THE EFFECT OF EXPECTED PRICE ON THE MANAGEMENT OF COTTON PRODUCTION

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Abstract

The paper applies marginal value product concepts to plant mapping yield distribution data and insecticide cost data. The implications of variable cotton prices on optimal insecticide use is discussed. In general, variable cotton prices and insecticide prices should be accounted for in biological-based management thresholds like X- node-above-white-flower termination rules or economic thresholds for insect pests.

Introduction

The marginal value product principle is implicit within biological-based management thresholds like "Node-above-white-flower" termination rules or economic thresholds for insect pests. The marginal value product principle implies that the profit maximizing level of any variable input occurs at the intersection of a value of marginal product (VMP) function and the marginal factor cost function for that input (Figure 1). The VMP curve for cotton insecticides is a function of the price of cotton and the marginal product of the input in question, i.e., $VMP = P*MP_x$. Therefore, the optimal level of insecticide varies directly with cotton price (Figure 1), provided that 1) insecticide price, w, remains relatively constant, and 2) the marginal product of insecticide is downward sloping.

This concept from first principles has important implications for the management of cotton production and the decision tools developed by researchers. Inefficient use of insecticides has long been suspected by economists who observe wide ranges of reported insecticide costs among farmers. Further, entomologists have long preached the application of simple economic thresholds in response to perceived over-use of insecticide. More recently, sophisticated decision models have been developed which incorporate plant physiology and other variables, (Mi et al., 1998; Cochran et al., 1998).

The problem of over-use of insecticides is often incorrectly classified as technical inefficiency, i.e., using inputs to produce in Stage III. Recent evaluations of termination rules using COTMAN show a reduction in insecticide use with no change in yield (Cochran et al., 1998). This suggests that the likely inefficiencies in insecticide use are allocative, not technical inefficiency. Allocative inefficiency results when input use violates the $VMP = P*MP_x$ condition, i.e., when the cost of insecticide isn't covered by the resulting increase in yield.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:238-239 (1999)
National Cotton Council, Memphis TN

Spatial/Dynamic Dimensions

A number of plant mapping studies have reported on the distribution of the value of bolls on the cotton plant. Because cotton bolls are produced over time, the spatial distribution of bolls on the plant implies a corresponding distribution of boll production through time. These studies have clear implications for late-season marginal input use decisions such as irrigation, insecticide application, and defoliation.

Optimal use of cotton insecticides is more complex in that different pests and pesticide patterns exist within the growing season. For the purposes of this paper, the insecticide use decisions in different periods are considered separately (although this would not be valid if insecticide use in the previous period influenced crop growth, insect damage, or control costs in subsequent periods, e.g., through resurgence or resistance). The latter situation would require a dynamic modeling framework.

The purpose of the paper is to examine late-season insecticide input use in terms of marginal analysis. Specifically, the results discussed by Parvin (1992) are extended to include more recent plant mapping studies (Jenkins and McCarty, 1995), current insecticide cost data, and alternative cotton prices.

Methods

The value of lint per acre distributed across different nodes was calculated following Parvin (1992) and Jenkins and McCarty (1995). The lint per acre per node was valued over the range of $0.60, $0.70 and $0.80 per pound of lint. Lint value per acre per node was then compared to the typical (modal) per acre insecticide applied at that stage of the growing season. Insecticide use data were collected from personal interviews of 15 Mississippi Delta cotton farms in 1996 and 26 farms in 1997. The sample, though not random, was selected as being representative of high management, Delta cotton farms, and included geographic representation of the entire region.

Results

Profitability Implications

Tables 1 and 2 present the distributions of cotton lint at different nodes, valued at alternative cotton prices. Table 1 represents a 1000 lb yield while Table 2 depicts a 1,500 lb yield crop. The distribution in Table 1 differs slightly from that in Table 2 due to different varieties and years. Table 1 shows that a majority of the lint and lint value is produced between nodes 10 and 15 on the cotton plant. The varieties reflected in Table 2 are earlier fruiting with a majority of the lint produced between nodes 8 and 12. The insecticide use data (same in Tables 1 and 2) shows that typical insecticide sprays are more costly as the season progresses.

Since the higher (late-season) nodes produce much less harvestable product, they are the focus of critical marginal input decision analysis. This is the time when the cost of spraying is much closer to the VMP for spraying. Thus decisions during this time can potentially save or waste money.

Based on the data in Table 1, the profit maximizing level of spraying should conclude with a $15 spray to protect the bolls at Node 18, for all three lint prices. Above Node 18, the insecticide treatment cost exceeds the VMP; profits will be reduced by trying to protect fruit that is not worth as much as the spray. Although this result is robust across all three lint prices, it is conceivable that the final optimal insecticide treatment may, at lower prices, be at an earlier node. For example, if the expected spray cost was $20/acre, the final optimal spray should be directed at Node 18 at $0.80/lb lint, but at Node 17 for $0.60/lb lint.

The results implied by the yield distribution in Table 2 are similar except that the optimal final spray (at $15/spray) should be directed at Node 17 for all three lint prices. If the cost of spraying was $12, then it would maximize profits to direct it at Node 18 only when cotton is valued at $0.80/lb (Table 2). In practice, a user of Table 1 would probably need to consider :

- number of adjacent nodes with susceptible fruit
- % loss of yield if these nodes aren't protected
- the time period that it takes susceptible fruit to reach the non-susceptible 15-day boll age vs. the residual efficacy of spraying

For example, at a given point in time there may likely be susceptible squares and bolls on nodes 17 and 18. The entomology report predicts that, by not spraying, there is a risk of losing 50% of the potential production on these nodes. If these fruiting forms can be sufficiently matured in the time provided by one additional spray, then the more realistic economic decision based on Table 1 would compare the marginal cost of spraying ($15/acre) with the value (at $0.70/lb) of 50% of the cumulative VMP at nodes 17 and 18 : VMP = 50%* ($30.02+$19.57) = $24.79/acre. In this case, the VMP exceeds the cost of spraying, and the profit maximizing decision is to make an additional spray.

These results suggest that simple decision tools like Table 1 or more complex tools like COTMAN are necessary to properly evaluate the worth of late-season insecticide sprays. It is inadequate to simply apply a biological threshold like pest density or node-above-white-flower rule without taking account of cotton prices and marginal spraying costs. If crop consultants or farmers make late season applications without accounting for the value of lint or the cost of spraying, they could conceivably waste money.

References

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Table 1. Distribution of Lint Yield and Typical Spray Costs from 1990 Beltwide Proceedings, Parvin & Cooke, 1000 lb/acre yield.

Node	Percent of Yield	*LintValue Per Acre* $0.60	$0.70	$0.80	Modal Spray Cost/Acre
21	0.27%	$1.63	$1.90	$2.17	
20	0.69%	$4.15	$4.84	$5.53	
19	1.46%	$8.77	$10.24	$11.70	$15.00
18	2.80%	$16.77	$19.57	$22.36	($12 to $21)
17	4.29%	$25.73	$30.02	$34.31	
16	6.06%	$36.34	$42.39	$48.45	
15	9.68%	$58.09	$67.77	$77.45	
14	10.67%	$63.99	$74.66	$85.32	
13	11.30%	$67.82	$79.13	$90.43	$13.00
12	12.17%	$73.02	$85.19	$97.37	($8 to $18)
11	12.14%	$72.86	$85.00	$97.15	
10	9.66%	$57.93	$67.59	$77.24	
9	7.80%	$46.81	$54.61	$62.42	$8.00
8	5.99%	$35.96	$41.95	$47.95	($6 to $13)
7	3.60%	$21.62	$25.23	$28.83	
6	1.42%	$8.53	$9.95	$11.37	$6.50
					($3 to $8)
TOTAL	100%	$600.02	$700.04	$800.05	

Table 2. Distribution of Lint Yield and Typical Spray Costs from MAFES Bulletin 1024, Jenkins and McCarty, 1,522 lb/acre yield

Node	Percent of Yield	*Lint Value Per Acre* $0.60	$0.70	$0.80	Modal Spray Cost/Acre
21					
20					
19	0.28%	$2.59	$3.03	$3.46	$15.00
18	1.11%	$10.16	$11.85	$13.55	($12 to
17	2.91%	$26.56	$30.98	$35.41	
16	4.22%	$38.55	$44.97	$51.40	
15	5.16%	$47.12	$54.97	$62.82	
14	7.41%	$67.68	$78.96	$90.24	
13	9.66%	$88.24	$102.94	$117.65	$13.00
12	11.16%	$101.94	$118.93	$135.92	($8 to $18)
11	11.16%	$101.94	$118.93	$135.92	
10	10.51%	$95.95	$111.94	$127.93	
9	11.35%	$103.66	$120.93	$138.21	$8.00
8	11.16%	$101.94	$118.93	$135.92	($6 to $13)
7	9.01%	$82.24	$95.95	$109.65	
6	4.41%	$40.26	$46.97	$53.68	$6.50
5	0.47%	$4.28	$5.00	$5.71	($3 to $8)
TOTAL	100%	$913.10	$1,065.29	$1,217.47	