FARM MANAGEMENT IMPLICATIONS OF REDUCING AGRICULTURAL POLLUTION RELATED TO COTTON PRODUCTION IN MISSISSIPPI

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Sunflower county is located in the heart of the Mississippi Delta. Agricultural pesticides applied to the 5 major crops in this county total an estimated 3,997,440 pounds of active ingredients.[1/] This amounts to 9 pounds per acre for every acre in the county.

Cotton is grown under numerous production strategies in Mississippi. However, cotton pesticide problems in Mississippi can be discussed by considering three cotton production situations: the sandy soils of the delta, the clay soils of the delta, and non-delta[2/] cotton production region.

A large percentage of the cotton grown in Mississippi is grown on the sandy soils of the Delta. The cost of producing solid cotton on that soil resource under usual input practices,[3/] is estimated to be $267.10 (Parvin et.al. 1976a). Solid cotton grown on the sandy soils of the Delta currently requires 34.02 pounds of pesticides per acre, 6.25 pounds of herbicide, 25.26 pounds of insecticide, 1.08 pounds of fungicide, and 1.43 pounds of defoliant. Cotton grown on clay soil in the Mississippi Delta requires higher herbicide rates per application. The non-delta cotton producers in Mississippi face more severe insect infestation (primarily boll weevil) than the Delta cotton producers. Consequently they apply additional insecticide applications.

Per acre returns to cotton production vary by region of the state and soil type (Table 1). Total specified expenses vary about ten dollars; however, differences in expected yield result in return estimates varying

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Table 1. Estimated cost and net return per acre, 3 production situations, cotton, usual input practices, 6 row equipment, Mississippi, 1976.

Production Situation	Delta - Sandy			Delta - Clay		Non Delta	
	Price	Quantity	Amount	Quantity	Amount	Quantity	Amount
	dol.	lb.	dol.	lb.	dol.	lb.	dol.
Cotton lint	.55	730.0	401.50	550.0	302.50	550.0	302.50
Cotton seed	.06	1132.0	67.92	853.0	51.18	853.0	51.18
Total income			469.42		353.68		353.68
Total specified expenses[1/]			267.10		258.99		257.06
Returns above specified expenses			202.32		94.69		96.62

1/ Excludes land, management and general farm overhead charges.

from approximately $95.00 to slightly more than $200.00.

What has been the effect of efforts to reduce agricultural pollution on cotton producers in Mississippi? The major pollutants are insecticides, herbicides, and soil erosion. Fungicides and defoliants are also listed as pesticides or pollutants. Fertilizer is occasionally listed as a pollutant but will not be discussed in this paper. Ginning is a portion of the production process that has been identified as contributing to air pollution.

Regulatory Activities

The organochloride insecticide, DDT, has been banned. Mercury has been banned as a seed treatment. Pesticide applicators must be licensed. Field reentry standards have been established. The labeling of pesticides is now more difficult and expensive (Hamman). However, considerably more regulatory activity has been underway. Cotton ginners have been threatened with increased air pollution control standards. There has been the threat that other organochloride insecticides (especially Toxaphene) would be banned. The organophosphorus insecticide, Methyl Parathion, has been under attack. The organic arsenic herbicides, MSMA and DSMA, have also been under attack.

To date, the major effect of pollution related activity on cotton production in Mississippi has been psychological rather than real. Most insect pests were highly resistant to DDT before it was banned. Numerous substitute seed treatment materials already existed for Mercury when it was banned. The licensing of pesticide applicators and the establishing of field reentry standards have not measurably affected Mississippi cotton producers. However, there is confusion on the part of farmers. No

one seems to know what material or activity might be banned or restricted next. However, everybody seems to know that most pollution related activity is in the area of insecticides, that insect resistance to currently available insecticides continues to develop, that stiffer standards covering the labeling of pesticides have significantly reduced the availability of new insecticides, and that insect control on cotton in Mississippi is still heavily dependant upon insecticides.

Ginning.--State air pollution standards and compliance dates have been established for cotton gins in Mississippi and all other states in the Cotton Belt.[4/] All compliance deadlines have passed. However, in view of the extreme seasonality of the ginning operation and continuing economic plight of most ginners, air pollution control boards have adopted a "go-slow" policy on enforcement.

Although air pollution control standards have not been enforced, the threat of air quality standards has had an effect. Some ginners with inadequate volumes, already facing uncertain futures, have elected to cease operation rather than to make even moderate outlays for new pollution control equipment. Consequently, some older low capacity gins have been replaced by newer, higher capacity plants. However, even the newest plants are not up to anticipated standards. What are the alternatives? Presently, there are none. Should the regulations be enforced, ginners will have to comply or cease operation.

Fungicides.--Fungicides are applied as a seed treatment and as a hopper box treatment at planting. In Mississippi, seed treatment materials are generally Cemosan and Terracost L21. These two materials amount to approximately .08 pounds of fungicide per acre. Soil treater XXX is

applied as a hopper box treatment at the rate of 1.00 pound per acre. The purpose of these materials is to help insure a stand in cool, damp weather. Fungicides are a recommended production practice.

Defoliants.--Most of the cotton acreage in Mississippi receives a defoliant treatment. Some of the acreage is double treated each year. The most popular materials are DEF or FOLEX applied at the rate of 1.30[5/] pounds per acre. Defoliation is a recommended production practice and it is unlikely that producers will not apply defoliant.

Erosion.--Currently, no erosion control standards are in effect in Mississippi. However, pressure does exist to enact some standards. Research indicates that relatively flat land is also subject to erosion problems and this is true for sandy and even clay soils of the Mississippi Delta. While soil movement and loss cannot be stopped altogether, the processes of erosion and pollution can be reduced.

MAFES[6/] is attempting to play a part in specifying the list of tillage operations that will be acceptable. Recommended tillage operations will vary by crop and by soil types. We have no recommended set of practices except for the Delta soils. It appears that we can reduce erosion from 15 tons/acre/year to approximately 5 tons/acre/year on sandy soils and from 13 tons/acre/year to 7 tons/acre year on clay soils.[7/] However, the tillage techniques that are currently being considered are not appropriate for approximately 75 percent of the cotton acreage in the state. We currently do not have the technology to specify a set of recommended tillage practices for each specific land resource that could be used for cotton production.

Herbicides.--At the present time no cotton herbicides have been

banned. Table 2 lists the most common weed control program used by cotton producers on sandy soils in the Mississippi Delta. It specifies 8 trips over the field not counting planting and hoeing. Table 2 indicates 6.52 pounds of herbicides. Herbicide costs are $22.37 per acre and total cost per acre including application cost are reported at $51.35. Are there alternatives to this program? Cotton production in Mississippi is currently not possible without the application of some herbicides. For example, farmers with severe weed control problems typically use 11 trips over the field for weed control. However, we have a group of cotton producers in Mississippi that have managed their weed problems continuously to the extent that they have relatively clean fields and this group typically uses only five trips over the field for weed control. They closely supervise their weed control operations to insure proper timing and placement of materials. However, their clean fields are the result of the proper use of chemical herbicides for the previous several years. MSMA is our most popular grass herbicide. Under current technology we can not profitably produce cotton on most fields in Mississippi without MSMA. It is also true that we can not produce cotton in Mississippi utilizing chemical herbicide weed control alone. We are still dependent to some degree on hoe labor and mechanical cultivation.

There are indications that new packages of technology may be forthcoming in the future relative to weed control. However, none of these bundles of technology have been put together in a manner suitable to be used by cotton producers in Mississippi today. We are probably moving toward a system of weed management for the entire farm. This conceptualized weed management program will probably utilize a wide variety of herbicides on crops.

Table 2. Weed control costs per acre, usual input practices, sandy soil, 6-row equipment, Mississippi Delta, 1976.

Operation	Pounds technical herbicide	Herbicide costs	Total costs
	Number	$/acre	$/acre
Disk and apply Treflan	0.50	3.47	6.47
Disk and incorporate Treflan	0	0	2.15
Plant and apply Karmex (DL)	.32	1.62	1.62[1/]
Cultivate	0	0	2.34
Cultivate and post direct MSMA	1.03	1.13	4.02
Cultivate and post direct Cotoran + MSMA	1.29	3.65	6.54
Hoe	0	0	4.60[2/]
Cultivate and post direct Cotoran + MSMA	1.29	3.65	5.82[3/]
Cultivate and post direct Karmex WP + MSMA	1.09	1.75	3.92
Hoe	0	0	4.60
Cultivate and post direct Lorox	1.00	7.10	9.27
TOTALS	6.52	22.37	51.35

Eight trips not counting planting and hoeing.

[1/] Herbicide only.

[2/] Two hours of labor.

[3/] Lower total cost due to faster performance rate of cultivation.

Insecticides.--Table 3 lists current insect control cost per acre for usual input practices in the Mississippi Delta. These costs apply to sand and clay soils. Excluding planting, 9 trips over the field are required. Bidrin is applied (usually in May) to control thrips. The other 8 applications are applied in July, August, and September to control the bollworm and tobacco budworm. This program specifies 25.26 pounds of insecticides. Total insecticide costs are $32.57. The total per acre cost of this insect control program is $43.02.

The boll weevil is an economic pest in the non-delta area of Mississippi. Under usual input practices in the non-delta area of Mississippi 12 applications excluding planting are required. The "usual input practices" insecticide program for the non-delta region is: Temik (.30 pound) applied at planting (mid-May), .20 pound of Bidrin in late May, five applications of .25 pound Guthion plus .20 pound Fundal during July and August, five applications of 2.00 pounds Toxaphene plus 1.00 pound Methyl Parathion during August and September, and one application of .25 pound Guthion in September. This program specifies 18.00 pounds of insecticide at a cost of $35.83. The total cost of the insect control program including application and scouting is $47.04 (Parvin, et.al., 1976b).

No DDT was sold in 1972. 1973 was the first year without DDT. It was speculated that the banning of DDT would result in increased insecticide applications by most producers (Cooke). It has not (Cooke, et.al., 1975; Parvin, et.al., 1976a). However, the use of Methyl Parathion has increased approximately 300 percent.[8/] The number of applications has not increased for two reasons. First, the Cooperative Extension Service and others have had massive education programs dealing with integrated

Table 3. Insect control costs per acre, usual input practices, Mississippi Delta, 1976.

Operation	Times over	Insecticide	Pounds technical insecticide	Insecticide costs	Total cost
	number	common name	number	$/acre	$/acre
Plant	1.0	Di-Syston	.01	---[1]	---[2]
		Temik	.30	4.74	4.74[2]
Apply ins. - Gr.	1.0	Bidrin	.20	.81	1.61
Apply ins. - Air	6.0	Toxaphene	12.00	---[3]	
		Methyl Parathion	6.00	15.70	
		Fundal	.75	6.09	28.29
Apply ins. - Air	2.0	Toxaphene	4.00	---[3]	
		Methyl Parathion	2.00	5.23	6.88
Insect Scouting	---	---	---	---	[illegible]
	9.0[4]		25.26	32.57	43.02

[1] Di-Syston is seed treatment--cost reflected in price of seed.

[2] Application cost charged to planting operation.

[3] Toxaphene and Methyl Parathion are sold as blended material.

[4] Nine trips over the field excluding planting.

pest management, especially scouting techniques. Second, insecticide costs have increased drastically.

The current approach to cotton insect management in Mississippi is a prescription (scouting) insecticide program. This approach alleviates many of the problems associated with regularly scheduled insecticide applications. Environmental pollution is reduced, cost is reduced, insecticide selection pressure is reduced, and natural enemies are preserved during most of the season to combat new pest and pest resurgence problems. The speed with which scouting techniques have been adopted has undoubtedly been increased by efforts to reduce pollution. However, the basic control technique is still chemical insecticides.

Currently the most serious cotton insect in Mississippi is the tobacco budworm. Problems encountered in tobacco budworm control in Mississippi during the 1975 crop year have emphasized the seriousness of the tobacco budworm situation. Many producers failed to control the tobacco budworm with repeated applications of recommended insecticides and costs in excess of $60.00 per acre. The situation is very serious and if present practices continue we face insecticide resistance in the tobacco budworm populations that could eliminate cotton production in Mississippi, just as it was eliminated from northern Mexico (Lukefaher).

Since the number of approaches to tobacco budworm control, other than insecticides, are extremely limited, each one should be fully investigated to determine its potential. Four areas of research seem to offer the most promise for tobacco budworm control: Insecticide testing, sterile release, host plant resistance, and pest management.

Our past program of unilateral reliance on chemical pesticides not only resulted in some serious control failures, but also had some

undesirable side effects. The current practice of scouting cotton fields, using insecticides only when necessary, and relying on natural enemies as much as possible appears to be inadequate. The concept of integrated insect pest management appears to offer promise of long-term solution to our cotton insect problems (Harris; Laster 1974;Newsom). However, a complete integrated insect pest management system for cotton in Mississippi has only been conceptualized and most of the visualized components are only in the research stage. There is a need for the basic research to be completed and for agricultural economists to evaluate the contribution of specific pest management strategies to an integrated cotton insect pest management program.

Research Implications

If we are to ever arrive at some reasonable compromise to the problem of agricultural pollution related to cotton production we must involve research scientists of all disciplines. The current emphasis has been on cotton insecticides. This is especially true at MAFES. However, pollution associated with cotton production involves gins, fungicides, defoliants, herbicides, and tillage (erosion), as well as insecticides. We are probably going to be required to develop new systems of cotton production which are both biologically and ecologically sound. At a minimum these new systems of cotton production will probably be required to include new insecticide, herbicide, and erosion components which result in the reduction of the pounds of pesticides used per acre and vastly improved erosion control standards.

A problem of this magnitude requires the system approval to research management. However, research designed to investigate all of the ramifi-

œations of agricultural pollution related to cotton is probably beyond the capabilities of any single experiment station. What can MAFES (or other Experiment Stations) do to assist cotton producers meet the problems associated with reducing agricultural pollution? First, we need not await regulatory action and be forced to react in a hurried fashion. Much regulatory activity is predictable. For example, three cotton pesticides, MSMA, Toxaphene, and Methyl Parathion are almost certain to be banned as soon as alternatives are available and they may be banned sooner. Agricultural economists should go ahead and evaluate the impact of banning these pesticides. By performing the analysis now, the study could be conducted in an unhurried fashion and the results of the study might have an impact on the regulatory agency. Some erosion control regulations are certain to be forthcoming in the near future. Researchers should immediately move to develop erosion control alternatives and attempt to have an impact or even assist the selected regulatory agency write the erosion control standards.

Finally, I believe that partial systems analysis is the appropriate approach to use to investigate the problem of agricultural pollution relative to cotton. This approach involves identifying the key components of the system to be studied and concentrating research resources in those areas. It is the approach we have taken at MAFES. Because insects are a serious problem on cotton in Mississippi and because insecticides make up approximately 74 percent of the pesticides applied to cotton in Mississippi, we have concentrated on alternative strategies of insect management. A plant growth model is being developed to simulate the effect on yield of weather, plant nutrition, and insects. However, we are

only in the very rudimentary stages of using systems methods to develop insect management techniques. It appears that the real impact of this technology on pest management is probably 10 to 15 years in the future.

SUMMARY

What current alternatives does the Mississippi cotton producer have available for maintaining net income in the face of the current emphasis on a cleaner environment and pesticide regulations? Almost none. Soybeans are the competing crop for cotton in Mississippi. Net return figures for soybeans comparable to those reported in Table 1 are: Delta-Sandy soil - $73.34, Delta-Clay soil - $71.59, and non-delta - $53.80 (Parvin, et.al., 1976a; Parvin, et.al., 1976b). Cotton producers will be sacrificing considerable net income if they shift to soybeans. We have no new cotton varieties that are near release that could significantly increase yield and reduce costs per pound of lint.

Four components of cotton production (weed control, insect control, harvesting, and ginning) make up over 80 percent of the cost of producing cotton in Mississippi. Regulatory activity associated with pesticide production is almost certain to increase weed and insect control costs (Day). Enforcement of pollution standards in gins will undoubtedly increase ginning costs. Harvesting costs total 24 percent of total costs. Reductions in the cost of harvesting cotton will require a technological breakthrough.

The development of resistance by the tobacco budworm to all available insecticides is dominating cotton production in Mississippi. Other than the proper use of an ovicide, the only alternative available to Mississippi cotton producers is to increase the rate of Methyl Parathion. Unless

this problem is solved in the next 2 to 4 years the farm management implications of reducing agricultural pollution related to cotton production in Mississippi may not be relevant. When this immediate problem is resolved, we must move toward developing systems of cotton production that are consistant with current and anticipated regulations. This may involve drastic genetic modification of the cotton plant, and will involve new systems of weed, insect, and erosion control.

FOOTNOTES

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1. Unpublished estimate provided by Dr. Bob Arthur, Department of Biochemistry, Mississippi Agricultural and Forestry Experiment Station.
2. Primarily the Northern portion of the State.
3. 6-row equipment.
4. This section is based on a 1974 study (Wilmot, Looney, McCaskill).
5. 1.43 pounds assumes 10 percent of the acreage is treated twice.
6. Mississippi Agricultural and Forestry Experiment Station.
7. One acre inch of topsoil weighs 166 tons.
8. Unpublished data--National Cotton Costs Surveys, Economic Research Service, USDA.

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