farmers, research and Extension staffs, lending agencies and others in agriculture. Estimated general costs per acre are displayed and space is provided for users to compare their values.

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The commercial products mentioned and/or used in this study do not imply endorsement by the authors, the University of Georgia or the College of Agriculture and Environmental Sciences over other products not named, nor does the omission imply they are not satisfactory. These are simply the products used for this research.

Introduction

This research is aimed at seeking the best fumigant substitute for methyl bromide (MB) along with the perfect mulch complement that effectively enhances production yield and profitability potential. The study is a follow-up of an earlier work by Ferrer, Fonsah and Escalante (2011) for which some sections were extracted. The main goal of this report is to make the alternatives accessible to farmers through different planning budgets they could use in decision making. Twenty-four budgets for the alternative production systems were utilized to develop the stochastic dominance analysis that determined the rankings of the fumigant and mulching techniques in the earlier study. A more detailed evaluation on the difference in costs and returns between alternatives is presented in this report to facilitate readability and understanding for a broader target audience.

Although the entire agricultural community can directly or indirectly benefit from this study, our target audiences are specialists, farmers, researchers, Extension agents, lending agencies, students, ag-business managers and policy makers. Bell pepper was purposely selected for the study because any fumigant system that works for this crop would also work for other commercial crops such as tomatoes, cucumbers, squash and zucchini produced in the state. The study revealed several superior alternatives to MB. For instance, Telone II with metam sodium combined with smooth low density black on black polyethylene mulch alternative revealed the highest profitability potential for growers. Several other better alternatives have been condensed and summarized to evaluate differences in costs and returns. Furthermore, there are ongoing studies for new and better alternatives such as paladin + pic system but there is not enough data to carry out economic analysis and/or determine the financial lucrativeness of the new research findings vis-à-vis the alternatives in this study (see www.gaweed.com). The data used for this study was collected in 2009 and since then there have been several changes in terms of input prices.

The use of fumigants has been an integral part in the production of certain key commercial vegetables in Georgia and the United States in general. According to Ferrer, Fonsah and Escalante (2011), although several chemicals have been used as fumigants in the past, methyl bromide has been the most extensively used commercial chemical because it is easy to use, less expensive compared to others and more effective. It is also used to control pests and noxious weeds like various nutsedges, which are the most problematic in the state of Georgia.

In 1995, production of methyl bromide was recommended to be discontinued since it was listed as an ozone depleting substance, according to the Montreal Protocol. This became a major concern to U.S. growers, particularly to commercial vegetable farmers in Georgia who were highly dependent on the product. Currently, most farmers are producing under the Critical Use Exemption (CUE), which allows them to use some methyl bromide in production given that they can provide sufficient proofs that they have no alternative chemicals for methyl bromide and its elimination in production would result in economic hardship (Byrd et al., 2006).

The state of Georgia at large and/or the Georgia Fruit and Vegetable Growers Association's (GFVGA) application for CUE included squash, tomato, pepper, cantaloupe, eggplant and cucumber. However, even though farmers still have access to methyl bromide, supplies are declining while prices are increasing, making research on the development of new alternatives to methyl bromide imperative (Kelley, 2009).

Fumigation – Mulch Systems

Five fumigant treatments and four different mulching methods were selected for field trials by the University of Georgia Extension Specialists at the Coastal Plain Experimental Station, Tifton, Georgia in 2006 (Culpepper, 2006). Methyl bromide was included as a basis for comparison. The study was intended to investigate an effective control for nutsedge, a weed that is highly competitive and problematic for peppers and other important commercial vegetables in the state. It also investigated the presence of nematodes, a destructive pest that attacks the root system of vegetable crops, affecting the yields significantly. The fumigant and mulch alternatives are presented in Table 1 with their corresponding abbreviations, which will be used to address each system for the rest of this report.

Table 1. Alternative fumigant and mulch systems and their abbreviations.

	Abbreviation
Fumigant	
Methyl Bromide plus Chloropicrin	MB
Methyl Iodide plus Chloropicrin [1]	MIDAS
Chloropicrin-250	PC250
Chloropicrin-400	PC400
1,3-Dichloropropene plus Chloropicrin	TEL
1,3-Dichloropropene plus Chloropicrin and Metam Sodium	TELV
Mulch	
Traditional Low Density Black on Black Polyethylene Mulch	LDPE
Smooth Low Density Black on Black Polyethylene Mulch	MS
High Barrier Black on Black Blockade Mulch	S
High Barrier Silver on Black Metalized Mulch	VIF-D
[1]MIDAS is not used in Georgia but was used for this study.	

The experimental design paired each fumigant factorially with every mulching method, resulting in 24 fumigant-mulch alternatives. The experiment included five successive weeks of harvest, whereas a normal production cycle averages four harvests only, so yield data were rearranged allowing for five replications per system in comparison. The gross and net return values were obtained from the alternative fumigant-mulch enterprise budgets for bell pepper developed by the UGA Extension Agricultural Economics Team displayed in the next section.

The Enterprise Budget

The budget presented in this report was prepared to provide general information for several different uses. It provides information concerning general levels of costs that need to be adjusted for specific situations upon personal use of the budgets. Most users should think of these budgets as a first approximation and then make appropriate adjustments using the "Yours" column provided on each budget to add, delete or change costs to reflect their specific situations. The budget reflects the cost of production per planted acre. It allows the producer to determine the break-even price needed for the vegetable grown. A sensitivity table reflecting different yields per acre compared to different market prices received for vegetables allows producers to estimate potential net returns (Table 2a).

Both gross and net return measures were calculated under five possible risk-rated pricing outcomes, namely best, optimistic, median, pessimistic and worst. The "median" yield was the actual average obtained from research harvesting data. The "optimistic" and "best" assumed 10 and 18.5 percent increase in yields, respectively, while "pessimistic" and "worst" assumed 11 and 23 percent decrease, respectively. The "median" price was the average obtained by Georgia bell pepper growers in 2011. The "optimistic" and "best" assumed 14 and 25 percent increase in price, respectively, while "pessimistic" and "worst" assumed 11 and 33 percent decrease in price, respectively. Additional input prices such as fertilizers, mulches, fungicides and other chemicals for pest and disease control were obtained from vendors, farmers and Extension county agents (Fonsah et al., 2007; Fonsah and Hudgins, 2007; and Fonsah et al., 2008).

Tables 2a and 2b illustrate the planning budget and detailed input costs, respectively. Only the budget for methyl bromide on a traditional low density black on black polyethylene mulch (MB-LDPE) production system is displayed as a guide. The same budget is used for the other production systems except for the items affected by the use of different fumigant-mulch alternatives. In the interest of space allocation, a summary table showing the differences on mean yield, fumigation and mulching costs, and total variable and fixed costs is presented in Table 3. To see the full budget for a specific production system, replace the mean yield, fumigation and mulching costs, and total variable and fixed costs in Table 2 with the specified values in Table 3. Further information regarding the details of input costs can be provided upon request.

The interest rate used for operating/variable costs (e.g., for the short-term loans) was 7 percent and was the going rate at the time. The interest rate used for fixed costs (tractor, plow, disk, bedder, transplanter etc.) and the irrigation system (pipe and fittings, well, pump and motor, etc.) was the going rate of 5 percent for the long-term loans. A fixed cost per hour of use of machinery (tractor and equipment, irrigation etc.) depicts ownership cost that was computed by first determining the capital recovery factor. Thereafter, this factor was utilized to estimate the annual capital recovery charge, taking into consideration depreciation, interest, taxes and insurance (Fonsah and Hudgins, 2007; Fonsah et al., 2007; Fonsah et al, 2008). Irrigation costs, investment and annual fixed costs and fixed payments are standard for each budget. Details of such costs can be found in the Appendices.

Table 2a: Estimated per acre resource use and costs for field operations, bell pepper production with methyl bromide (MB) on traditional low density black on black polyethylene mulch (LDPE) in Georgia, 2011.

	BEST	OPTIMISTIC	MEDIAN	PESSIMISTIC	WORST
Yield (cartons)	1702	1545	1387.05	1229.46	1072
Price per carton	16.00	14.00	12.00	10.00	8.00
Item	**Unit**	**Quantity**	**Price**	**Amt./acre[1]**	**Yours**
Variable Costs					
Plants	Thousand	7.50	$29.50	$221.25	
Lime, applied	Ton	1.00	$28.50	$28.50	
Base Fertilizer	Ibs.	12.00	$26.41	$316.88	
Side-dress Fertilizer (soluble)	Gal.	60.00	$2.82	$169.37	
Insecticide	Acre	1.00	$240.16	$240.16	
Fungicide	Acre	1.00	$349.02	$349.02	
Nematicide	Acre	1.00	$822.88	$822.88	
Herbicide	Acre	1.00	$111.68	$111.68	
Plastic	Roll	2.80	$68.50	$191.80	
Plastic Removal	Acre	1.00	$75.00	$75.00	
Drip Tape	Ft	8700.00	$0.02	$174.00	
Fumigation and Mulching	Acre	1.00	$2,220.33	$2,220.33	
Machinery	Hr.	5.00	$21.00	$105.00	
Transplant Labor	Hr.	20.00	$7.00	$140.00	
Labor	Hr.	33.00	$6.00	$198.00	
Land rent	Acre	1.00	$110.00	$110.00	
Irrigation (Mach + Labor)	Acre	1.00	$65.08	$65.08	
Interest on Operation Capital	$	5538.94	$0.07	$193.86	
Pre-Harvest Variable Costs				**$5,732.81**	
Harvest and Marketing Costs					
Picking and hauling	Ctn.	1387	$0.85	$1,178.99	
Grading and packing	Ctn.	1387	$1.10	$1,525.75	
Container	Ctn.	1387	$0.75	$1,040.29	
Marketing	Ctn.	1387	$1.02	$1,414.79	
Total Harvest and Marketing			**$3.72**	**$5,159.82**	
Total Variable Costs				**$10,892.63**	
Fixed Cost					
Machinery	Acre	1.00	$53.59	$53.59	
Irrigation	Acre	1.00	$220.65	$220.65	
Land	Acre	1.00	$0.00	$0.00	
Overhead and Management	$	5732.81	$0.15	$859.92	
Total Fixed Costs				**$1,134.16**	
Total budgeted cost per acre				**$12,026.79**	

	Optimistic		**Expected**		**Pessimistic**		
Returns($)	9,216	7,683	6,151	4,618	3,085	1,552	19
Chances	7%	16%	31%	50%	31%	16%	7%
CHANCES FOR PROFIT		**93%**	**BASE BUDGETED NET REVENUE**				**4,618**

[1]There may be rounding errors.

Table 2b: Input costs for bell pepper production with methyl bromide on traditional low density black on black polyethylene mulch (LDPE) in Georgia, 2011*.

	No. Appl.	Unit	Quantity	Price	Amount
Base Fertilizer (granular)					
Nitrogen	1.00	lbs.	233.00	$ 0.71	$165.43
Phosphorus	1.00	lbs.	233.00	$ 0.23	$53.59
Potassium	1.00	lbs.	233.00	$ 0.42	$97.86
Lime	1.00	Ton	1.00	$ 28.50	$28.50
Total Base Fertilizer		**lbs.**			**$316.88**
Sidedressing (soluble)					
Nitrogen	3.00	Ton	0.27	$ 349.50	$94.37
Potassium	3.00	Ton	0.15	$ 250.00	$37.50
Phosphorus	3.00	Ton	0.15	$ 250.00	$37.50
Total Sidedresing					**$169.37**
Fungicide					
Quadis	3.00	fl. oz.	36.00	$ 2.95	$106.20
Cabrio	3.00	oz.	36.00	$ 1.74	$62.64
Maneb	7.00	lbs.	14.00	$ 3.13	$43.82
Copper	7.00	lbs.	14.00	$ 3.09	$43.26
Ridomil Copper	1.00	lbs.	2.50	$ 13.04	$32.60
Ridomil EC	1.00	pt.	0.50	$ 121.00	$60.50
Total Fungicide					**$349.02**
Nematicide					
Nematicide application	**1.00**	**lbs.**	**1.00**	**$822.88**	**$822.88**
Fumigation					
Methyl Bromide	1.00	lbs.	347.00	$ 5.45	$1,891.15
Mulching					
LDPE	1.00	roll	2.18	$ 151.00	$329.18
Total Fumigation					**$2,220.33**
Insecticide					
Asana (Weevil/caterpillar)	3.00	Gal	0.24	$ 103.57	$24.86
Vydate (weevil)	1.00	Gal	0.25	$ 73.46	$18.37
Spintor (caterpillar)	2.00	Gal	0.05	$ 781.20	$39.06
Orthene (thrips)	1.00	lbs.	0.50	$ 9.05	$4.53
Admire (thrips, aphits, whitefly)	1.00	Gal	0.13	$ 875.00	$113.75
Agrimek (broad mites & two spotted mite)	1.00	Gal	0.07	$ 565.80	$39.61
Total Insecticide					**$240.16**
Weed Control					
Methyl Bromide 67/33	1.00	lbs.	150.00	$ 0.00	$0.00
Dual Magnum +	1.00	Gal	0.13	$ 106.37	$13.30
Command	1.00	Gal	0.23	$ 112.42	$25.29
Devrinol	1.00	lbs.	3.70	$ 10.47	$38.74
Common pre-emergence (Surflan)	1.00	Gal	0.25	$ 47.96	$11.99
Gramozone+Boa	2.00	Gal	0.50	$ 33.85	$16.93
Crop oil concentrated	2.00	Gal	0.50	$ 10.87	$5.44
Total Weed Control					**$111.68**

*The commercial products mentioned and/or used in this study do not imply endorsement by the authors, the University of Georgia or the College of Agriculture and Environmental Sciences over other products not named, nor does the omission imply they are not satisfactory. These are simply the products used for this research.

Table 3: Summary of differences in median yield and costs among the alternative systems.

Production Systems	Median Yield (in cartons)	Fumigation and Mulching Cost[a] ($)	Total Variable Cost[a] ($)	Total Fixed Cost[a] ($)
MB-LDPE	1387.05	2220.33	10892.63	1134.16
MB-MS	1598.19	2490.65	11957.84	1176.13
MB-S	1374.29	2490.65	11124.95	1176.13
MB-VIF-D	1399.05	2414.35	11138.10	1164.28
MIDAS-LDPE	1478.01	4305.80	13389.45	1457.93
MIDAS-MS	1553.52	4576.12	13950.16	1499.90
MIDAS-S	1413.24	4576.12	13428.29	1499.90
MIDAS-VIF-D	1128.81	4499.82	12291.26	1488.05
PC250-LDPE	1387.06	991.68	9621.02	943.41
PC250-MS	1529.01	1262.00	10428.84	985.38
PC250-S	1442.67	1262.00	10107.65	985.38
PC250-VIF-D	1308.25	1185.70	9528.66	973.54
PC400-LDPE	1263.19	1389.18	9571.63	1005.13
PC400-MS	1360.50	1659.50	10213.40	1047.09
PC400-S	1415.97	1659.50	10419.76	1047.09
PC400-VIF-D	1335.33	1583.20	10040.82	1035.25
TEL-LDPE	1288.79	948.68	9210.96	936.74
TEL-MS	1508.68	1219.00	10354.09	971.58
TEL-S	1428.16	1219.00	10009.18	978.71
TEL-VIF-D	1242.25	1142.70	9238.63	966.86
TELV-LDPE	1490.13	1286.18	10309.24	989.14
TELV-MS	1621.90	1556.50	11079.20	1031.10
TELV-S	1453.17	1556.50	10451.52	1031.10
TELV-VIF-D	1409.89	1480.20	10211.57	1019.26

[a] Further information on details of input costs can be provided to the reader upon request.

Table 3 provides the summary of differences in costs as a result of different fumigant-mulch alternatives. Columns 2 to 5 represent the items in the budget that are affected by the use of different production systems. The mean yield varies between alternatives because different production systems have different production efficiencies. Obviously, fumigant and mulching costs are directly affected due to different prices and amounts used in production. As a result, the total variable cost also varied, although these costs are not the only factor. The interest on operating capital was affected because it is dependent on the total operating cost, whereas the harvest and marketing costs changed due to dependency on the median yield. The change in total fixed costs, on the other hand, is attributable to the overhead and management cost, which is dependent on the pre-harvest variable cost.

The Best and Worst Alternatives

Among the alternatives taken into consideration, results showed that several alternatives performed better than MB. To make it straightforward to the intended users and to have a direct approach, a simple ranking of the gross and net revenues were undertaken. The rankings were consistent with the findings under low- and neutral-risk situations of Ferrer, Fonsah and Escalante (2011), which accounts for a farmer's risk preferences in decision making. Furthermore, the overall outcome of the earlier work and this report still runs parallel, making this report a useful tool for farm decision making. However, if further details on different levels of risk-related decision making are desired, especially for high-risk averse farmers, it is suggested to refer to the earlier published study of Ferrer, Fonsah and Escalante (2011), which uses stochastic dominance analysis.

The alternatives highlighted in red are the top three alternative production systems while the ones highlighted in green are the bottom three production systems (Table 4). The ranking goes from 1 to 24 (1 being the best and 24 the worst). TELV-MS was the superior choice among the alternatives considered. This option was exceptionally robust since it ranked first both for gross and net returns rankings. Next to TELV-MS, after weighing all factors, were PC250-MS and TEL-MS. The second and third place between the gross and net returns rankings were different but it is better to look at the net revenue results since it considers the production costs. Also note that all of the top rankings used MS as the mulching option, indicating that it is the superior mulch option across the board. On the other hand, MIDAS-VIF-D was the least favored risk-return profile due to its high cost structure (Table 3). Moreover, the fumigant MIDAS represents the bottom three production systems, indicating that its high cost structure and low production efficiency is not a good combination and is not working in favor of farmers.

However, not all alternatives to MB under consideration necessarily performed better economically. It should be noted that some of the alternatives were ranked lower than the MB options both in gross revenues and net returns analysis. These were all due to the combination of input prices, productivity and efficacy of the alternative itself. Other alternatives exhibited superiority to MB after the production cost structures were factored in, as evidenced by MB's inferior net rankings, giving more available options to the farmers.

The results of this study suggest that economically viable alternatives exist for Georgia pepper producers that could easily replace MB. Nevertheless, various factors affecting the successful adoption of these alternatives should be considered. Farm outcomes could vary based on the alternatives' consistency, efficiency and reliability across different farm conditions and over longer periods of time. MB has proven its ability to eradicate diseases and pests over a wide range of environmental and growing conditions over time. In this regard, only actual on-farm use of the suggested fumigants can establish whether the alternatives are as flexible and adaptable to different farm conditions as MB.

Table 4. Simple gross and net revenue rankings of the different fumigant-mulch alternatives.

Production Systems	GROSS	Rank	NET	Rank
MB-LDPE	16,644.59	16	4,617.80	17
MB-MS	19,178.23	2	6,044.26	8
MB-S	16,491.51	17	4,190.42	20
MB-VIF-D	16,788.65	14	4,486.27	19
MIDAS-LDPE	17,736.08	7	2,888.69	22
MIDAS-MS	18,642.28	3	3,192.23	21
MIDAS-S	16,958.84	12	2,030.65	23
MIDAS-VIF-D	13,545.76	24	(233.56)	24
PC250-LDPE	16,644.74	15	6,080.31	7
PC250-MS	18,348.10	4	6,933.87	2
PC250-S	17,311.99	9	6,218.96	5
PC250-VIF-D	15,699.03	20	5,196.83	13
PC400-LDPE	15,158.26	22	4,581.51	18
PC400-MS	16,325.98	18	5,065.48	14
PC400-S	16,991.67	11	5,524.81	11
PC400-VIF-D	16,024.01	19	4,947.95	15
TEL-LDPE	15,465.51	21	5,317.82	12
TEL-MS	18,104.16	5	6,778.49	3
TEL-S	17,438.00	8	5,955.38	9
TEL-VIF-D	14,907.01	23	4,701.52	16
TELV-LDPE	17,881.54	6	6,583.16	4
TELV-MS	19,462.77	1	7,352.46	1
TELV-S	17,137.91	10	6,150.02	6
TELV-VIF-D	16,918.71	13	5,687.88	10

Conclusion

This research illustrates the best fumigant substitute for methyl bromide (MB) and the best mulch complement that effectively enhances production yield and profitability potential for pepper in Georgia. Our results indicate that several alternatives out-performed MB. For instance, TELV-MS was the superior choice in terms of gross and net returns among the different alternatives considered. The runner up was PC250-MS, which ranked second and fourth in terms of gross and net returns, respectively, while TEL-MS came in third and fifth in both net and gross returns, respectively. Net return ranking is preferable since pre-harvest costs, harvesting and marketing costs, and fixed costs have all been deducted. It is important to emphasize here that all of the top-ranking alternatives adopted the MS mulching option, indicating that it is the superior mulch option across the board.

On the other hand, several alternatives were less efficient and ranked lower than the MB options both in gross revenues and net returns. For instance, MIDAS-VIF-D was the least favored risk-return profile due to its high cost structure. Moreover, the MIDAS fumigants were the bottom three production systems, indicating that its high cost structure and low production efficiency is not a good combination for Georgia growers in terms of financial lucrativeness.

These results will be useful not only to Georgia's pepper producers but also to neighboring states and the Southeast region in general since production practices are similar.

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Appendices

Appendix 1: Irrigation costs per acre of bell pepper production, fresh market (wholesale), irrigated, 6 ft. row spacing, 16 gpm with 7,260 ft. of drip tape, in Georgia, 2011.

VEGETABLE DRIP IRRIGATION					
Acres in system				40.00	
Interest Rate				5.00%	
Row width in feet				6.00	
Price of Tape ($/ft.)				$0.02	
Years tubing is to be used				1.00	
Investment		**Years**	**Depreciation**	**Interest**	**Taxes & Ins. [1]**
Pipe & fittings	8000.00	20	400	280	$ 60.00
Storage tanks	500.00	10	50	18	$ 3.75
Well	6500.00	25	260	228	$ 48.75
Pump & motor	4000.00	12	333	140	$ 30.00
Filter & Auto	250.00	10	25	9	$ 1.88
Injection system	750.00	10	75	26	$ 5.63
Tubing	5800	1	5800	203	$ 43.50
Installation	8500.00	20	425	298	$ 63.75
TOTAL	**34300**		**7368**	**1202**	**$ 257.26**
TOTAL ANNUAL FIXED COSTS					**$ 8,827.26**
TOTAL ANNUAL FIXED COSTS PER ACRE					**$ 220.68**
OPERATING COSTS					
Motor size (HP)				**Total**	**Per Acre**
Repairs				15.00	
Annual pumping hours				185.00	4.63
Electricity				2500.00	
Demand (standby charge) per year					
Rate $ per KWH				180.00	
Annual energy cost				0.08	
Annual energy cost per acre				2418.00	60.45
OPERATING COST PER ACRE PER YEAR					**$65.08**

[1]There may be rounding errors.

Appendix 2: Investment and annual fixed costs per acre of bell pepper production, fresh market (wholesale), irrigated, 6 ft. row spacing, 16 gpm with 7,260 ft. of drip tape, in Georgia, 2011. Number of acres of this crop: 40; Interest rate: 5.00%

EQUIPMENT COSTS FOR THIS CROP								
Item	**% of time for this crop**	**Cost**	**Salvage Value**	**Yrs. of Life**	**Depreciation**	**Int.**	**Tax & Ins**	**FC/Ac. [1]**
Tractors	10%	70000	14000	15	373	294	59	18
Plow	20%	6600	1320	10	106	55	11	4
Disk	10%	12000	2400	10	96	50	10	4
Bedder	50%	3000	600	10	120	63	13	5
Transplanter	50%	2900	580	10	116	61	12	5
Sprayer	30%	15000	3000	10	360	189	38	15
Side-dresser	20%	4500	900	10	72	38	8	3
TOTAL		**17870**	**3574**		**1243**	**751**	**151**	**54**
Interest on Investment				$750.00				
Taxes and Insurance				$151.00				
Total Annual Fixed Costs				**$2,199.00**				
Total Annual Fixed Costs Per Acre				**$54.98**				

[1]There may be rounding errors.

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