Alternative Cutworm Control Strategies

The effect on Missouri corn farmers of a cancellation of the pesticides chlordane and heptachlor

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SUMMARY AND IMPLICATIONS

The hypothetical nature of this study does not permit many concrete conclusions. However, it does illustrate what per acre production costs and revenues for Missouri corn production would have been in 1973-74 if pesticide prices had been at current levels and if the various treatment methods had been performed according to the efficacy assumptions. There are, however, certain inferences which can be drawn as a result of this exercise.

(1) It appears that diazinon at its current price is not a cost-effective compound for cutworm control.

(2) If the assumptions about the replanting strategy apply, replanting is nearly as cost-effective as the use of chlordane, given the current cost of chlordane.

(3) It appears unlikely that large numbers of Missouri corn farmers will be severely hurt if the registration of chlordane and heptachlor is cancelled. It may be noted, however, in Table 12 that the financial impact will be felt more by the farmers with a small amount of equity than those with large amounts of equity. For example, if a farmer decided to use carbaryl bait, and realized an average 5% yield loss (budget 8), the residual to risk, management, and land would decline to $86.48. This decline of $11.46 per acre would cause a 144% decline in the residual return to risk, management and equity for a farmer with $90 per acre interest cost,[10] but only a 11.7% decline in the residual return to risk, management, and equity for a farmer with 100% equity in his land.

(4) Although the mean income may not change significantly, the variance will probably increase.

(5) Probably the most important inference that can be drawn from this exercise is that the decision to use a chemical pest control method in the production of a crop is an economic decision and does not entirely depend on how well the chemical controls the pest. This decision is influenced by the ability of the chemical to increase output by reducing pest damage, the value of the additional output, and the cost of the chemical control.

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The Effect on Missouri Corn Farmers of a Cancellation of the Pesticides Chlordane and Heptachlor

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Introduction

The United States Environmental Protection Agency issued a notice of intent to cancel[1] nearly all of the registered uses of chlordane and heptachlor on November 18, 1974 on the basis of findings that questioned the safety of the use of these compounds. Many of the registered uses were suspended December 24, 1975, but due to concern for certain areas, the use on corn was allowed to continue until August of 1976. All future uses of these compounds will be determined in the forthcoming cancellation hearings to be held by the Environmental Protection Agency.

Chlordane and heptachlor have become more important for control of soil insects in Missouri since the suspension of aldrin prior to the 1975 growing season. Even though the Environmental Protection Agency (EPA) predicts only small effect on the national corn output due to cancelling the registration of these insecticides,[2] the effect on certain lowlands of Missouri and Ohio is expected to be

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[1]The final decision on the use of these compounds will be made in the cancellation hearings which are in progress. The registration of a particular use of a pesticide is cancelled if it is determined that its use will cause an "unreasonable adverse effect" on the environment. If cancellation procedures are in progress, a registration may be suspended by the administration of the EPA if he feels that further use of the compound during the cancellation hearings would create an "imminent hazard" in the environment. A suspension only prohibits use of the chemical while the decision is being made on cancellation. Currently, the registration for chlordane and heptachlor for use on corn is involved in cancellation proceedings, after being suspended as of 1 August 1976.

[2]"Decision of the Environmental Protection Agency Administrator on the suspension of heptachlor-chlordane," FIFRA Docket No. 384, 24 December 1975.

sizeable. The primary cause for concern is cutworm damage on corn raised in these areas.

The Administrative Law Judge in his recommended decision and the Administrator of the EPA in his decision on the suspension of certain uses of chlordane and heptachlor have both expressed concern for the possible effect of this suspension on individual farmers in these high risk regions, but so far, all economic analysis has been aimed at the aggregate effects, and little attention has been given to the individual impacts. The purpose of this study is to estimate the effect of a cancellation of the insecticides chlordane and heptachlor on individual Missouri farmers who raise corn on land susceptible to damaging cutworm infestations.

METHOD

To evaluate the potential effect of this ation on Missouri corn farmers, budgets were developed estimating the per acre costs and revenues of corn production for various cutworm control techniques. The difficulty with this method, however, is that the efficacy of the alternative cutworm control strategies is not known with any great certainty. To cope with this problem, budgets are developed for a variety of efficacy assumptions for each control strategy. The result is a series of budgets showing the potential per acre effect of the use of a variety of control strategies under a variety of efficacy assumptions. The alternate control techniques examined were: (1) no treatment, (2) other pre-emergent insecticides, (3) post emergent "rescue" treatments, and (4) replanting.

The data used for the budgets were obtained from a sample of 37 large Missouri corn farms for the crop years 1973 and 1974.[3] These years were chosen to represent a recent good year for corn profits and a recent bad year. The data show costs of corn production that are very similar to the results of a recent USDA study.[4] The budgets for the alternative control strategies and efficacy assumptions are developed by altering the 1973-74 average costs according to current treatment costs and by altering the revenues according to the alternative efficacy assumptions. The result is a series of 11 budgets portraying 11 different scenarios.

The return to risk, management, and land that each budget indicates represents the average return that these farms would have realized for the years 1973 and 1974 *if* they had realized the current costs of the alternative treatment, and if their yield had been altered according to the efficacy assumptions. These costs, revenues, and returns may not be realized this year, or in future years due to rapidly changing prices, but they do reflect how Missouri corn farmers would have fared in this two-year period without chlordane, heptachlor, or aldrin under certain assumptions.

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[3]Data were obtained in aggregate form from Dr. Carrol Kirtley, Mail-In Record Program, Department of Agricultural Economics, University of Missouri.

[4]Economic Research Service, U.S. Department of Agriculture, *Costs of Producing Selected Crops in the United States– 1974* (Washington, D.C.: Government Printing Office, 1976), p. 60.

THE DATA

The 1973-74 cost and revenue data are shown in Table 1. The average crop chemical expenditure for these farms was $11.22 per acre. This amount included expenditures for herbicides and insecticides. For the farms showing insecticide

TABLE 1
1973 AND 1974 COSTS AND REVENUES PER ACRE FOR CORN PRODUCTION ON LARGE MISSOURI CORN FARMS*

	1973	1974	Average
Gross Revenue Per Acre	$216.39	$207.51	$211.95
Variable Costs:			
Plant food	26.79	37.37	32.08
Crop chemicals	11.50	10.93	11.22**
Crop insurance	0.32	0.56	0.44
Seed	5.95	6.90	6.43
Other crop materials and services	0.86	0.55	0.70
Labor (includes operator labor)	12.95	12.73	12.83
Machine hire	2.91	2.19	2.55
Machinery and equipment operation	10.27	13.35	11.81
Utilities	2.23	2.47	2.35
Insurance	0.62	0.87	0.74
Personal property and sales taxes	0.26	0.88	0.57
Real estate repair and maintenance	1.12	1.45	1.28
Miscellaneous overhead	0.45	0.74	0.60
Operating interest (calculated)	3.61	6.01	4.81
Total variable costs	$ 79.83	$ 97.00	$ 88.42
Fixed Costs:			
Real estate taxes and depreciation	$ 5.31	$ 5.06	$ 5.19
Interest and depreciation on machinery and equipment	15.16	18.72	16.94
Total except for interest on real estate	20.47	23.78	22.13
Returns to management, risk and land	$116.09	$ 86.73	$101.40

*Based on a sample of 13 Missouri farms in 1973 and 24 Missouri farms in 1974, all with 400 or more acres of corn. Data obtained from mail-in record program, Department of Agricultural Economics, University of Missouri. The yields on these farms averaged 99.6 bushels in 1973 and 59.6 bushels in 1974.

**$2.50 is assumed to be the average 1973-74 cost for soil insecticides and the remaining $8.72 is for other chemicals.

expenses separately, the average was $2.50 per acre. Since this was approximately the cost of treating with aldrin, it was assumed that the average farm with soil insect problems spent $2.50 per acre on insecticides in 1973-74 and $8.72 per acre on other chemicals. Table 1-A shows a condensed version of the budget data that is used for developing comparative budgets. The variable costs do not include any cost for insecticides. To illustrate the effect of alternative cutworm control strategies, the variable costs are altered according to the current per acre cost of the control technique and the revenue per acre is altered as the efficacy assumptions influenced yield.

TABLE 1-A
BUDGET FOR MISSOURI CORN PRODUCTION
1973-74 AVERAGE

Gross Revenue/Acre		$211.95
Variable Cost/Acre Not Including Insecticide*	$85.92	
Fixed Cost/Acre Not Including Interest on Land	22.13	
		$108.05
Residual for Insecticide, Risk, Management and Land		$103.90

*Assumes previous pesticide cost of $2.50/acre on the average.

COST OF ALTERNATIVE CONTROL STRATEGIES

The current costs of heptachlor, chlordane, and a suggested[5] alternative preplant insecticide, diazinon,[6] are listed in Table 2. The cost of all of these chemicals has increased sharply in the past year. Table 3 shows the current cost of the recommended post emergence "rescue" treatments for cutworms. Since

[5]George W. Thomas et al, *1976 Corn Soil Insect Control,* Science and Technology Guide 4150, University of Missouri, Extension Division, 1976.
[6]Currently recommended for dairy farms.

TABLE 2
CURRENT COST* OF PREPLANT BROADCAST TREATING CORN LAND FOR CUTWORMS IN MISSOURI WITH CHLORINATED HYDROCARBONS AND DIAZINON

	Preplant Treatment		
Chemical	Formulation	Rate/Acre	Cost/Acre
Heptachlor	20% granules	10-14 lb.	$5-7.00
Chlordane	72% liquid	2 qts.	$6.06
Diazinon	14% granules	28 lb.	$28.00

*Cost obtained by obtaining the best price available in Columbia, Missouri on 21 April 1976. Application rates obtained from "1976 Corn Soil Insect Control," Science and Technology Guide #4150, Department of Entomology, University of Missouri.

TABLE 3
ESTIMATES OF ANNUAL AVERAGE COST* OF POST EMERGENCE CUTWORM CONTROL IN MISSOURI ASSUMING TREATMENT IS NECESSARY TWO YEARS OUT OF FIVE

Treatment With 5% Carbaryl Apple Pomace Bait:	
Chemical cost/acre	$14.80
Aerial application cost/acre	2.25
Total Cost/acre	$17.05
Average annual cost/acre (0.4 x $17.05)	$ 6.82
Treatment With Toxaphene:	
Chemical cost/acre	$ 2.96
Aerial application cost/acre	2.25
Total Cost	$ 5.21
Average annual cost/acre (0.4 x $5.21)	$ 2.08

*Cost obtained by obtaining the best price available in Columbia, Missouri on 21 April 1976. Application rates obtained from "1976 Corn Soil Insect Control," Science and Technology Guide #4150, Department of Entomology, University of Missouri.

rescue treatments are only applied in years of actual infestations, the average annual cost is calculated under the assumption that treatments would be applied two out of every five years. Although the current average annual cost of the carbaryl rescue treatment is about equal and the cost of the toxaphene rescue treatment is less than the cost of chlordane or heptachlor, it is not likely that either will be as effective as chlordane or heptachlor.

Table 4 shows estimates of replanting cost. Since cutworm damage generally occurs in late May, it is possible to replant sections that are damaged by cutworms. Table 4 shows the estimated average annual cost per acre of a strategy

TABLE 4
ESTIMATES OF THE COST OF REPLANTING CORN LOST TO CUTWORMS ASSUMING THAT 30% OF ACREAGE MUST BE REPLANTED TWO OUT OF EVERY FIVE YEARS-HERBICIDES NOT REAPPLIED

Seed cost/acre	$ 6.43
Replanting cost/acre (machinery fuel and labor)	3.00
Total replanting outlay/acre*	$ 9.43
Revenue losses due to late planting	
A. 10 bu./acre	$25.00
B. 20 bu./acre	$50.00
Total cost and revenue loss if 10 bu./acre is lost	$34.43
Average annual cost/acre**	$ 4.13
Total cost and revenue loss if 20 bu./acre is lost	$59.43
Average annual cost/acre**	$ 7.13

*It is assumed that replanting is done without heavy discing. Herbicides are not reapplied.

**Assumes 30% of acreage two years out of five, i.e. (0.3) (0.4)X= 0.12X

of replanting damaged acres under the assumption that damaging infestation occurs two years out of five, 30% of the corn acreage has to be replanted in these years, and herbicides need not be reapplied. Since corn yields may decline due to late planting, two alternative assumptions are made about yield loss: (1) that only 10 bushels per acre are lost as a result of late planting on the 30% of the acreage replanted and (2) that 20 bushels per acre are lost. The actual yield loss, of course, would depend on how early replanting was completed.[7] The dollar value of these

[7]M.S. Zuber, *Date of Planting Studies with Corn,* Bulletin #832, Jan. 66, Bulletin 862, Jul. 67, Bulletin 868, Jan. 68, Agricultural Experiment Station, University of Missouri, Columbia.

revenue losses may be overstated because reduced yields would also reduce harvesting, drying, and transportation costs to a certain extent.[8] Note that under these assumptions, the average annual cost of replanting compares favorably with the current cost of using chlordane every year on all corn acres as an insurance measure. Table 5 also shows the costs of replanting under the same assumptions as Table 4 except that it is assumed that herbicides would be reapplied.

TABLE 5
ESTIMATES OF THE COST OF REPLANTING CORN LOST TO CUTWORMS ASSUMING THAT 30% OF ACREAGE MUST BE REPLANTED TWO OUT OF EVERY FIVE YEARS--HERBICIDES REAPPLIED

Seed Cost	$ 6.43
Herbicide cost*	8.72
Replanting cost (machinery, fuel and labor)	3.00
Total replanting outlay	$18.15
Revenue losses due to late planting	
A. 10 bu./acre	$25.00
B. 20 bu./acre	$50.00
Total cost and revenue loss if 10 bu./acre is lost	$43.15
Average annual cost/acre**	$ 5.18
Total cost and revenue loss if 20 bu./acre is lost	$68.15
Average annual cost/acre**	$ 8.18

*Assumes that it was necessary to do heavy discing before replanting requiring new herbicide application.

**Assumes 30% of acreage two years out of five, i.e., (0.3) (0.4) X = 0.12X

[8]The current cost of seed is understated, however, as the listed cost is the 1973-74 average.

COMPARATIVE BUDGETS FOR ALTERNATIVE CUTWORM CONTROL STRATEGIES

One possible alternative to the use of chlordane for cutworm control would be to use no insecticide and suffer the loss. Cost of the chemical and its application would be saved. Due to the erratic nature of cutworm infestations and a lack of good data, opinion varies on how much loss they can be expected to cause on Missouri bottomlands without treatment.

No Treatment Strategy

Budgets 1, 2, and 3 in Table 6 show what the per acre effect for Missouri corn farmers would have been in 1973-74 if they had not used a chlorinated hydrocarbon for cutworm control under the assumptions of 5%, 10%, and 20% yield loss due to cutworm damage. It is assumed that these yield losses would not effect the price of corn since the impact on national corn output would be very small. Therefore, the percentage reduction in yield and the percentage reduction in gross revenue per acre would be equal.

Preplant Insecticide Strategy

Budgets 4, 5, 6, and 7 in Table 7 show what Missouri corn costs and revenues per acre would have been for 1973-74 if a preplant insecticide was used for cutworm control. Budget number 4 shows costs and revenues of using chlordane for cutworm control under the assumptions that no yield loss occurred and that the cost of chlordane was at its current level.

The alternative preplant cutworm insecticide is diazinon. It is not known, however, whether diazinon will be as reliable for cutworm control as chlordane since, among other things, chlordane has a residual effect.

Budgets 5-7 illustrate costs and revenues for corn production, including the current cost of diazinon and assuming 0%, 5%, and 10% average yield losses. Comparison of budgets 2 and 5 reveals that more than 10% of average yield could be lost to cutworms and the farmer would still be better off than if he used diazinon, even if it worked as well as chlordane.

Rescue Treatment Strategy

Budgets 8 and 9 in Table 8 list costs and revenues of corn production using a rescue treatment for cutworm control. The costs include the current average annual cost of applying a carbaryl bait by aerial application two years out of five and the revenues reflect a 5% and a 10% average yield loss. Note that a 10% average yield loss is the same as a 25% loss two years out of five, or a 5% loss three years out of five and a 17½% loss two years out of five. Therefore, if cutworm infestations occurred two years out of five and if a rescue treatment limited losses to 25%, it would have been more profitable to have used a rescue treatment than apply diazinon annually, even if diazinon was as effective as chlordane.

TABLE 6

COMPARATIVE BUDGETS FOR RAISING CORN IN MISSOURI ASSUMING NO INSECTICIDE IS USED FOR CUTWORMS UNDER DIFFERENT YIELD LOSS ASSUMPTIONS RESULTING FROM CUTWORM DAMAGE

(1) Budget For Corn In Missouri Assuming 5% Average Yield Loss		
Gross Revenue/Acre		$201.35
Variable Cost/Acre	$85.92*	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$108.05
Residual for Risk, Management and Land		$ 93.30
(2) Budget For Corn In Missouri Assuming 10% Average Yield Loss		
Gross Revenue/Acre		$190.76
Variable Cost/Acre	$85.92*	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$108.05
Residual for Risk, Management and Land		$ 82.71
(3) Budget For Corn In Missouri Assuming 20% Average Yield Loss		
Gross Revenue/Acre		$169.56
Variable Cost/Acre	$85.92*	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$108.05
Residual for Risk, Management and Land		$ 61.51

*Assuming no soil insecticide is used.

TABLE 7

COMPARATIVE BUDGETS FOR RAISING CORN ON LAND IN MISSOURI PRONE TO CUTWORM INFESTATIONS WITH CHLORDANE AND WITH SUBSTITUTE INSECTICIDE DIAZINON WITH VARYING ASSUMPTIONS ABOUT THE RELATIVE EFFICACY OF DIAZINON

(4) Budget for Corn Raised With Chlordane for Control of Cutworms

Gross Revenue/Acre		$211.95
Variable Cost/Acre*	$91.88	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$114.01
Residual for Risk, Management and Land		$ 97.94

(5) Budget for Corn Raised With Diazinon for Control of Cutworms (Assuming Same Yield as Chlordane on the Average)

Gross Revenue/Acre		$211.95
Variable Cost/Acre**	$113.92	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$136.05
Residual for Risk, Management and Land		$ 75.90

(6) Budget for Corn Raised with Diazinon for Control of Cutworms Assuming a 5% Yield Loss on the Average Compared with Chlordane.

Gross Revenue/Acre		$201.35
Variable Cost/Acre**	$113.92	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$136.05
Residual for Risk, Management and Land		$ 65.30

TABLE 7 (CONTINUED)

(7) Budget for Corn Raised with Diazinon for Control of Cutworms Assuming a 10% Yield Loss on the Average Compared with Chlordane.

Gross Revenue/Acre		$190.76
Variable Cost/Acre**	$113.92	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$136.05
Residual for Risk, Management and Land		$ 54.71

*Includes current cost of chlordane, see Table 2.
**Includes current cost of diazinon, see Table 2.

TABLE 8

COMPARATIVE BUDGETS FOR RAISING CORN ON LAND IN MISSOURI PRONE TO CUTWORM INFESTATIONS ASSUMING A TYPICAL POST EMERGENCE TREATMENT* IS APPLIED TWO YEARS OUT OF FIVE UNDER DIFFERENT INSECT LOSS ASSUMPTIONS

(8) Budget Assuming a Rescue Treatment is Used and 5% Average Yield Loss Assumptions.

Gross Revenue/Acre		$201.35
Variable Cost/Acre*	$92.74	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$114.87
Residual for Risk, Management and Land		$ 86.48

(9) Budget Assuming a Rescue Treatment is Used and 10% Average Yield Loss Assumptions.

Gross Revenue/Acre		$190.76
Variable Cost/Acre*	$92.74	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$114.87
Residual for Risk, Management and Land		$ 75.89

*Average annual cost of treatment assumed to be $6.82/acre, see Table 3.

TABLE 9

COMPARATIVE BUDGETS FOR RAISING CORN ON LAND IN MISSOURI PRONE TO CUTWORM INFESTATIONS ASSUMING THAT NO INSECTICIDE IS USED FOR CUTWORMS AND THAT 30% OF THE ACREAGE MUST BE REPLANTED TWO OUT OF EVERY FIVE YEARS UNDER DIFFERENT YIELD LOSS ASSUMPTIONS

(10) Budget Assuming 30% of Corn Acreage is Replanted Two Years Out of Five and 10 bu. /acre is Lost Due to Late Planting on the Acres Replanted

Average Gross Revenue/Acre		$209.41
Variable Cost/Acre	$87.05	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$109.18
Average Residual for Risk, Management and Land		$100.23

(11) Budget Assuming 30% of Corn Acreage is Replanted Two Years Out of Five and 20 bu. /acre is Lost Due to Late Planting on the Acres Replanted.

Average Gross Revenue/Acre		$206.87
Variable Cost/Acre	$87.05	
Fixed Costs/Acre Excluding Interest on Land	22.13	
		$109.18
Average Residual for Risk, Management and Land		$ 97.69

Replant Strategy

Budgets 10 and 11 in Table 9 and budgets 12 and 13 in Table 10 show data for a strategy of replanting acreage that is damaged by cutworms. Since cutworm damage tends to be spotty and tends to occur in May, it is often possible to replant the acreage damaged by cutworms.

The cost of using the replanting strategy includes the replanting cost and the yield loss assumed to result from late planting. If replanting should be accomplished by May 20, a yield loss of only 10 bushels per acre would be expected. A more realistic replanting date for cutworm damaged corn would probably be June first. In this case, a yield loss of approximately 20 bushels per acre could be expected.

TABLE 10

COMPARATIVE BUDGETS FOR RAISING CORN ON LAND IN MISSOURI PRONE TO CUTWORM INFESTATIONS ASSUMING THAT NO INSECTICIDE IS USED FOR CUTWORMS AND THAT 30% OF THE ACREAGE MUST BE REPLANTED AND HERBICIDES MUST BE REAPPLIED TWO OUT OF EVERY FIVE YEARS UNDER DIFFERENT YIELD LOSS ASSUMPTIONS

(12) Budget Assuming 30% of Corn Acreage is Replanted with Herbicides Reapplied Two Years Out of Five and 10 bu. /acre is Lost due to Late Planting on the Acres Replanted.

Average Gross Revenue/Acre		$209.41
Variable Cost/Acre	$88.10	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$110.23
Average Residual for Risk, Management and Land		$ 99.18

(13) Budget Assuming 30% of Corn Acreage is Replanted with Herbicides Reapplied Two Years Out of Five and 10 bu. /acre is Lost due to Late Planting on the Acres Replanted.

Average Gross Revenue/Acre		$206.87
Variable Cost/Acre	$88.10	
Fixed Cost/Acre Excluding Interest on Land	22.13	
		$110.23
Average Residual for Risk, Management and Land		$ 96.64

The average annual cost of using this strategy is presented in Tables 4 and 5, depending upon assumptions about reapplying herbicides. These costs and expected revenue losses are included in the variable costs of budgets 10, 11, 12, and 13. Note that, under these assumptions, if replanting is accomplished by the first of June, the average residual return to risk, management, and land compares very favorably to the strategy of using chlordane as insurance.

Strategy Summary

Table 11 ranks each control strategy according to the size of the residual return for risk, management, and land. The assumptions on which each budget is

TABLE 11
SUMMARY RANKING OF BUDGETS FOR CORN RAISED ON LAND SUSCEPTIBLE TO CUTWORM INFESTATIONS IN MISSOURI FOR ALTERNATIVE CONTROL ASSUMPTIONS

Name of Strategy	Budget Number	Assumptions Underlying Budget	Residual for Risk, Management and Land ($/acre)
Replant	10	No insecticide used, 30% of acreage replanted 2 years out of 5 and 10 bu. per acre yield loss on replanted acres due to late planting.	$100.23
Replant	12	No insecticide used, 30% of acreage replanted with herbicide reapplied 2 years out of 5 and 20 bu. /acre yield loss on replanted acres due to late planting.	99.18
Chlordane	4	Chlordane is used and no cutworm damage is incurred.	97.94
Replant	11	No insecticide is used, 30% of acreage is replanted 2 years out of 5 and 20 bu. /acre is lost on replanted acreage due to late planting.	97.69
Replant	13	No insecticide used, 30% of acreage replanted with herbicide reapplied 2 years out of 5 and 20 bu. /acre is lost on replanted acres due to late planting.	96.64
No Treatment	1	No insecticide is used, no replanting is done, and 5% yield is lost on the average due to insect damage e. g., ($12\frac{1}{2}$ % 2 years in 5).	93.30

Name of Strategy	Budget Number	Assumptions Underlying Budget	Residual for Risk, Management and Land ($/acre)
Rescue Treatment	8	Carbaryl bait is applied as a rescue treatment 2 years out of 5 and average yield declines by 5% due to insect damage (e.g., 12½% 2 years in 5).	86.48
No Treatment	2	No soil insecticide is used, no replanting is done, and yields decline 10% on the average (e.g., 5% decline 3 years in 5 and 17.5% decline 2 years in 5).	82.71
Diazinon	5	Diazinon is applied as a pre-emergent treatment and no insect loss is incurred.	75.90
Rescue Treatment	9	Carbaryl bait is applied as a rescue treatment 2 years out of 5 and average yield declines by 10% due to insect damage (e.g., 5% decline 3 years out of 5 and 17.5% decline 2 years out of 5).	75.89
Diazinon	6	Diazinon is applied as a pre-emergent treatment and yield declines 5% on the average.	65.30
No Treatment	3	No insecticide is used, no replanting is done and yield declines 20% on the average due to insect damage (e.g., a 10% decline 3 years out of 5 and a 45% loss 2 years out of 5).	61.51
Diazinon	7	Diazinon is used as a pre-emergent treatment and average yield declines 10%.	54.71

based are listed along with the residual return so that the effect of each set of assumptions can be readily determined.

The highest ranking strategy is replant Budget 10, which assumes that 30% of the corn acreage is replanted two years out of five and 10 bushels per acre are lost on the acres replanted. The use of chlordane ranks second and the replanting strategy which assumes a 20 bushel yield loss is third.

Therefore, given the current cost of insecticides, a strategy of replanting appears to be the best economic alternative, if the assumptions about acreage and frequency prove accurate. Depending on assumptions about infestation levels and efficacy of the post emergent treatments, the strategies of no treatment or the use of a rescue treatment rank second, and the use of diazinon ranks last.

THE EFFECT OF EACH CONTROL STRATEGY ON FARM INCOME AND THE RETURN TO FACTORS OF PRODUCTION

There are many concepts and measures of income. One such measure is the return to risk, management, and owner's equity. This measure diverges somewhat from both the accounting concept of income and the concept of economic income. The return to risk, management, and ownership equity measures the residual available to compensate ownership and management after all direct costs are paid, including interest on land, and after the costs of operator labor, operating interest, depreciation and interest on machinery are imputed.

The most variable of these elements is clearly the interest cost for land. Recently purchased, highly productive corn land could require a cash interest payment of $90 per year, while land purchased five years ago may have both a smaller balance due and be financed at a lower interest rate. Some farmers, of course, will have no cash interest cost.

Table 12 illustrates the effect of each of these cutworm control scenarios on per acre farm income from corn, by showing the return to risk, management, and equity in land for each budget under three alternative equity assumptions. Note that the cases where an actual average loss should be expected are on land with high indebtedness when variable costs exceed $90 per acre or when average annual yield loss exceeds 10% or when both occur (budgets 8, 2, 5, 9, 6, 3, 7).

The rescue treatment portrayed in budget 8 shows the sensitivity of the economic condition of low equity. The costs of this rescue treatment scenario are about the same as those of the chlordane scenario in budget 4. However, the 5% reduction in yield assumed for the rescue treatment gave a residual too small to pay the interest.

In contrast, in order to meet the assumptions of budget 3, a 20% average annual loss would be required. This would be equal to a 100% loss one year out of five, or a 50% loss two years out of five. Losses of this magnitude seem unlikely. If they do occur they are a big problem principally for the low equity operator. For equity assumption 1, large percentage declines in residual income could occur. Some substantial reductions in profit could occur also on farms where managers are not alert to infestations or are slow to take such action as replanting or application of rescue treatments or both. Those forced into late planting in mid-May may be more likely to experience these problems.

TABLE 12

RETURN TO RISK, MANAGEMENT AND OWNER'S EQUITY IN LAND FOR MISSOURI CORN FARMS FOR ALTERNATIVE CONTROL STRATEGIES AND EQUITY ASSUMPTIONS

Name of Strategy	Budget Number	Residual to Risk, Management and Land	Residual to Risk, Management and Equity Under Assumption #1*	Residual to Risk, Management and Equity Under Assumption #2**	Residual to Risk, Management and Equity Under Assumption #3***
		($/acre)	($/acre)	($/acre)	($/acre)
Replant	10	$100.23	$ 10.23	$ 47.73	$ 76.23
Replant	12	99.18	9.18	46.68	75.18
Chlordane	4	97.94	7.94	45.44	73.94
Replant	11	97.69	7.69	45.19	73.69
Replant	13	96.64	6.64	44.14	72.64
No Treatment	1	93.30	3.30	40.80	69.30
Rescue Treatment	8	86.48	-3.52	33.98	62.48

*Assumption #1--Assumes a balance of land indebtedness of $1000/acre at 9%, i.e., $90 interest/acre/year.

**Assumption #2--Assumes a balance of land indebtedness of $700/acre at 7½%, i.e., $52.50 interest/acre/year.

***Assumption #3--Assumes a balance of land indebtedness of $400/acre at 6%, i.e., $24.00 interest/acre/year.

TABLE 12 (CONTINUED)

Name of Strategy	Budget Number	Residual to Risk, Management and Land	Residual to Risk, Management and Equity Under Assumption #1*	Residual to Risk, Management and Equity Under Assumption #2**	Residual to Risk, Management and Equity Under Assumption #3***
		($/acre)	($/acre)	($/acre)	($/acre)
No Treatment	2	82.71	-7.29	30.21	58.71
Diazinon	5	75.90	-14.10	23.40	51.90
Rescue Treatment	9	75.89	-14.11	23.39	51.89
Diazinon	6	65.30	-24.70	12.80	41.30
No Treatment	3	61.51	-28.49	9.01	37.51
Diazinon	7	54.71	-35.29	2.21	30.71

*Assumption #1--Assumes a balance of land indebtedness of $1000/acre at 9%, i.e., $90 interest/acre/year.

**Assumption #2--Assumes a balance of land indebtedness of $700/acre at 7½%, i.e., $52.50 interest/acre/year.

***Assumption #3--Assumes a balance of land indebtedness of $400/acre at 6%, i.e., $24.00 interest/acre/year.