ECONOMIC EVALUATION OF METHYL BROMIDE ALTERNATIVES FOR STRAWBERRY PRODUCTION.

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The phase-out of methyl bromide in 2005 may result in the considerable financial losses for the US farmers. According to the Agricultural Research Service of the United States Department of Agriculture, "there is no known single alternative fumigant, chemical, or other technology that can readily substitute for methyl bromide (MB) in efficacy, low cost, ease of use, wide availability, worker safety, and environmental safety below the ozone layer". Possible alternatives may "include host plant resistance, biological control, alternative chemicals, and different cultural practices, either alone or in combination". The availability of the alternative control measures "will generally be limited to a specific crop or use because specific crops have widely varying requirements associated with variations in the target pests, soil types, climates, and state and local regulations" (Agricultural Research Service, USDA).

Strawberries, tomatoes, ornamentals and nursery crops, and peppers account for nearly 80 % of pre-plant methyl bromide soil fumigation. Consequently, strawberry growers present one of the major groups impacted by the new MB regulations. For example, in the southeastern United States (North Carolina, Georgia, Virginia, South Carolina) the revenue of small to mid-sized farms could decrease 15-20 % due to the phase-out of MB if a suitable replacement is not found (Cooperative State Research, Education, and Extension Service, USDA). Therefore, the purpose of this report is to evaluate the economic feasibility of the chemical alternatives that can be substituted for MB in the production of strawberries.

Methodology and Assumptions.

A cost model for a plasticulture production system was first developed for a 5 acre (2.0ha) strawberry planting in the Piedmont and Coastal Plain regions of North Carolina using MB as the standard fumigation treatment. The production practices were based on the management practices recommended by North Carolina State University extension and research specialists.

It was assumed that all the machinery and equipment were purchased new at 2001 purchase prices. The machinery and equipment used in this budget reflects machinery components that can be used for other farming enterprises in addition to growing strawberries on a typical diversified farm. Therefore the machinery expenses reflect the equipment costs for a total farm business and not just for strawberry production. The exceptions to this are the fumigation and irrigation equipment, which was used solely for strawberry production. The overhead irrigation system was a hand-moved sprinkler system used primarily for frost and freeze protection and the drip irrigation system was used for soil moisture.

Input prices were obtained from local dealers who regularly supply North Carolina strawberry growers. Because land values vary throughout the state, a land charge was not included in this budget. Hired employees were paid $8.25/h while the owner/operator was compensated at a rate of $16.39/h. These labor rates include workers' compensation, unemployment, FICA taxes and other overhead expenses as well as the base wage rate and were meant to be representative of the "true" costs of labor and not just the base wage rate.

The harvest season was assumed to last 6 weeks starting in the third week of April and continuing through May. The marketing process obviously bears a cost and this cost varies considerably depending on the marketing system producers decide to use. In this study it was assumed that all of the fruit would be sold at the farm with two-thirds of the strawberries sold through the PYO operation and one-third sold at the fruit stand. A labor charge of $1.15/6-lbs basket was added to the cost of the pre-pick strawberries; while supervision labor was compensated at a rate of $8.25/h. Supervision tasks included overseeing the pickers and checkout operations as well as the general management of the direct market operations. It was assumed that growers received $1.40/lb of pre-picked strawberries and $0.90/lb of PYO strawberries.

Partial budget analysis was used to evaluate the alternative fumigation treatments. This technique can be used to assess the effects of a relatively small production adjustment on farm profitability. The cost and yield data required for the partial budgets were drawn from the observations of the actual practices of North Carolina strawberry growers and studies of the alternative fumigation treatments conducted by the Departments of Plant Pathology and Horticultural Science of North Carolina State University.

The partial budget technique compares the negative effects of applying a new treatment relative to a base or standard treatment to the positive effects associated with the new treatment relative to the base or standard treatment. Therefore, it requires the consideration of both profitability of treatments and changes in the structure of the production costs. The typical partial budget analysis follows a seven-point format (Dalsted and Gutierrez, 1992), which includes:

A. Negative Effects:	
Added Costs attributable to the new fumigant	$ ________
Reduced Returns attributable to the new fumigant	$ ________
Total Negative Effects attributable to the new fumigant	$ ________
B. Positive Effects:	
Reduced Costs attributable to the new fumigant	$ ________
Added Returns attributable to the new fumigant	$ ________
Total Positive Effects attributable to the new fumigant	$ ________
C. Total Effects (Additional/Reduced Revenue)	$ ________

In this analysis, added costs were incurred if the alternative treatment resulted in higher fumigation costs per acre and/or the alternative treatment resulted in higher yields, and therefore higher yield-related labor and material costs. Reduced returns were incurred if the alternative treatment resulted in a lower yield, and therefore returns per acre were lower relative to methyl bromide. Costs were decreased if the alternative treatment resulted in lower fumigation costs per acre and/or the alternative treatment resulted in lower yields, and therefore lower yield-related labor and material costs. Returns were increased if the alternative treatment brought about a higher yield, and therefore the returns per acre were higher relative to the methyl bromide.

Results.
The total harvest, marketing, and production costs, using methyl bromide as the fumigant, were estimated to be $13,532 per acre (data not shown). Pre plant operations were the most expensive set of procedures costing an estimated $4,399 per acre while harvest operations were the second most expensive phase costing $3,528 per acre. Pre-harvest operations were $2,115 per acre and transplant and post plant operations totaled $2,034 per acre. Overall materials accounted for $6,470 per acre, labor costs made up $5,336 per acre, and the costs linked to owning and operating the equipment totaled $1,727 per acre.

The fumigation alternatives evaluated in this study were Telone-C35, Telone II, chloropicrin, InLine, shank-applied metam sodium, metam sodium applied through a drip irrigation system, and a non-fumigated alternative. Although field studies were also conducted for iodomethane and a combination of iodomethane and chloropicrin, these alternatives were not included in the economic analysis because of the lack of the product cost information for iodomethane.

The estimated costs of these fumigants and the labor and machinery costs associated with applying the chemical are shown in Table 1. Methyl bromide accounted for the highest fumigation costs totaling $1,267 per acre. The shank-applied metam sodium cost $1,196 per acre which reduced the fumigation cost an estimated $71.04 per acre relative to MB. Fumigating with chloropicrin cost $1,175 per acre or $92.00 per acre lower than MB. Not surprisingly, the non-fumigated alternative was cheapest option resulting in a total cost of $767 per acre or $500 per acre cheaper than MB.

The average yield estimates were synthesized from experimental plots located in Plymouth, Clayton, Bunn, NC and Vidalia, GA. Fumigation treatments varied with respect to the number of years of data and the locations of the study plots (see Table 2). The highest average strawberry yield recorded was 28,377 lbs per acre which was attained with the Chloropicrin treatments. Fumigation with Telone-C35 resulted in an average yield of 26,806 lbs per acre while the average yield for the MB treatment was estimated to be 26,673 lbs per acre. Average yields for the shank-applied metam sodium, the InLine treatment, drip-applied metam sodium, and the Telone II treatment were 26,604 lbs per acre, 24,193 lbs per acre, 24,103 lbs per acre, and 22,253 lbs per acre, respectively. The non-fumigated alternative was had the lowest average yield estimate of 20,010 lbs per acre.

The results of the partial budget analysis are presented in Table 3. Since MB is the standard or base treatment, there were no added costs or reduced returns and therefore the total effect was zero. Fumigating with chloropicrin yielded the best results with an additional return of $1,167 per acre ($2,882.5/ha) compared to the MB treatment (Table 5). The Telone-C35 treatment also resulted in a positive return of $291 per acre ($718.8/ha), while the estimated return for the shank applied metam sodium was approximately equal to MB at $3 per acre ($7.4/ha). However applying metam sodium through the drip system, the InLine drip treatment, Telone II, and the non-fumigated treatment reduced the returns relative to MB. InLine drip treatments were inferior at all three sites in 2001, possibly due to a formulation problem.

Conclusions.

This analysis indicates that based on economic efficiency and cost-effectiveness there are feasible fumigation alternatives to methyl bromide in the production of strawberries in the southeastern US. Chloropicrin showed the "best" potential in the growing conditions of the Piedmont and Coastal Plain regions of North Carolina and resulted in an estimated additional return of $1,767 per acre compared to MB. This calculation is based on 2 years of research at one site. More modest improvements were estimated for Telone-C35 (15 cumulative years of research) and shank-applied metam sodium (9 cumulative years of research) with additional returns of $291 and $3 per acre. Technical issues may persist including lack of broad spectrum control of pests (weeds, nematodes and plant pathogens) and problems related to plant-back time intervals, particularly in wet years. Variability in soil characteristics presents a challenge to achieve consistent efficacy with drip applied products. Additional research and on-farm trials should offer more information concerning the general applicability of the results presented here. The research base and economic framework developed should enable growers and other stakeholders to make more informed choices concerning the implementation of MB alternatives.

Literature Cited.

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Table 1. Estimated fumigation cost per acre associated with selected fumigation alternatives.

Fumigation Alternative	Labor ($/acre)	Machinery ($/acre)	Materials ($/acre)	Total ($/acre)	Reduced ($/acre)
Methyl bromide	$ 39.34	$ 288.06	$ 939.50	$ 1,266.90	$ 0.00
Metam sodium (shank)	$ 68.84	$ 417.53	$ 709.50	$ 1,195.86	$ 71.03
Chloropicrin	$ 39.34	$ 288.06	$ 847.50	$ 1,174.90	$ 92.00
Telone-C35	$ 39.34	$ 288.06	$ 779.50	$ 1,106.90	$ 160.00
InLine (drip)	$ 0.00	$ 6.72	$ 1,052.00	$ 1,058.72	$ 208.18
Telone II	$ 39.34	$ 288.06	$ 660.50	$ 987.90	$ 279.00
Metam sodium (drip)	$ 0.00	$ 6.72	$ 897.00	$ 903.72	$ 363.18
Non-fumigated	$ 39.34	$ 288.06	$ 439.50	$ 766.90	$ 500.00

Table 2. Estimated average yield associated with alternatives fumigation treatments: Piedmont and Coastal Plain region of North Carolina (represented locations are Plymouth, Clayton, Bunn) and Vidalia, GA.

Fumigation Alternative	Average Marketable Yield (lbs/acre)	Years Represented (cumulative yrs of research)	Locations Represented
Chloropicrin	28,377	2000 – 2001 (2)	Plymouth
Telone-C35	26,806	1996 - 2001 (15)	Plymouth, Clayton, Bunn, Vidalia
Methyl bromide	26,673	1996 - 2001 (15)	Plymouth, Clayton, Bunn, Vidalia
Metam sodium (shank)	26,604	1996 - 2001 (9)	Plymouth, Clayton
InLine (drip)	24,193	2000 - 2001 (6)	Plymouth, Clayton, Vidalia
Metam Sodium (drip)	24,103	2000 - 2001 (2)	Plymouth
Telone II	22,253	2000 -2001 (2)	Plymouth
Non-fumigated	20,010	1996 - 2001 (15)	Plymouth, Clayton, Bunn, Vidalia

Table 3. Partial budgets of the alternatives fumigation treatments: Piedmont and Coastal Plain region of North Carolina and Ga.

Fumigation Alternative	Added Costs ($/acre)	Reduced Returns ($/acre)	Total Negative Effects ($/acre)	Reduced Costs ($/acre)	Added Returns ($/acre)	Total Positive Effects ($/acre)	Additional Return ($/acre)
Chloropicrin	142.00	0.00	142.00	92.00	1,817.60	1,909.60	1,767.60
Telone-C35	11.08	0.00	11.08	160.00	141.87	301.87	290.79
Metam sodium (shank)	0.00	73.60	73.60	76.78	0.00	76.78	3.18
Methyl Bromide	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Metam Sodium (drip)	0.00	2,741.33	2,741.33	577.35	0.00	577.35	-2,163.98
InLine (drip)	0.00	2,645.33	2,645.33	414.85	0.00	414.85	-2,230.48
Telone II	0.00	4,714.67	4,714.67	547.33	0.00	547.33	-4,167.34
Non-fumigated	0.00	7,107.20	7,107.20	1,055.25	0.00	1.055.25	-6,051.95