ESTIMATING THE EFFECTS OF PESTICIDE USE ON BURLEY AND FLUE-CURED TOBACCO

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The only pesticides a farmer may use on his crops are those that are registered for such use by the U.S. Environmental Protection Agency (EPA). Registration of a particular pesticide can be withdrawn or partially restricted if the EPA determines that the risk to society outweighs the benefits of continued unrestricted use. Such a change in pesticide availability can reduce crop output, which in turn may affect the market price of the crop and ultimately prices and quantities of the commodity (or its products) available to consumers.

Ridomil[R] (metalaxyl) has become an important pesticide for control of blue mold and black shank, major diseases affecting tobacco production.[1] The objective of this paper is to summarize the economic impacts of Ridomil[R] use on tobacco. In the process, the economic structure of the burley and flue-cured tobacco markets are identified and quantified. The analysis begins with a brief discussion of blue mold and black shank and the usage and efficacy of Ridomil[R] and its alternatives. The model of the tobacco industry used to generate price effects is then presented. Finally, impacts on prices, costs, producer revenue, and consumer expenditures are shown.

BLUE MOLD, BLACK SHANK, AND ALTERNATIVE CONTROLS

Blue mold is a tobacco disease found in the plant bed and field that occurs wherever tobacco is grown. Left uncontrolled, it can destroy an entire plant bed. Field infection is variable, depending on weather conditions, age of plants, and stage of disease development. Hot summers in the U.S. often restrict blue mold to the plant bed, but in the late seventies, just before Ridomil[R] was introduced, there were increasingly severe outbreaks in the field. Estimates made of losses in 1979 found that producers lost $252 million or 9.4 percent of gross revenue to blue mold.[2] There are a number of alternatives to Ridomil[R], such as maneb, zineb, and mancozeb, but these are not systemic and do not have the eradicant properties of Ridomil[R]. Hence they must be applied much earlier and more often, and furthermore, they do not control black shank. Black shank is a disease that affects the roots and lower stem of tobacco in the field. Unlike the sporadic outbreaks of blue mold, black shank is a consistent, yearly problem. The most common alternatives to Ridomil[R] include soil fumigation with Telone[R] C-17 or Terrocide[R] in conjunction with crop rotation and use of resistant varieties.

Acreage treated with Ridomil[R] and its alternatives for the control of blue mold and black shank is summarized in Table 1. The six states listed harvest over 90 percent of the tobacco grown in the U.S. An estimated 71 percent of U.S. tobacco acreage is treated with Ridomil[R] each year. If Ridomil[R] were unavailable, we estimate that Telone[R] C-17, Terrocide[R], and the dithiocarbamates would be used as shown in Table 2. In particular, usage of the dithiocarbamates would significantly increase.

EFFICACY OF RIDOMIL[R] AND ALTERNATIVES

The efficacy of Ridomil[R] and its alternatives was determined through use of published experimental data

Table 1. Estimated Usage of Ridomil[R], Telone[R] C-17, Terrocide[R], and the Dithiocarbamates on Tobacco Acreage in the Major Tobacco Producing States[a]

State	Total Tobacco Acreage[b] (1000)	Acre Treatments (1000)[c]			Dithiocarbamates[d]	
		Ridomil[R]	Telone[R] C-17	Terrocide[R]	Acres Treated (1000)	Acre Treatments (1000)
N. Carolina	378.8	310.6	34.1	34.1	7.6	26.5
Kentucky	200.9	100.4	--	--	2.0	7.0
Virginia	65.3	42.4	0.6	0.3	2.0	6.9
S. Carolina	65.0	55.2	2.0	1.3	--	--
Tennessee	64.8	32.4	--	--	--	--
Georgia	55.0	46.8	0.2	0.1	--	--
Total	829.8	587.8	36.9	35.8	11.6	40.4

[a] Estimated from a 1982 survey of tobacco disease specialists.
[b] *1981 Agricultural Statistics*, USDA.
[c] Maneb, zineb, and mancozeb are the major alternatives, although a few other fungicides and streptomyecin are applied to a lesser extent.

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The use of trade names in this article is for identification only and does not constitute an endorsement of these products or imply discrimination against similar products.

[1] Ridomil[R] is a protectant fungicide with eradicant properties registered as a preplant, soil-applied systemic for control of black shank on flue-cured tobacco and blue mold on all types of tobacco. It is also used to control blue mold in tobacco plant beds.
[2] Estimate presented at Blue Mold Symposium III. Tobacco Workers Conference, Williamsburg, Virginia, January 11, 1983.

Table 2. Estimated Usage of Telone^{R} C-17, Terrocide^{R}, and the Dithiocarbamates to Control Blue Mold and Black Shank on Tobacco if Ridomil^{R} were Unavailable[a]

	Acres Treated (1000)			Acre Treatments (1000)[b]		
State	Telone^{R} C-17	Terrocide^{R}	Dithiocarbamates[c]	Telone^{R} C-17	Terrocide^{R}	Dithiocarbamates[c]
N. Carolina	56.8	56.8	318.2	56.8	56.8	1113.7
Kentucky	9.9	9.9	102.5	9.9	9.9	358.6
Virginia	5.0	2.5	44.4	5.0	2.5	155.4
S. Carolina	7.8	5.2	57.2	7.8	5.2	200.2
Tennessee	3.2	3.2	33.1	3.2	3.2	115.7
Georgia	8.7	5.8	46.8	8.7	5.8	163.6
Total	102.8	94.8	602.2	102.8	94.8	2107.2

[a] Estimated from a 1982 survey of tobacco disease specialists and 1982 market shares.
[b] Maneb, zineb, mancozeb.

and a 1982 mail survey of tobacco disease specialists in several states.[3] These sources indicate that Ridomil^{R} reduces yield loss over its alternatives by 6–30 percent for black shank. Success of black shank control by each chemical treatment is partly a function of disease pressure. Telone^{R} and Terrocide^{R} effectiveness quickly deteriorates with increased disease pressure, while Ridomil^{R} remains a viable control material.

The results of comparing Ridomil^{R} and its dithiocarbamate alternatives for blue mold control are similar to the black shank comparisons. As with black shank, the performance of Ridomil^{R} and its alternatives for blue mold control is partly a function of disease pressure. According to the disease specialists, if Ridomil^{R} were unavailable, yield loss due to blue mold would increase an estimated 21 percent under the potentially severe blue mold conditions that currently exist. In the field, tobacco is susceptible to both blue mold and black shank, among a host of other diseases. Yield losses due to black shank and blue mold can be combined because black shank strikes early and kills plants quickly, while blue mold affects remaining plants later in the season. If Ridomil^{R} were available, the estimated annual yield loss due to both diseases would be 4.5–8.5 percent. If Ridomil^{R} were not available, the estimated annual yield loss would be 26–45 percent. If Ridomil^{R} were not available, current burley production would decline by approximately 242 to 410 pounds per acre, and flue-cured production would decline by 363 to 616 pounds per acre.

ECONOMIC MODEL OF THE TOBACCO INDUSTRY

An econometric model was developed to isolate price impacts resulting from the above estimated yield changes. A number of previous studies have constructed models of the burley tobacco market (Reed; Reed and Schnepf) and for the flue-cured tobacco market (R. Mann; Norton). A few have examined both markets (J. Mann; Sutton). Rather than borrowing past estimates, a new model was estimated because of the need for a model that: (1) contained both flue-cured and burley tobacco at the farm and retail level, (2) endogenized yield and exports, and (3) was estimated with recent data, since policy shifts occurred in flue-cured tobacco in 1965 and in burley tobacco in 1971. Previous studies met some, but not all, of these criteria. Flue-cured and burley account for over 90 percent of total U.S. tobacco production, and cigarettes account for over 90 percent of the retail demand for tobacco products. Thus, our analysis includes most of the U.S. tobacco economy.

The major flue-cured tobacco-producing states are North Carolina, South Carolina, Virginia, Georgia, and Florida. Burley is produced mainly in Kentucky, Tennessee, Virginia, and North Carolina. After harvest, tobacco is cured. Both harvesting and curing, especially for flue-cured tobacco, have undergone major labor-saving technological changes in the past decade. The cured tobacco is moved to the auction market for sale. There it is purchased by manufacturers or dealers, or, if it is eligible for price support and the bid is not high enough, it is taken by a cooperative association as agent for the Commodity Credit Corporation. In all cases, it is put into storage for at least 2 to 3 years for aging prior to processing into tobacco products.

Since the Emergency Agricultural Adjustment Act of 1933 established a tobacco program, tobacco growers have agreed to operate under a number of constraints in return for an annually determined level of price support. The support-price component of the tobacco program has been in effect in an essentially unchanged form since 1961 when the present formula for calculating the support level was instituted. Since 1982, individual tobacco growers have contributed to a fund that places the support program on a no-net-cost-to-

[3] Two reports prepared for the EPA which contain detailed information on both the experimental data and the mail survey are available from the authors. Data were collected for individual states and figures presented in this paper are weighted state averages.

taxpayers basis as a condition of their crop being eligible for price support.

The most visible of the constraints imposed by the tobacco programs are supply controls, of which there have been two types: allotments and quotas. Allotments restricted acreage planted. Each grower participating in the program was prohibited from planting more than his assigned allotment for that year. These allotments partially controlled supply, but as long as the support price was above the equilibrium price, the marginal value of the other inputs was enhanced. Farmers put on more yield-increasing inputs, and the result was oversupply and increases in government-owned stocks (C. Mann). Attempts were made to counteract this tendency towards overproduction by decreasing the size of allotments. However, this did not prove effective. By the 1960s it became obvious that a more effective means of reducing excess production was necessary. A poundage quota was placed in effect for flue-cured tobacco in 1965 and for burley tobacco in 1971.[4] Acreage allotments remained in effect for flue-cured, but not burley tobacco. The presence of a marketing quota implies that the supply function has a kink in it at the price that calls forth production equal to the marketing quota. The supply side of the model was developed to mirror these policy phenomena. Structural equations were developed to explain burley and flue-cured tobacco acreage, yield, and total production.[5]

(1) AB_t: PB_{t-1}, EQB_t, e_1

(2) AF_t: AF_{t-1}, PF_{t-1}, GPF_t, ALF_t, e_2

(3) YB_t: T, $T \times GPB_t$, e_3

(4) YF_t: T, $T \times GPF_t$, e_4

(5) $QPB_t = AB_t \times YB_t$

(6) $QPF_t = AF_t \times YF_t$

where:

AB_t = acreage of burley (1,000 acres)
AF_t = acreage of flue-cured (1,000 acres)
YB_t = yield per acre burley (pounds)
YF_t = yield per acre flue-cured (pounds)
QPB_t = quantity produced of burley tobacco (million pounds)
QPF_t = quantity produced of flue-cured tobacco (million pounds)
PB_{t-1} = average price per pound to growers, burley, previous year (cents/pound)
PF_{t-1} = average price per pound to growers, flue-cured, previous year (cents/pound)
EQB_t = effective quota, burley (million pounds)
GPB_t = government policy dummy, burley (1950–1970 = 1, 1971–1981 = 0)
GPF_t = government policy dummy, flue-cured (1950–1964 = 1, 1965–1981 = 0)
ALF_t = acreage allotted, flue-cured (1,000 acres)
T = time, 1950, 1951 . . . 1981
e_1, e_2, e_3, e_4 = random error terms

For burley, acreage is a function of lagged price and effective quotas, equation (1). For flue-cured, acreage is a function of lagged acreage, lagged price, and a shift dummy to capture the addition of marketing quotas. An allotment variable is also included for flue-cured because allotments were in effect throughout the 32-year period over which the model is estimated. Annual yield is treated as endogenous in the model, equations (3) and (4), with a time variable included to capture technological change and continual adjustment by farmers to the increasing value of marginal product of input factors. A slope dummy on the time variable is included to capture the dampening effect that imposition of marketing quotas is hypothesized to have on tobacco yields. This yield specification is not entirely satisfactory in that yield is not a function of behavioral variables. However, theoretically more appealing specifications, which included rainfall, wages, lagged price, and support price as explanatory variables, resulted in coefficients that did not have the expected signs and/or were insignificant. A rational expectations formulation of the type found in Shonkweiler and Emerson was also attempted, again with disappointing results. The effect of the tobacco program and the high net returns associated with tobacco growing are probably major reasons for the poor results of alternative price specifications. Total burley and flue-cured output is obtained by multiplying yield times acreage. Equations and identities were developed to represent the price formation process in the auction markets, export demand for tobacco, additions to government stocks, manufacturers' demand for tobacco, and market-clearing identities.

(7) PB_t: XB_t, QPB_t, SB_t, QLB_t, e_5

(8) PF_t: XF_t, QPF_t, SF_t, QLF_t, SPF_t, e_6

(9) XB_t: PB_t, $MARK_t$, $ECJQC_t$, ITP_t, e_7

(10) XF_t: PF_t, $MARK_t$, $DECJQC_t$, WXF_t, e_8

(11) GSB_t: $PB_t - SPB_t$, QPB_t, e_9

(12) GSF_t: $PF_t - SPF_t$, QPF_t, e_{10}

(13) $DB_t = B \times QCP_t$

[4] Quotas have to be approved in a national referendum by producers every 3 years. A national marketing quota for each type of tobacco is proclaimed for 3 years and the quota announced each year. A national quota is determined by the U.S. Secretary of Agriculture to maintain total supply at the reserve supply level. The reserve supply is the normal supply plus 5 percent to meet domestic and foreign demand in years of drought, flood, and other adverse conditions. Normal supply is the normal year's domestic consumption and exports (average domestic consumption and exports for the last 10 marketing years adjusted for trends) plus 175 percent of a normal year's domestic consumption and 65 percent of a normal year's export as an allowance for a normal carry-over (J. Mann). Each grower is permitted to market up to 110 percent of his assigned quota without penalty. Individual quotas are adjusted each year to reflect changes in the national quota and under- or over-marketing from the previous year's crop.

[5] Endogenous variables are overlined and the symbol ":" denotes "is a function of."

(14) $DF_t = F \times QCP_t$

(15) $SB_{t+1} = SB_t + QPB_t - DB_t - XB_t - ODB_t + IB_t$

(16) $SF_{t+1} = SF_t + QPF_t - DF_t - XF_t - ODF_t + IF_t$

where:

XB_t = exports of burley tobacco (million pounds)
XF_t = exports of flue-cured tobacco (million pounds)
IB_t = imports of burley tobacco (million pounds)
IF_t = imports of flue-cured tobacco (million pounds)
SB_t = beginning year stocks of burley (million pounds)
SF_t = beginning year stocks of flue-cured (million pounds)
QLB_t = percent of total burley crop which is choice, fine, and good quality
QLF_t = percent of total flue-cured crop which is choice, fine, and good quality
SPB_t = support price burley (cents/pound)
SPF_t = support price flue-cured (cents/pound)
WXF_t = foreign exports of flue-cured (million pounds)
$MARK_t$ = West German exchange rate (marks per dollar)
ITP_t = Average price of Italian tobacco exports (dollars/pound)
$ECJQC_t$ = cigarette production in the Common Market and Japan
$DECJQC_t$ = the change in Common Market and Japanese cigarette production between years t and t − 1
GSB_t = new government stocks of burley (million pounds)
GSF_t = new government stocks of flue-cured (million pounds)
DB_t = burley tobacco used in cigarette manufacturing (million pounds)
DF_t = flue-cured tobacco used in cigarette manufacturing (million pounds)
QCP_t = production of cigarettes (billions)
B = pounds of burley tobacco used per 1,000 cigarettes
F = pounds of flue-cured tobacco used per 1,000 cigarettes
SB_{t+1} = year-end inventory of burley (million pounds)
SF_{t+1} = year-end inventory of flue-cured (million pounds)
ODB_t = burley used for products other than cigarettes (million pounds)
ODF_t = flue-cured used for products other than cigarettes (million pounds)

The price growers receive for tobacco should be related negatively to current production and the size of existing stocks and positively to export demand, the price-support level, and to crop quality, equations (7) and (8). Export demand is a function of foreign demand for tobacco and the price of U.S. tobacco, equations (9) and (10). Cigarette production in the major importing countries is used to capture demand factors. The West German exchange rate is used to capture the impact of the changing value of the dollar on the price of U.S. tobacco facing importers since West Germany is a major importer of both U.S. burley and flue-cured tobacco. The Italian tobacco price is included in the burley export equation because Italy is a major burley exporter. World production of flue-cured is used in place of tobacco prices in other leading exporting countries in the flue-cured export equation because time series of price data were unavailable. New government stocks are related to the level of production and the difference between the auction and support price, equations (11) and (12). Cigarette manufacturers' demand for tobacco is related to cigarette production, equations (13) and (14). Production in excess of domestic disappearance and exports is added to stocks.[6]

Four behavioral relations and identities are specified for cigarettes to explain: the quantity of cigarettes consumed per capita, total domestic cigarette consumption, the price of cigarettes, and the production of cigarettes.

(17) QC_t: QC_{t-1}, FL_t, ANTI, PC_t, e_{11}

(18) $QCC_t = QC_t \times POP_t$

(19) PC_t: TAX_t, PB_{t-3}, PF_{t-3}, $WAGE_t$, e_{12}

(20) $QCP_t = QCC_t + QCX_t + SC_{t+1}$

where:

QC_t = per capita cigarette consumption (in terms of population 18 years and older)
QCC_t = total domestic cigarette consumption (billions)
PC_t = average retail price of all cigarettes (cents/pack)
FL_t = percent of cigarettes filter tipped
ANTI = 1964 Surgeon General's report on smoking and antismoking campaign in 1968 and 1969 (0,1 dummy; 1964, 1968, and 1969 = 1)
POP_t = population 18 years old and over (billion)
$WAGE_t$ = minimum wage (dollars/hour)
QCX_t = quantity of cigarettes exported (billion)
TAX_t = cigarette tax (cents/pack)
SC_{t+1} = additions to stocks of cigarettes (billion)
e_{11}, e_{12} = random error terms

[6] In actual practice, because tobacco must be aged before use, production for the current year is added to carry-over, and tobacco for domestic disappearance comes out of aged stocks.

Per capita demand for cigarettes is posited to be a function of lagged cigarette consumption, of the percent of cigarettes filter tipped, and of cigarette price. A dummy variable is included for 1964, 1968, and 1969 to reflect the 1964 Surgeon General's report and effects of the antismoking campaign, equation (17). Cigarette price is related to burley and flue-cured prices lagged three years, to cigarette taxes, and to a wage variable designed to capture margin changes, equation (19). Tobacco prices are lagged because cigarettes are manufactured with aged tobacco. The percentage of cigarettes filter tipped is included because filters are hypothesized to mitigate the downward effect of health concern upon per capita consumption. The model is closed by identities for total cigarette consumption and production. Cigarette exports and additions to stocks are treated as exogenous.

This system of structural equations contains 12 behavioral equations and 8 identities and was estimated for the period 1950–81. It most closely resembles the model by J. Mann and models the policy, technological, and market factors that determine production and consumption of flue-cured and burley tobacco and cigarettes. Unlike J. Mann's model, this model treats exports and yields as endogenous. The system is primarily recursive, with the only simultaneity occurring between the price and export equations.

Data sources included the USDA publications *Annual Report on Tobacco Statistics, Tobacco Outlook and Situation,* and *Agricultural Statistics,* as well as the USDC publications *Statistical Abstract of the United States* and *Historical Statistics of the United States.* Also included were the U.N. *Statistical Yearbook,* U.N. *Yearbook of Industrial Statistics,* the I.M.F. *International Financial Statistics,* and a Tax Council publication, *The Tax Burden on Tobacco.*

Table 3. Estimated Structural Equations for Burley Tobacco, Flue-Cured Tobacco, and Cigarettes[a]

	Equation (estimated standard errors beneath)	Statistics
(1)	$AB_t = -65.71 + 0.88\ PB_{t-1} + 0.08\ EQB_t$ (650.49) (0.20) (0.04)	$\bar{R}^2 = .69$ D.W.=1.82
(2)	$AF_t = -28.49 + -0.30\ PF_{t-1} + 0.06\ AF_{t-1} + 31.15\ GPF_t + 0.93\ ALF_t$ (40.57) (0.27) (0.06) (16.89) (0.05)	$\bar{R}^2 = .98$ D.W.=1.12[b]
(3)	$YB_t = -1463.45 + 48.37\ TIME + 6.78\ T{*}GPB$ (563.57) (7.63) (2.28)	$\bar{R}^2 = .60$ D.W.=1.03[b]
(4)	$YF_t = -766.95 + 36.99\ TIME + 4.91\ T{*}GPF$ (511.45) (7.22) (1.99)	$\bar{R}^2 = .49$ D.W.=0.70[b]
(5)	$PB_t = 10.82 + 0.75\ XB_t - 0.71\ QPB_t - 0.69\ SB_t - .03\ QLB_t$ (2.82) (0.11) (0.22) (0.33) (.11)	$\bar{R}^2 = .86$ D.W.=2.26
(6)	$PF_t = 0.86 + 0.22\ XF_t - 0.16\ QPF_t - 0.13\ SF_t + 0.14\ QLF_t + 0.37\ SPF_t$ (1.58) (0.13) (0.08) (0.12) (0.06) (0.05)	$\bar{R}^2 = .99$ D.W.=2.23
(7)	$XB_t = 9.22 - 1.48\ PB_t - 2.35\ MARK_t + 0.68\ ECJQC_t + 0.24\ ITP_t$ (4.84) (1.02) (0.96) (0.28) (0.13)	$\bar{R}^2 = .90$ D.W.=1.62
(8)	$XF_t = 12.83 - 0.74\ PF_t - 1.14\ MARK_t + 1.75\ DECJQC_t - 0.28\ WXF_t$ (3.58) (0.55) (0.64) (0.93) (0.08)	$\bar{R}^2 = .72$ D.W.=2.40
(9)	$GSB_t = -84.67 - 3.90\ (PB_t - SPB_t) + 0.30\ QPB_t$ (58.88) (1.32) (0.10)	$\bar{R}^2 = .46$ D.W.=1.21[b]
(10)	$GSF_t = -239.72 - 9.81\ (PF_t - SPF_t) + 0.37\ QPF$ (87.86) (2.24) (0.07)	$\bar{R}^2 = .69$ D.W.=1.09[b]
(11)	$QC_t = 1366.18 + .66\ QC_{t-1} + 6.45\ FL_t - 160.25\ ANTI - 11.27\ PC_t$ (431.19) (.11) (1.71) (43.76) (2.70)	$\bar{R}^2 = .89$ D.W."h"=2.64
(12)	$PC_t = -8.40 + 1.05\ TAX_t + .02\ PB_{t-3} + .24\ PF_{t-3} + 5.78\ WAGE_t$ (2.33) (.17) (.05) (.06) (1.70)	$\bar{R}^2 = .99$ D.W.=1.07[b]

[a] Estimated standard errors are in parentheses.
[b] Prior to correction.

RESULTS

The estimated structural equations are shown in Table 3. Equations (5) and (7) and equations (6) and (8) in the table are simultaneous and were estimated with two-stage least squares. All variables in these four equations are in natural logs. The remaining equations are recursive and were estimated with least squares. Equations (2), (3), (4), (9), (10), and (12) are corrected for first-order serial correlation using a variation of the Cochrane-Orcutt procedure. The Durbin-Watson statistics indicate that serial correlation is not a problem in the other equations.

Coefficient signs in each equation are as expected, except for the negative but nonsignificant coefficients on lagged price in the flue-cured acreage equation and tobacco quality in the burley price equation. Inclusion of lagged price in the acreage equation is based on the adaptive expectations hypothesis. This works well for burley tobacco, but the acreage allotment variable dominates the flue-cured acreage equation. Tobacco quality is either not sufficiently captured by the variable used or is relatively unimportant for burley price. The positive sign on the dummy interaction variable in the yield equations supports the hypothesis that the imposition of marketing quotas decreased the rate of yield increase. Recognizing that standard errors in two-stage least squares are only asymptotically correct, most coefficients in the model are significant at least at the 10 percent level for one-tailed t-tests. The coefficient on lagged cigarette consumption in equation (11) reflects the habit-forming nature of cigarettes. This equation indicates a price elasticity of demand at 1981 levels of just over 0.2. This is also consistent with the habit-forming nature of cigarettes. The cigarette price equation shows that the incidence of cigarette taxes falls largely on consumers. The high standard error on the burley price coefficient reflects the fact that the aging period is not consistently three years in length.

ECONOMIC EFFECTS OF RIDOMIL[R] USAGE

Tobacco and cigarette price impacts that would result if Ridomil[R] were unavailable are presented in Table 4. Short-run (one year) price impacts resulting from decreased burley tobacco yield increase grower prices in the first year by as much as 23.9 cents per pound.[7] Short-run (one year) price impacts resulting from decreased flue-cured tobacco yield would translate into an estimated maximum increase of 7.5 cents per pound in the first year and a 1.8 cents per pack increase in cigarette price 3 years hence. This cigarette price increase would result in a maximum decline in per capita cigarette consumption of 0.5 percent. Total consumer

[7] That cigarette prices are not set in a perfectly competitive market is recognized. A few major manufacturers set cigarette prices, but the goodness of fit of the cigarette price equations in Table 3 indicate that they are strongly are influenced by the market forces embodied in that equation.

Table 4. Short-Run Impacts Due to Changes in Burley and Flue-Cured Yields

	Per Acre Yield		Grower Price		Cigarette Price	
	Change (lbs.)	% Change	Change (¢/lb.)	% Change	Change (¢/pack)	% Change
Burley	-410	-19.3	23.9	13.8	N.S.[a]	N.S.[a]
	-242	-11.4	14.2	8.2	N.S.[a]	N.S.[a]
Flue-Cured	-616	-29.9	7.5	4.8	1.8	2.7
	-363	-17.6	4.4	2.8	1.1	1.7

[a] Not calculated because of insignificant coefficient on lagged burley price in Table 3, Equation 12.

expenditures on cigarettes are estimated to increase by $281–$458 million (1.3–2.2%).

Changes in pesticide costs, production, and prices were used to calculate total changes in net revenues to U.S. burley and flue-cured tobacco producers. Net revenues in the short run could decline in 1981 prices by as much as $462.2 million (26%) for flue-cured producers and $96.1 million (8%) for burley producers.

CONCLUSIONS AND FURTHER IMPLICATIONS

Yield effects of Ridomil[R] usage have a relatively small impact on tobacco and cigarette prices because of the strong influences of the support program and of the concentrated nature of the cigarette-manufacturing industry. Impacts have been quantified for a given period change in tobacco yield resulting from Ridomil[R] usage. However, long-run and short-run (one year) impacts will probably differ for two reasons. First, after the first year producers would probably expand burley acreage in an attempt to compensate for lower yields resulting from the use of less effective chemicals. Program (acreage allotment) adjustments would likely occur for flue-cured tobacco, also enabling those producers to compensate for lower yields. Second, there is reason to believe that yield changes will differ due to the tobacco plant developing resistance to Ridomil[R]. This is likely to occur because of the nature of the particular chemical. Therefore, the effects estimated here should be relevant only for the immediate future.

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