The Consequences of an Open Field Burning Ban on the U.S. Kentucky Bluegrass Seed Industry

R. J. Folwell, L. A. Burt and M. E. Wirth

An econometric model of the U.S. Kentucky bluegrass seed industry in the Pacific Northwest is specified and estimated in order to evaluate the short and long run consequences of yield reductions associated with a ban on open field burning of grass residues. While results differ among regions, model simulations of short run effects of reduced yields attributed to the burning ban indicate price increases for grass seed ranging from 0 to 69 percent and long run effects indicate increased acreage of grass seed production due to producers responses to higher prices.

The Kentucky bluegrass seed industry is concentrated in the Pacific Northwest states of Oregon, Idaho, and Washington. About 90 percent of U.S. Kentucky bluegrass seed was produced in the Pacific Northwest in 1975. The bluegrass seed industry in the Pacific Northwest is facing a possible change in its cultural (production) practices because of environmental concerns over open field burning of grass seed production residues. The state of Washington, as an example, is presently contemplating a total burning ban. The production impact of a burning ban will be reduced yields. Burning not only removes the residue, but also induces better growth and controls diseases and insects.

The only practical alternative to open field burning is mechanical removal. Mechanical removal does not have the beneficial cultural aspects of burning and has the implications of higher production costs and reduced yields. The overall estimated reduction in yield from open burning on a typical 7-year seed crop rotation under mechanical straw removal is 45 percent. However, if growers switch to a 3-year stand of grass seed and use mechanical straw removal techniques, the yields will only drop 26 percent [Canode and Law]. Machine burning of commercial grass seed production residue economically has not yet been demonstrated. Also, mechanical removal followed by thatch burning is unacceptable since yields are still significantly reduced and air pollution from incomplete combustion is greatly increased [Canode and Law].

R. J. Folwell, L. A. Burt and M. E. Wirth are Associate Professor, Research Assistant and Professor, respectively, in agricultural economics at Washington State University. Work was conducted under project 0230, College of Agriculture Research Center, Washington State University, Scientific paper number 5039.

The objectives of this paper are to present an econometric model of the U.S. Kentucky bluegrass seed industry and to use the model to estimate short and long-run changes that could be expected from reduced per acre yields as a result of a ban on open field burning.

Model Specification and Estimation

The parameters of the structural model were estimated with an annual data set ranging from 1963 to 1975. The estimation techniques consisted of ordinary least squares (OLS) for those structural equations not involving simultaneity and two-stage least-squares (2SLS) for those equations involving simultaneity. The entire structural model was evaluated using measures of goodness of fit applied to the solution values. The solution values were found via the Gauss-Seidel technique. The measures of goodness of fit were the mean percent error, the squared correlation between the observed and the solution values for the normalized endogeneous variables in the model, and Theil's U_2 statistic [Leuthold].

The specification of the structural model attempted to capture the behavioral aspects of the participants in the bluegrass seed industry as well as the technical, institutional, and interlocking aspects with other agricultural sectors or with alternative enterprises on the farm. The structural model included subsets of equations representing acreages, production identities, inventories, demand, market clearing identities, and price mapping equations. The acreage, production identities, and price mapping equations were specified for each major grass seed producing region. These regions were Oregon and the Inland Pacific Northwest areas. The latter consists of the grass seed growing areas in Washington and Idaho. It was necessary to stratify the Pacific Northwest industry into major areas in order to capture the effects of environmental regulations on burning that will be administered by individual states or production areas. All other structural equations were specified and estimated at the national level. Each subset of equations included separate equations for Common and Merion types of bluegrass due to differences in their supply and demand characteristics.

Table 1 contains the alphanumeric identification codes, definitions, and units of the variables in the structural model. The estimated structural equations (1-4) explaining the acreages by the types of bluegrass seed in Oregon and the Inland Pacific Northwest are shown in Table 2. The four acreage equations are similar. The price received in the previous year for the particular type of seed in an area is an explanatory variable in each equation. The lagged price of the seed under consideration is assumed to influence price expectations of growers. The use of the lagged price in the equations as a modified expectations formulation results in the lagged value of the dependent variable also being an explanatory variable.[1] The lagged dependent variable acts as a proxy for past investment and production capacity of the area for that particular type of seed. The grower price received for the major alternative agricultural enterprise available to producers in each area is likewise specified as an explanatory variable. In the case of the acreage equations for the Inland Pacific Northwest, wheat was specified as a major alternative enterprise. In Oregon, the major alternative enterprises were specified as Red Fescue grass seed for Common bluegrass and rye grass as an alternative to Merion.

The behavioral relationships explaining acreages are based primarily upon explanatory variables which reflect gross revenues per unit and not net revenues per unit. With the change in production practices, production costs might change and thus net revenues might change. This possibility is not accounted for in the structural model. Thus, the results presented in this paper are based upon the implicit assumption that the costs of production for grass seed and alternative crops will maintain their historical relationship. That is, net returns will change only because of price changes.

All t values shown in the parentheses below the coefficients in the structural equations are greater than one (in absolute value) and are interpreted as indicating statistical significance in this research. The signs on each coefficient are in agreement with a priori reasoning derived from economic theory and knowledge of the industry.[2] The

[1]The specification of the acreage equations with the lagged dependent variable should not be interpreted as a Koyck type transformation to account for a distributive lagged supply response. Some of the estimated coefficients on the lagged acreage variables are greater than 1.0. The specifications of Equations 1 through 4 were never intended to be used in a Koyck transformation. However, since the specification of the acreage equations is essentially of the form of difference equations, it should be recognized that extrapolation beyond the data set could be dangerous. The system is explosive because some of the coefficients are greater than 1.0.

[2]In earlier specifications of the structural model, costs of production as well as prices were tried as explanatory variables in both acreage and yield equations. Wrong signs according to economic theory and slope coefficients that were not statistically significant resulted in the cost variables being dropped.

R^2 statistics range from .66 to .94, and the Durbin-Watson values indicate no first order autocorrelation problems. The Durbin-Watson statistics are biased because of the lagged value of the dependent variable on the right hand side of the equation. It was not possible to use the statistic prepared by Durbin for cases where a lagged value of the dependent variable is on the right hand side of an equation. This test statistic is tested as a standard normal deviate and there were less than 30 observations in the sample data set.

The structural inventory equations explaining the ending levels of inventories for Common and Merion in the U.S. are shown in equations 5 and 6 in Table 3. Both equations are of the log inverse functional form. The inventory equation for Common includes the total quantity of Common grass seed produced in the U.S., the ending inventory of the previous time period, and the amount of net foreign trade (exports less imports) that occurred in Common grass seed during that time period.[3] The net foreign trade on Common and Merion were treated exogenously in the model.

The Merion inventory equation includes not only the current production of Merion, the ending stocks of the previous time period, and the net foreign trade of Merion, but also the current price of Merion and the lagged number of housing starts in the U.S. It was hypothesized in the initial specification of the model that there was speculation involved in the demand for Merion inventories. The speculation would be based upon the current price, the lagged value of a major demand shifter for Merion, like housing starts, as well as the overall supply situation in terms of current production, beginning inventory levels, and net foreign trade.

The Common inventory relationship (Equation 5) can be considered strictly a pipeline or buffer formulation of the inventory relationship without a speculative motive as indicated in the specification of Merion inventory levels (Equation 6). The alternative bases for the specifications of the two inventory equations explain the negative sign on the current price of Merion. A low level of Merion production and resulting high price would induce holders of inventories with a speculative motive to deplete their inventory holdings.

All coefficients signs estimated in the inventory equations are consistent with a priori reasoning based upon the pipeline and speculative specifications. All slope coefficients are statistically significant, but the t tests are only approximate under 2SLS.

The demand equations estimated for Common and Merion are shown as Equations 7 and 8 in Table 3. The quantity and price variables in the demand equations are specified on a per capita and deflated basis, respectively.

The specification of the linear demand equation for Common bluegrass includes the price of Common bluegrass and the lagged value of housing starts per capita. In earlier specifications and estimations, the price of Merion grass seed and per capita income were tried. Because of signs contrary to what would be expected and insignificant slope coefficients, the variables were dropped from the final specification.

The explanatory variables in the nonlinear Merion demand equation include the deflated prices of Merion and Common seed, and time. The price of Common bluegrass seed was included in this equation as a substitute commodity. The sign associated with the time variable is negative. In earlier specifications and estimations, negative signs were associated with variables reflecting demand shifters for Merion.

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[3]Equation 5 was estimated with 2SLS since it cannot be argued that the error terms in this equation are statistically independent of the errors in Equations 1 through 4 plus the identities shown in Table 4 as Equations 13 through 18. A more proper estimation-technique would have consisted of OLS with the values of QC_t being estimated values from Equations 1 through 4 plus the production identities. Since the values of QC_t in the first stage of the 2SLS procedure are a function of all the predetermined variables in the system, the only limitation of the estimation technique used for Equation 5 was that too many variables were used to estimate the values of QC_t.

TABLE 1. Coding, definitions and units of variables.

Variable Code	Variable Definition	Variable Unit
CC	U.S. Consumption (disappearance) of Common Kentucky bluegrass	000's of lbs.
CM	U.S. consumption (disappearance) of Merion Kentucky bluegrass	000's of lbs.
CPI	U.S. consumer price index - all items	1967=100
HS	U.S. nonfarm housing starts	000's
IAC	Inland Pacific Northwest acreage of Common Kentucky bluegrass	acres
IAM	Inland Pacific Northwest acreage of Merion Kentucky bluegrass	acres
IC	Total U.S. Common Kentucky bluegrass inventory	000's of lbs.
IM	Total U.S. Merion Kentucky bluegrass inventory	000's of lbs.
IPC	Inland Pacific Northwest price of Common Kentucky bluegrass	$/cwt.
IPM	Inland Pacific Northwest price of Merion Kentucky bluegrass	$/cwt.
IPW	Inland Pacific Northwest price of wheat	$/bu.
IQC	Inland Pacific Northwest production of Common Kentucky bluegrass	000's of lbs.
IQM	Inland Pacific Northwest production of Merion Kentucky bluegrass	000's of lbs.
IYC	Inland Pacific Northwest yield of Common Kentucky bluegrass	1bs./acre
IYM	Inland Pacific Northwest yield of Merion Kentucky bluegrass	lbs./acre
N	U.S. population	millions
NFTC	Net foreign trade in Common Kentucky bluegrass	000's of lbs.
NFTM	Net foreign trade in Merion bluegrass seed	000's of lbs.
ϕAC	Oregon acreage of Common Kentucky bluegrass	acres
ϕAM	Oregon acreage of Merion Kentucky bluegrass	acres
ϕPC	Oregon price of Common Kentucky bluegrass	$/cwt.
ϕPM	Oregon price of Merion Kentucky bluegrass	$/cwt.
ϕPR	Oregon price of ryegrass seed	$/cwt.
ϕPRF	Oregon price of red fescue grass seed	$/cwt.
ϕQC	Oregon production of Common Kentucky bluegrass	000's of lbs.
ϕQM	Oregon production of Merion Kentucky bluegrass	000's of lbs.
ϕYC	Oregon yield of Common Kentucky bluegrass	lbs./acre

Table 1. (cont.)

Variable Code	Variable Definition	Variable Unit
ϕYM	Oregon yield of Merion Kentucky bluegrass	lbs./acre
PC	U.S. Common Kentucky bluegrass price	$/cwt.
PM	U.S. Merion Kentucky bluegrass price	$/cwt.
QC	Total U.S. production of Common Kentucky bluegrass	000's of lbs.
QM	Total U.S. production of Merion Kentucky bluegrass	000's of lbs.
RQC	Total U.S. production of Common Kentucky bluegrass less Inland Pacific Northwest and Oregon production (residual production)	000's of lbs.
RQM	Total U.S. production of Merion Kentucky bluegrass less Inland Pacific Northwest and Oregon production (residual production)	000's of lbs.
T	Time	1965-1977

All slope coefficients estimated in the demand equations for grass seed are statistically significant. The signs of the coefficients are in agreement with a priori economic reasoning.

Table 4 contains the price dependent equations or price mapping equations for each type of grass seed in the Inland Pacific Northwest and Oregon production areas. The explanatory variable is the current deflated price of those types of seed at the national level which are in Equations 7 and 8. The slope coefficients of these price variables have positive signs and are statistically significant. In Equations 9-12, the slope coefficient is less than 1.0 when the value of the intercept is positive and greater than 1.0 when the intercept is negative. Both results are acceptable on an economic basis.

Identities which complete the structural model are reported in Table 5. Equations 13-18 link the acreages and production levels by the average yields. Equations 19 and 20 relate the aggregate consumption of each type of grass seed to domestic production, stock changes, and net foreign trade. These equations make the economic model complete, in that there is one structural equation for each endogenous variable.

Goodness of Fit

The Gauss-Seidel method was used to generate the values of the endogenous variables as solutions to the structural equations for the 1965 to 1975 time period. Various measures of goodness of fit were then applied to the observed and solution values for the endogenous variables.

The model had to be slightly modified from that shown in Tables 2 through 5. The modification consisted of normalizing each equation in the model so that an endogenous variable appeared on the left-hand side of each structural equation and was unique only to that equation in the sense that each endogenous variable can appear on the left-hand side of an equation only once. In this normalization, 1) the prices on the left-hand side of the various structural equations were not deflated; 2) the quantities that appeared on the left-hand side were per capita; and 3) the antilogarithmic values of the quantities were estimated rather than the logarithmic values in those equations where the inverse logarithmic functional form was used. Table 6 contains the measurements of goodness of fit for each of the normalized endogenous variables in the U.S. bluegrass seed model.

TABLE 2. Estimated structural equations of the acreages of bluegrass seed.

Equations	Estimation Technique	Related Statistics			
		R^2	$\hat{\sigma}$	D.W.	$\bar{y}$
Inland Pacific Northwest					
Common					
Eqn. 1: $IAC_t = 2042.377 - 7529.523{*}IPW_{t-1} + 1.038{*}IAC_{t-1} + 424.619{*}IPC_{t-1}$	OLS	.94	4,534.7	1.82	36,767
(0.51) (−3.50) (9.56) (2.85)					
Merion					
Eqn. 2: $IAM_t = 1484.201 - 1192.851{*}IPW_{t-1} + 0.830{*}IAM_{t-1} + 30.423{*}IPM_{t-1}$	OLS	.94	1,425.2	2.05	9,392
(0.46) (−3.25) (3.32) (1.70)					
Oregon					
Common					
Eqn. 3: $\phi AC_t = 13{,}232.960 + 237.903{*}\phi PC_{t-1} + 0.412{*}\phi AC_{t-1} - 274.105{*}\phi PRF_{t-1}$	OLS	.77	2,217.5	1.56	20,750
(2.53) (1.47) (1.94) (−1.51)					
Merion					
Eqn. 4: $\phi AM_t = -528.107 + 24.0466{*}\phi PM_{t-1} + 1.050{*}\phi AM_{t-1} - 218.111{*}\phi PR_{t-1}$	OLS	.66	880.8	1.99	4,925
(−0.33) (2.54) (3.76) (−2.61)					

NOTES: The values shown in parentheses below each coefficient are t values.
R^2 is the squared correlation coefficient or the coefficient of determination.
$\hat{\sigma}$ denotes the standard error of the estimate.
D.W. is the Durbin Watson statistic.
$\bar{y}$ is the mean of the dependent variable.
See Table 1 for the alpha numeric identification codes and variable definitions and units.

TABLE 3. Estimated structural equations of the inventories and demands for bluegrass seed.

Equations	Estimation Technique	Related Statistics R^2	$\hat{\sigma}$	D.W.	$\bar{y}$
U.S. Inventory Levels					
Common					
Eqn. 5: $LnIC_t = 7.77386 + 0.0000249{*}QC_t + 0.0000610{*}IC_{t-1} + 0.00001388{*}NFTC_t$ (23.28) (2.78) (4.50) (1.15)	2SLS	NA	.213	NA	9.5
Merion					
Eqn. 6: $LnIM_t = 7.754 - 0.00807{*}PM_t - 0.000142{*}QM_t + 0.000148{*}IM_{t-1} + 0.000144{*}NFTM_t$ (13.79) (−2.24) (−1.39) (1.82) (3.05) $+ 0.000495{*}HS_{t-1}$ (2.33)	2SLS	NA	.192	NA	7.8
U.S. Demand					
Common					
Eqn. 7: $CC_t/N_t = 0.18962 - 0.00325{*}PC/CPI_t + 0.010231{*}HS_{t-1}/N_{t-1}$ (9.27) (−5.63) (3.05)	2SLS	NA	.013	NA	0.2
Merion					
Eqn. 8: $Ln(CM_t/N_t) = 97.053345 - 0.004438{*}\frac{PM_t}{CPI_t} + 0.0110697{*}\frac{PC_t}{CPI_t} - 0.0512159{*}T_t$ (2.95) (−1.94) (1.78) (−3.07)	2SLS	NA	.167	NA	−3.82

NOTES: NA denotes case where statistic is not applicable.
See Table 2 for other explanatory notes.

TABLE 4. Estimated structural equations for prices by area.

Equations	Estimation Technique	Related Statistics			
Price Equations by Area		R^2	$\hat{\sigma}$	D.W.	$\bar{y}$
Inland Pacific Northwest					
Common					
Eqn. 9: $IPC_t/CPI_t = -3.33189 + 1.08247 * \frac{PC_t}{CPI_t}$ $(-2.58) \quad (25.32)$	2SLS	NA	1.258	NA	28.03
Merion					
Eqn. 10: $IPM_t/CPI_t = 1.73067 + 0.94079 * \frac{PM_t}{CPI_t}$ $(0.98) \quad (39.19)$	2SLS	NA	1.840	NA	67.27
Oregon					
Common					
Eqn. 11: $\phi PO_t/CPI_t = 6.06044 + 0.83473 * \frac{PC_t}{CPI_t}$ $(2.96) \quad (12.32)$	2SLS	NA	1.993	NA	30.24
Merion					
Eqn. 12: $\phi PM_t/CPI_t = -2.63264 + 1.09192 * \frac{PM_t}{CPI_t}$ $(-0.87) \quad (26.40)$	2SLS	NA	3.171	NA	73.44

NOTE: See Table 2 for explanatory notes.

TABLE 5. Identity relations of structural model.

Production Identities

Inland Pacific Northwest

common

Eqn. 13: $IQC_t = IAC_t \cdot IYC_t$

merion

Eqn. 14: $IQM_t = IAM_t \cdot IYM_t$

Oregon

common

Eqn. 15: $\phi QC_t = \phi AC_t \cdot \phi YC_t$

merion

Eqn. 16: $\phi QM_t = \phi AM_t \cdot \phi YM_t$

U.S.

common

Eqn. 17: $QC_t = IQC_t + \phi QC_t + RQC_t$

merion

Eqn. 18: $QM_t = IQM_t + \phi QM_t + RQM_t$

Market Clearing Identities - U.S.

common

Eqn. 19: $CC_t = QC_t + CI_{t-1} - CI_t + NFTC_t$

merion

Eqn. 20: $CM_t = QM_t + MI_{t-1} - MI_t + NFTM_t$

NOTE: See Table 2 for explanatory notes.

TABLE 6. Measures of goodness of fit for each normalized endogenous variable in the U.S. Kentucky bluegrass seed model.

Variable	Mean Percent Error	Y vs. Y-hat Squared Correlation	Theil $-U_2$ Statistic
IAC	−1.35436	0.92103	0.73704
IAM	−0.72220	0.65602	0.85257
ϕAC	0.37814	0.68805	0.85764
ϕAM	0.85427	0.70721	0.80304
IQC	−1.37241	0.93726	0.32325
IQM	−0.72251	0.78634	0.65523
ϕQC	0.37815	0.73529	0.58707
ϕQM	0.81719	0.78615	0.64727
QC	0.29244	0.95212	0.28226
QM	−0.00469	0.76089	0.69199
IC	−0.54010	0.93887	0.57385
IM	1.54604	0.88338	0.64149
CC/N	−0.27231	0.73007	0.38471
CM/N	0.37498	0.88357	0.46421
PC	−2.67372	0.86025	0.36774
PM	−0.82284	0.51608	0.81543
IPC	−3.02976	0.85891	0.35754
IPM	−1.50641	0.49116	0.79655
ϕPC	−2.65960	0.81931	0.39518
ϕPM	0.57609	0.54977	0.82587

The three measurements indicate that the model provides a good fit to the historical values of the endogenous variables. The mean percent error on each of the current endogenous variables was three percent or less. The squared correlation coefficients between the observed and the solution values for the normalized endogenous variables are high. The lowest squared correlation coefficient is 0.49 for the Inland Pacific Northwest price of Merion. All other squared correlation coefficients are higher than this value, and 75 percent of these coefficients are at least 0.7 or greater. In a similar vein, all the values for Theil's U_2 statistic are less than 1.0. This indicates a moderately good fit of the structural model to the historical time period of 1965 to 1975 [Leuthold].

Multipliers and Simulation Results

Multipliers were estimated for the normalized structural model using the Gauss-Seidel technique. The Gauss-Seidel technique was used to estimate the multipliers because nonlinearities introduced with the inverse logarithmic functional forms made it impossible to derive the reduced form from the estimated structural model.

While both long- and short-run impact multipliers were estimated for all exogenous variables in the model, only those dealing with a 45 percent decrease in yields are presented here. Each yield variable was decreased individually while all other variables were held constant at their historical mean values. A simulation of the effects of a simultaneous reduction in all yields by 26 percent with other factors held constant is presented after the discussion of the multipliers.

Multipliers

Mechanical straw removal as opposed to open field burning which has been used historically is expected to result in a 45 percent decrease in average yield levels below their historical means with a 7-year stand of grass seed [Canode and Law]. In the case of Common, this yield reduction would be 205 pounds per acre in the Inland Pacific Northwest and 290 pounds in Oregon. In the case of Merion grass seed production, the yield reduction would be 119 pounds per acre in the Inland Pacific Northwest and 153 pounds in Oregon [Wirth, Burt, Canode and Law].

Table 7 shows the short-run or one-period multipliers and the long-run multipliers of ten years, both resulting from decreased yields of the two types of grass seed in the Inland Pacific Northwest and Oregon. Each column of multipliers was estimated given the 45 percent decrease in the exogenous variable shown in the column heading from its historical mean value. Table 7 reveals a diagonal matrix of short-run impact multipliers as a result of the recursive nature of the supply side of the structural model. Where the yield levels were decreased, the acreages of the various grass seeds would not be affected in the short-run. However, the quantities available of the various grass seeds would be reduced by the decreased yields.

With decreased yields, all the inventory levels would be reduced in the short-run. The per capita consumption of Common would decrease or remain the same for any of the yield decreases. The decreased yields of Merion would always reduce consumption of Merion. However, the per capita consumption of Merion would increase when yield levels of Common are decreased. This result is attributed to the specification of Common as a substitute product in the structural demand equation for Merion.

The percentage increases in prices resulting from the reduced yields range approximately from zero to 69 percent. In analyzing the effects upon U.S. price levels as well as by production areas, the 45 percent decrease in the yield of Common in the Inland Pacific Northwest will increase the prices of both Common and Merion. The yield decrease for Common in Oregon also results in similar directional price changes. For Oregon prices, the price increase resulting from the decreased yield in Oregon is less than the increase in the prices resulting from the de-

TABLE 7. Short and long-run impact multipliers arising from a 45 percent decrease in yields.

Endogenous Variable		Exogenous Variables							
Alpha Num Code	Historical Mean Solution Values	IY C lbs./acre	IY M lbs./acre	ϕY C lbs./acre	ϕY M lbs./acre	IY C lbs./acre	IY M lbs./acre	ϕY C lbs./acre	ϕY M lbs./acre
		Short run Multipliers				Long run Multipliers			
IA C	36,820 (Acres)	0.0	0.0	0.0	0.0	26162.4800	20.8984	14,634.2400	15.7539
IA M	9,397 (Acres)	0.0	0.0	0.0	0.0	−107.6641	410.1406	−149.6133	581.0859
ϕA C	21,125 (Acres)	0.0	0.0	0.0	0.0	816.3789	2.7266	39.3867	4.1602
ϕA M	4,924 (Acres)	0.0	0.0	0.0	0.0	374.3110	2947.0020	127.9321	2446.6240
IQ C	16,753 (1,000 lbs.)	−7548.2000	0.0	0.0	0.0	−982.9844	9.5078	6,658.5780	7.1679
IQ M	2,490 (1,000 lbs.)	0.0	−1118.2870	0.0	0.0	−28.5317	−948.8992	−39.6482	153.9880
ϕQ C	13,604 (1,000 lbs.)	0.0	0.0	−6126.1170	0.0	525.7500	1.7578	−6,044.2460	2.6836
ϕQ M	1,669 (1,000 lbs.)	0.0	0.0	0.0	−753.3708	126.8916	999.0344	43.3701	−156.9976
Q C	36,255 (1,000 lbs.)	−7548.2000	0.0	−6126.1170	0.0	−457.2305	11.2695	614.3320	9.8515
Q M	4,204 (1,000 lbs.)	0.0	−1118.2850	0.0	−753.3689	98.3599	50.1350	3.7219	−3.0097
I C	13,079 (1,000 lbs.)	−2238.0500	−1.7773	−1847.3280	−1.7773	−1985.5780	35.8555	−468.0117	24.2422
I M	2,611 (1,000 lbs.)	−222.9700	−446.3315	−180.0242	−297.7576	8.3372	58.2544	40.9365	−15.3506
C C /N	.19 (lbs./N)	−0.0263	0.0	−0.0211	0.0	−0.0038	0.00001	0.0013	0.0
C M /N	.02 (lbs./N)	0.0011	−0.0033	0.0009	−0.0023	0.0004	0.0002	0.0	−0.00005
P C	31.59 ($/cwt.)	9.6129	−0.0223	7.7449	−0.0223	1.3928	0.0061	−0.4956	0.0105
P M	65.61 ($/cwt.)	11.0212	43.0437	8.8101	28.3659	−2.1074	−2.8541	−1.3585	0.5453
IP C	30.23 ($/cwt.)	10.4056	−0.0242	8.3837	−0.0242	1.5076	0.0067	−0.5365	0.0114
IP M	63.79 ($/cwt.)	10.3687	40.4951	8.2885	26.6864	−1.9826	−2.6851	−1.2781	0.5130
ϕP C	33.59 ($/cwt.)	8.0241	−0.0186	6.4649	−0.0186	1.1626	0.0051	−0.4137	0.0088
ϕP M	68.50 ($/cwt.)	12.0343	47.0003	9.6199	30.9733	−2.3011	−3.1164	−1.4834	0.5954

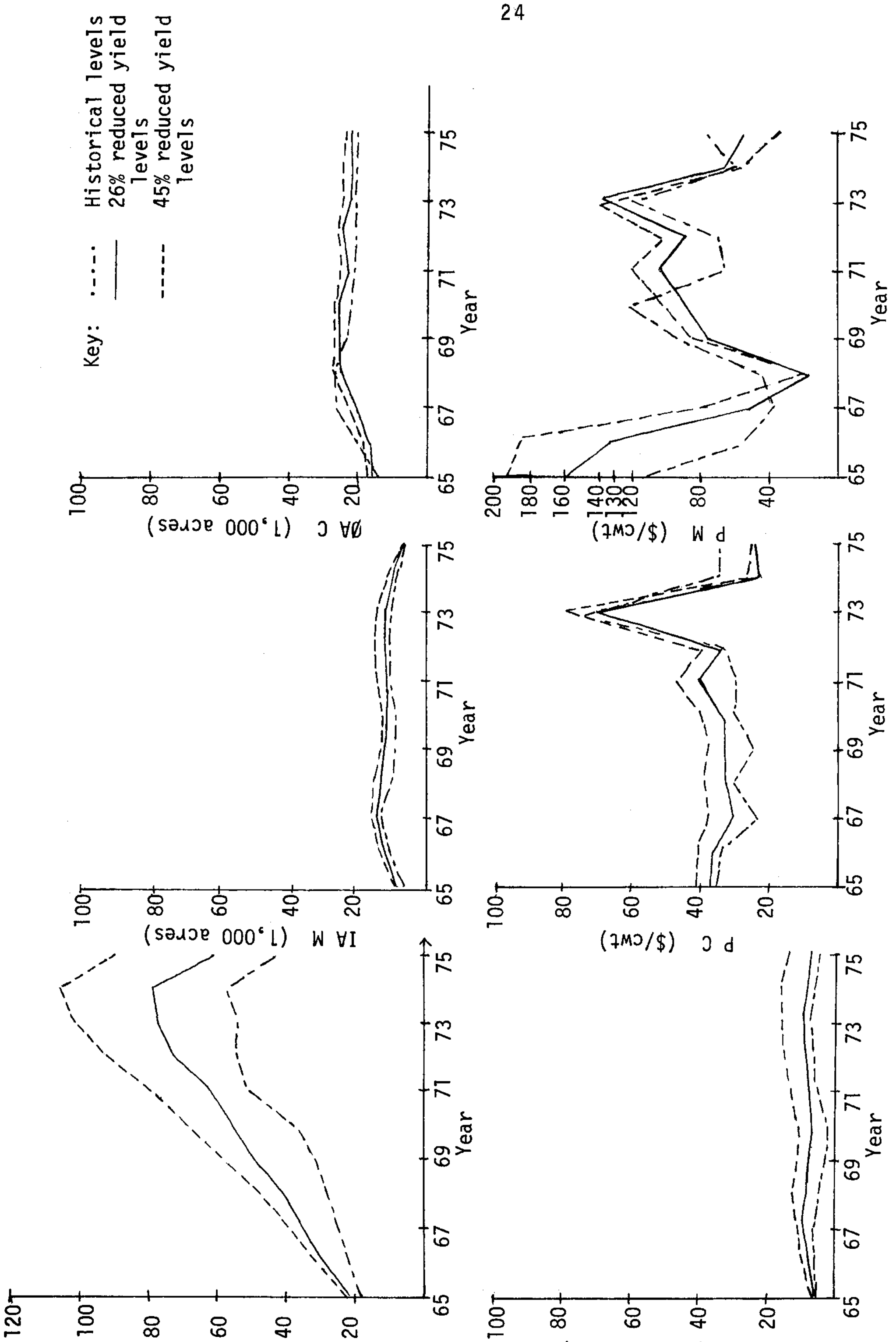

Figure 1. Historical values and simulation results with 26% and 45% decreases in the yield levels on acreages by production areas and U.S. prices of common and Kentucky bluegrass seed.

crease in yield in the Inland Pacific Northwest. The relative importance of the two areas in producing the two types of seed is the major explanation of the differing sizes of impact multipliers as well as the relationships of the intercept to slope coefficients in the price mapping equations (Equations 9-12 in Table 3).

The long-run[4] multipliers reported in Table 7 indicate that the 45 percent reduction in grass yields results in increased acreage of grass seed production over the long-run. These increased acreages result because prices for such grass seed are expected to be higher in the long-run due to the lower supply levels. Hence, producers would have a positive supply response to such price signals in the marketplace, assuming no significant changes in costs.

Another long-run effect of decreased yields was to decrease the inventory level of Common and increase the inventory level of Merion. The inventory level of Merion increases in all cases except when the yield of Merion in Oregon is decreased. The consumption of each grass seed changes slightly.

The impact multipliers shown on the prices of grass seed in the producing areas are mixed in terms of direction of change. These long-run impacts are only a fraction of those estimated in the short-run. The smaller long-run multipliers result from the fact that the supply side of the market reacts in the long-run with larger acreages — an impossibility in the short-run. The mixed results of the price changes are associated with the magnitude of the growers' acreage responses and with the fact that the yield of only one type of grass seed in the one area was changed at a time in estimating the multipliers.

Simulation Results

Simulations were made for 26 percent and 45 percent reductions in yields occurring simultaneously in all production areas. These reduced yield levels are expected to occur in the long-run from a burning ban and were run over the 1965-1975 period. All exogenous variables in the model except the yield levels were maintained at their historical values from 1965 to 1975 in generating the simulation results. The historical values and simulation results for the acreages by production areas and U.S. price levels for Common and Merion seed are shown in Figure 1. Only the area acreages and U.S. price levels are presented for the sake of brevity.

Regardless of whether the yield levels are reduced by 26 percent or 45 percent, producers would be expected to increase acreages because of the higher price levels. In the first year of simulation, 1965, the acreages are the same in the solutions because of the recursive nature of the supply side of the structural model. However, starting in the second year of the simulations, producers increase their acreages. The increase with the 26 percent reduction in yields is always less than with the 45 percent reduction because of the smaller increases in prices.

The acreage response was greater for Common than Merion in the Inland Pacific Northwest and the opposite was found for Oregon. The contrasting results are a direct reflection of the differing sizes of coefficients of the lagged price variables in the structural model and the variation in prices for each type.

The degree of price variability resulting from the reduced yield levels was greater for the larger reduction in yields and for Merion as compared to Common. Such a relationship in variability was also observed in the historical period. The area price levels follow the U.S. price levels in the fashion indicated by the price mapping equations in Table 3.

Conclusions

Overall, the expected long-run impact of a ban on burning would be to increase the acreage of grass seed because of agricultural

[4]The long-run was defined as ten years in the multiplier analysis. This length of time allows for one complete 7-year change in the acreage of grass seed.

producers' response to higher prices in the marketplace. Grass seed production would become more attractive relative to alternative enterprises on the farm. The model did not account for changing net returns because in earlier research efforts the cost of production was not a statistically significant variable in explaining changing acreages or yields. The model used gross and not net revenues per unit in the behavioral equations. If production practices change, costs and net revenues might change. The results are based upon the assumption that net revenues will change only as a result of price changes.

The impacts upon the prices in the various production areas would differ. These results indicate that the direction and magnitude of the changes in prices will be partially determined by how much the producers of the various types of seed respond to the higher (initially) prices which they could expect to receive for their production. These results suggest larger increases in the acreage of Common than Merion in the Inland Pacific Northwest, and larger acreage increases for Merion than Common in Oregon.

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