1300 10-16-81

Demand and Supply in the Oregon Grass Seed Industry: An Economic Analysis

Station Bulletin 652
September 1981

Agricultural Experiment Station
Oregon State University, Corvallis

DEMAND AND SUPPLY IN THE OREGON GRASS SEED INDUSTRY:

AN ECONOMETRIC ANALYSIS

James T. Ryan
Frank S. Conklin
John A. Edwards

A research study
funded jointly by
Agricultural Experiment Station
Oregon State University
and
Office of Solid Waste Management
Environmental Protection Agency
Washington, D.C.

SUMMARY

This report provides an empirical analysis of the demand for and supply of eight major cool season grasses grown for seed in the United States at farm and wholesale market levels. Special emphasis is placed on the Willamette Valley of Oregon which produced more than 70 percent of total U.S. production in 1979. The time series base used in the analysis is provided in a companion document, "Supply and Disposition of Cool Season Grass Seeds in U.S. and Overseas Markets," Oregon Agricultural Experiment Station Circular of Information 689, March, 1981.

AUTHORS

James T. Ryan is a lecturer of agricultural economics, California State University, Fresno, and formerly research assistant in agricultural and resource economics, Oregon State University; Frank S. Conklin and John A. Edwards are professors of agricultural and resource economics, Oregon State University.

CONTENTS

INTRODUCTION.... 1

MODEL FORMULATION.... 4

MODEL 1: Short-Run Supply-Demand.... 4

Domestic Demand.... 4

Export Demand.... 6

Wholesaler Supply.... 8

Wholesale Market Equilibrium.... 9

Farm Demand.... 9

Farm Supply.... 11

Farm Market Equilibrium.... 12

Identities.... 12

MODEL 2: Long-Run Willamette Valley Supply Response.... 14

Data Requirements.... 18

Grass Seed Prices.... 18

Grass Seed Quantities.... 18

Demand Shift Variables.... 19

Supply Shift Variables.... 20

Production Costs.... 20

Weather Variables.... 21

RESULTS.... 22

Wholesale Level Demand in U.S. Markets.... 22

Wholesale Level Demand in Foreign Markets.... 24

Farm Level Demand.... 26

Demand Response in Grass Seed Markets.... 26

Buyer Response in Foreign Markets.... 29

Buyer Response at Wholesale Level in U.S. Markets.... 31

Buyer Response at Farm Level in U.S. Markets.... 33

Substitution and Complementarity in Demand Markets.... 35

Short-Run Supply Relationships.... 38

Supply in Wholesale Markets.... 39

Supply in Farm Markets.... 39

Short-Run Supply Response to Price Changes.... 42

Long-Run Supply Relationships 43
Willamette Valley Grass Seed Yield Response 43
Willamette Valley Grass Seed Acreage Response 45
Producer Response to Price Changes 49
Producer Response to Cost Changes 51
Analytical Limitations 52
SUMMARY AND CONCLUSIONS 56
Policy Implications for Market Orders 56
Policy Implications for Reduced Field Burning 57
BIBLIOGRAPHY 59
Appendix 60
Appendix Table 1 - Calculated Quantities of Grass Seed Sold by U.S. Farmers by Seed Type, 1959-1976 61
Appendix Table 2 - Calculated Quantities of Grass Seed Sold by U.S. Wholesalers by Seed Type, 1959-1976 62
Appendix Table 3 - Selected Demand Shift Variables for Cool Season Grass Seed in U.S. Retail Markets 63
Appendix Table 4 - Estimated Operating Costs Per Acre for Producing Selected Grass Seed Types in Willamette Valley of Oregon, 1959-1978 64

TABLES

Table Number		Page
1	Schedule of Acreage to be Burned and Associated Burning Fees	17
2	Estimated U.S. Demand Equations at the Wholesale Level for Selected Grass Seed Types, 1959-1975	23
3	Estimated Export Demand Equations at the Wholesale Level for Selected Grass Seed Types, 1959-1975	25
4	Estimated Farm Demand Equations for Selected Grass Seed Types, 1959-1975	27
5	Buyer Response in Foreign Markets Measured by Price Elasticity of Demand at the Wholesale Level by Grass Seed Type	29
6	Buyer Response in U.S. Markets Measured by Price Elasticity of Demand at the Wholesale Level by Grass Seed Type	30
7	Buyer (Wholesaler) Response at Farm Level in U.S. Markets Measured by Price Elasticity of Demand by Grass Seed Type	34
8	Buyer Response Between Seed Types at the Wholesale Level in U.S. Markets by Grass Seed Type Measured by Cross-Price Elasticity of Demand	36
9	Buyer Response Between Seed Types at the Wholesale Level in Foreign Markets by Grass Seed Type Measured by Cross-Price Elasticity of Demand	37
10	Estimated Wholesale Level Supply Equations for Selected Grass Seed Types, 1959-1975	40
11	Estimated Farm Level Supply Equations for Selected Grass Seed Types, 1959-1975	41
12	Average Short-Run Supply Response to Price Measured by Price Elasticities of Supply by Grass Seed Type at the Farm and Wholesale Levels, 1959-1975	43
13	Mean Yield and Dispersion Characteristics for Selected Grass Seed Types, Willamette Valley, Oregon, 1959-1975	44
14	Estimated Willamette Valley Yield Response Equations for Selected Grass Seed Types, 1959-1976	46
15	Estimated Willamette Valley Acreage Response Equations for Selected Grass Seed Types, 1959-1975	48

Table Number		Page
16	Willamette Valley Producer Acreage Response to Price for Selected Grass Seed Types Measured by Price-Elasticities of Acreage Response, 1959-1976	49
17	Willamette Valley Producer Acreage Response to Cost for Selected Grass Seed Types Measured by Cost Elasticities of Acreage Response, 1959-1976	51

DEMAND AND SUPPLY IN THE OREGON GRASS SEED INDUSTRY: AN ECONOMETRIC ANALYSIS

INTRODUCTION

The grass seed industry is of considerable importance to the economy of Oregon, and of special significance to the agricultural community of the Willamette Valley. Grass seed production generated $59 million in Oregon farm receipts in 1978, with $50 million accruing to Willamette Valley farmers. These figures represent 9 percent of the state's crop production income, and 15 percent of the Willamette Valley's crop income. Processing contributed an additional $8 million [14].

Some 306 million pounds of grass seed were produced on 256,000 acres in Oregon in 1979, accounting for 72 percent of the total volume of cool season grass seed grown in the United States. Eight major cool season grass seed types are grown in Oregon--annual ryegrass, perennial ryegrass, bentgrass, fine fescues, Merion Kentucky bluegrass, other Kentucky bluegrass, orchardgrass, and tall fescue. The annual and perennial ryegrasses represent the most widely grown seed types, accounting for almost 70 percent of Oregon's grass seed acres. Oregon is the sole producer of ryegrasses in the United States. Linn County accounts for 75 percent of Oregon's production. Some 90 percent of the value of Oregon's grass seed production is generated by Willamette Valley producers [14].

The seed trade classifies the eight cool season grass seed types into three use categories: (1) lawn and turf use (fine fescue [chewings and red], bentgrass, other Kentucky bluegrass, Merion Kentucky bluegrass); (2) covercrop and pasture use (orchardgrass and tall fescue); and multipurpose use (annual ryegrass and perennial ryegrass). Annual and perennial ryegrasses often form the dominant grass type in seed mixes because (1) their growth characteristics after seeding provide rapid emergence and luxuriant groundcover well in advance of most other grass and legume seedings, and (2) their price is generally low, relative to other grass types.

Some grass seed types are utilized almost entirely in domestic markets; others are exported. Merion Kentucky bluegrass and orchardgrass sales are limited to the United States, but other Kentucky bluegrass, tall fescue, fine fescue, and ryegrasses enter both domestic and foreign markets. Bentgrass, in recent years, has been sold almost entirely in foreign markets. The southeastern region of the United states is an important recipient of Oregon grass seeds, particularly annual and perennial ryegrasses for pasture and covercrop purposes. Export markets for grass seed include Canada, the European Economic Community (EEC), and Japan, with Europe being the largest recipient [6, 7, 8].

Until 1970, most foundation seed used in improving plant species was propogated by and distributed from public breeding programs. Under the Plant Variety Protection Act, Public Law 91-577, approved December 24, 1970, private and public breeders are protected by proprietary patent rights.

A discussion of the production and market disposition of cool season grass seeds is provided in "Supply and Disposition of Cool Season Grass Seeds in U.S. and Overseas Markets," Oregon Agricultural Experiment Station Circular of Information 689, March 1981.

The objectives of this study were to (1) identify and measure the dominant forces influencing the demand for and supply of each major type of cool season grass seed grown in the United States; (2) determine the extent of market interrelatedness among the grass seeds; (3) determine the responsiveness of buyers to price changes for each cool season grass seed type, and (4) determine the responsiveness of Oregon grass seed producers to price changes and political constraints to field burning.

To achieve these objectives, one statistical model was developed to identify the equilibrating forces at work in the market for each of the cool season grass seed types. A second statistical model was developed to evaluate the responsiveness of Oregon grass seed producers to price changes.

MODEL FORMULATION

The analysis presented here involves two separate, though interrelated, models. Model 1 establishes a set of supply and demand relationships which determine equilibrium prices and quantities for a single production year. Model 2 estimates the long-term supply response of Oregon grass seed producers to changes in farm prices and the outlook for profitability in the grass seed industry. The economic forces which affect supply at any time in Model 1 are hypothesized as being quite different from those which influence long-run production decisions of grass seed producers in Model 2.

Model 1: Short-Run Supply-Demand

The statistical model for empirical evaluation of short-run supply and demand relationships utilizes a simultaneous equation system where supply and demand are estimated for each grass seed type in both domestic and foreign markets at both wholesale and farm level. It is viewed as a single year model with farm production considered a predetermined variable in the analysis.

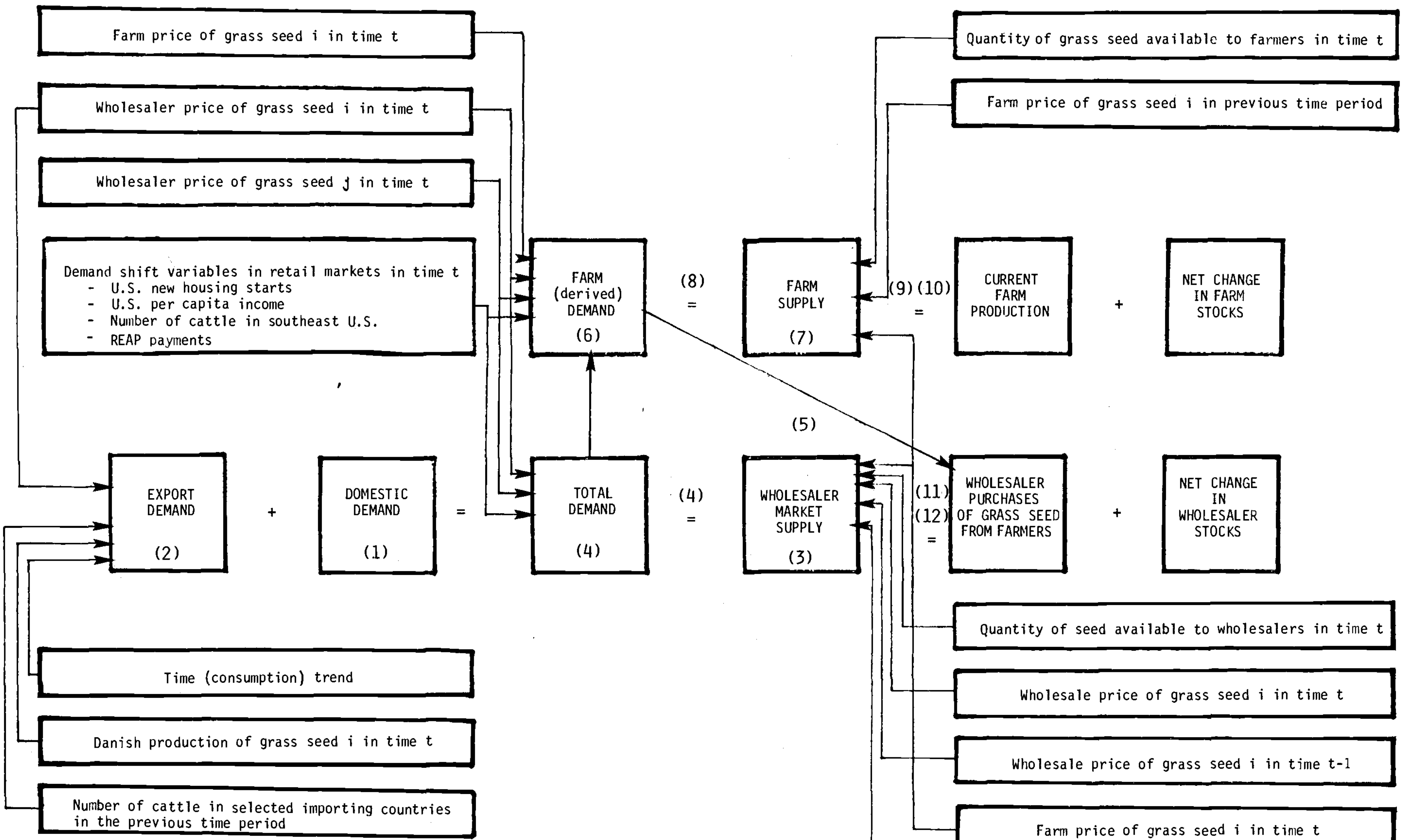
Solution of Model 1 results in the estimation of farm and wholesale prices, domestic and export wholesaler sales, farmer sales, and stocks held at the end of each time period by farmers and wholesalers.

A graphic depiction of the short-run supply-demand model is presented in Figure 1. Grass seed growers are portrayed as suppliers and wholesalers (processors at the first handler level beyond the farm gate) as demanders of grass seed. The numbers in parenthesis correspond to the equations and identities discussed in this section.

Domestic Demand

On the demand side in U.S. markets, the quantity demanded at the wholesale level of a specific grass seed type is hypothesized to be a function of its wholesaler price, the price of closely related substitutes and complements, and the number, tastes and preferences, and income levels of consumers who ultimately buy grass seed for various uses in retail markets.

FIGURE 1. U.S. SHORT-TERM SUPPLY-DEMAND MODEL FOR GRASS SEED



NOTE: Numbers in parentheses refer to equations in the text.

Domestic demand equations are of the following general form:

$$\left(Q_{it}^{WDD*}{}^{1/}, \quad P_{it}^{W}, \quad P_{jt}^{W*}; \; Z_t\right) \qquad (1)$$

where Q_{it}^{WDD*} = domestic disappearance of grass seed i in time t;

P_{it}^{W*} = Oregon wholesale price of grass seed i in time t;

P_{jt}^{W*} = Oregon wholesale price of grass seed j in time t;

Z_t = demand shift variables in U.S. retail markets in time t;

(1) Domestic new housing starts.

(2) Domestic per capita personal disposable income.

(3) Number of cattle in southeast U.S.

(4) Acreages on which REAP (Rural Environmental Assistance Programs) payments were made.

Grass seed, within each consumer use class, is hypothesized to have few substitutes. Although artificial turf and sod are substitutes for grass seed in lawn and turf mixes, and legumes compete with grass seed in hay and pasture mixes, these commodities are perceived not to substitute for grass seed to an extent that they markedly influence grass seed prices, at least in the short-run.

Individual grass seed types which are, or can be, used for the same purpose, are hypothesized to be substitutes for each other. Thus, Merion Kentucky bluegrass, other Kentucky bluegrass, and fine fescue are hypothesized to be substitutes for each other as lawn and turf seed types. Bentgrass is excluded since essentially all of it is sold in the export market. The covercrop and pasture grass seed types (orchardgrass and tall fescue) are expected to be substitutes for each other. As general purpose grasses, annual and perennial ryegrass are hypothesized to be substitutes or complements

---

1/* Denotes endogenous variable.

for all grass seed types used in both lawn and turf mixes and covercrop mixes. The extent to which ryegrasses substitute in these mixes is likely a function of their price and purpose in a seed mix. Their degree of complementarity is perceived to be related both to their biological ability to provide early groundcover and protection during stand establishment for high quality grasses used in a mix, and the economic intent of using the ryegrasses to lower the cost of a mix.

The level of new housing starts and per capita income in the United States is expected to influence the demand for lawn and turf seed types by serving as demand shifters. An increase in new housing starts is expected to increase the demand for Merion Kentucky bluegrass, other Kentucky bluegrass, fine fescue, and ryegrasses used for lawns. As home and yard improvement is expected to increase with income, an increase in per capita income is expected to increase the demand for lawn and turf grasses and the general purpose ryegrasses. This assumes that a drastic change in consumer preference from lawns to shrubs and ornamental ground cover does not occur.

Changes in the number of brood cows fattened on pasture in the United States is hypothesized to serve as a demand shifter for pasture and covercrop mixes. The mixes are used primarily in the southeastern United States for beef cow-calf operations; hence, the number of cattle in these states is expected to serve as a proxy in measuring the demand changes for pasture grass seed mixes.

The U.S. government, with the exception of 1973 when federal funds were withheld, has made conservation payments to farmers through the Rural Environmental Assistance Program (formerly Agricultural Conservation Program), which have been used to partially reimburse, among other things, the cost of pasture and covercrop seedings. This suggests that the acreages on which REAP payments are made (to establish or improve permanent pasture) may influence the demand for pasture and covercrop mixes. An increase in the number of acres on which these payments are made is hypothesized to be a positive demand shifter for these grass seed types.

Export Demand

Export demand for U.S.-produced grass seed is separated from domestic demand in this study to evaluate the separate impacts of domestic and foreign markets for grass seed. Grass seed types exported from the

United States include annual and perennial ryegrass, tall fescue, fine fescue, other Kentucky bluegrass, and bentgrass. Europe is the principal foreign destination for all but tall fescue, which is exported to Japan, Africa, Mexico, and South America.

Since the early 1960s, nearly all U.S. production of bentgrass has been exported. Some 40 to 80 percent of the domestic production of fine fescue is exported annually, while 10 to 30 percent of perennial ryegrass and other Kentucky bluegrass production is exported. Less than 10 percent of domestic production of tall fescue and annual ryegrass is shipped overseas.

Export demand equations are of the following general form:

$$\left(Q_{it}^{WXD*}, \quad P_{it}^{W*}; \text{ TIME}, \; Q_{it}^{DEN}, \; CTT_{t-1} \right) \qquad (2)$$

where Q_{it}^{WXD*} = quantity of grass seed i exported from the U.S. in time t;

P_{it}^{W*} = Oregon wholesale price of grass seed i in time t;

TIME = consumption trend in the export market (1959 = 1, ..., 1974 = 16);

Q_{it}^{DEN} = Danish production of grass seed i in time t;

CTT_{t-1} = number of cattle in selected importing countries in the previous time period;

The export demand equation hypothesizes that the quantity of each grass seed exported is a function of wholesale price in the United States (no retail price in foreign markets is available), a consumption time trend in the export market, the number of cattle in selected importing countries, and the quantity of seed available from alternative sources.

Data relating to housing starts in foreign countries are not available for use as a demand shifter for lawn and turf grasses. Such data might be of questionable value if available, since industry sources have indicated that little of the grass seed exported to Europe is used for lawn and turf purposes. Time trend was included as a variable to detect whether general trends in consumption patterns have occurred over time without quantification of specific explanatory variables. The extent to which this variable is useful in an explanatory sense is not known. The number of cattle in Italy, the Netherlands, and Japan was hypothesized as a demand shifter for annual and perennial ryegrasses; cattle numbers in Argentina and Japan are considered to influence the demand for tall fescue.

A variety of tariff and non-tariff barriers exist that limit and, in some cases, prohibit importation of certain U.S.-produced grass seeds unless a short crop occurs in Europe, in which case, the institutional barriers are relaxed. Restraint examples include national variety lists, extended testing programs for acceptance of a foreign variety, phytosanitary requirements, ISTA seed tests, and others. The quantity of the specific grass seed produced in Denmark serves as a dual proxy, indicating the amount of seed available on the world market, and also evaluating the success of the European growing season. In both cases, an increase in Danish production is expected to decrease the demand for U.S.-grown seed. Denmark is the major country producing grass seed in the EEC. Production information from other EEC countries was not available.

<u>Wholesaler Supply</u>

Wholesalers have the option of storing or selling the seed they have available. The quantity sold by seed wholesalers is hypothesized to be a function of the quantity available for sale, wholesaler expectations concerning price, and the price at which he can purchase seed. The general form of the wholesaler supply equation is:

$$\left(Q_{it}^{WS*},\ Q_{it}^{TWA*},\ P_{it}^{W*},\ P_{it}^{F*},\ Q_{it}^{IMP};\ P_{it-1}^{W}\right) \qquad (3)$$

where Q_{it}^{WS*} = quantity wholesalers supply of grass seed i in time t in the U.S.;

Q_{it}^{TWA*} = quantity of grass seed available to wholesalers in time t in the U.S.;

P_{it}^{W*} = Oregon wholesale price of grass seed i in time t;

P_{it}^{F*} = Oregon farm price of grass seed i in time t;

Q_{it}^{IMP} = quantity of grass seed i imported into the U.S. in time t;

P_{it-1}^{W} = Oregon wholesale price of grass seed i in time t-1.

The quantity wholesalers supply in any time period depends on the quantity available for sale. The greater the quantity, the more grass seed wholesalers are willing to sell at existing prices. Wholesalers also are expected to supply greater quantities at higher prices. Wholesale price also is lagged one time period as a measure of wholesaler expectations about the current price. The lower the price in the previous time period, the greater the quantity wholesalers are expected to supply in the current period, anticipating a return to lower prices in the future. Wholesalers are hypothesized to supply smaller quantities at low farm prices since they are expected to accumulate inventories when prices are low.

Imports are included as a separate variable because they are perceived to be beyond the control of wholesalers. That is, imports are not included in the quantity wholesalers supply but are evaluated separately. An increase in imports is expected to decrease the quantity wholesalers supply since imported seed can be viewed as a substitute for domestically produced seed.

Wholesale Market Equilibrium

Equilibrium in the wholesale market is established by the identity:

$$Q_{it}^{WS*} = Q_{it}^{WDD*} + Q_{it}^{WXD*} \tag{4}$$

where Q_{it}^{WS*} = quantity of grass seed i wholesaler's supply in time t in the U.S.;

Q_{it}^{WDD*} = domestic demand at the wholesale level for grass seed i in time t in the U.S.;

Q_{it}^{WXD*} = export demand for grass seed i in time t;

The equilibrium establishes that the quantity of each grass seed type available disappears into either domestic or foreign markets, or is held as stocks.

Farm Demand

The model hypothesizes that the demand for grass seed facing farmer-producers is derived from demand for grass seed at the wholesale level. The actual quantity purchased by wholesalers from farmers is determined by the identity:

$$Q_{it}^{FD*} = Q_{it}^{WDD*} + Q_{it}^{WXD*} + (K_t^{W*} - K_{t-1}^{W}) - Q_{it}^{IMP} \qquad (5)$$

where Q_{it}^{FD*} = farm demand for grass seed i in time t in the U.S.;

Q_{it}^{WDD*} = domestic demand at the wholesale level for grass seed i in time t in the U.S.;

Q_{it}^{WXD*} = export demand for grass seed i in time t;

K_t^{W*} = wholesaler stocks of grass seed i at end of time t in the U.S.;

K_{t-1}^{W} = wholesaler stocks of grass seed i at the beginning of time t in the U.S.;

Q_{it}^{IMP} = quantity of grass seed i imported into the U.S. in time t.

The quantity of seed demanded from farmers by wholesalers is determined by the quantity wholesalers can sell, net changes in wholesaler inventories, and the level of imports. This quantity is hypothesized to be related to farm and wholesale prices and other variables affecting the final demand for each seed type. The general form of the farm demand equations is:

$$\left(Q_{it}^{FD*}, P_{it}^{W^*}, P_{it}^{F*}, P_{jt}^{W*} ; Z_t \right) \qquad (6)$$

where Q_{it}^{FD*} = farm demand for grass seed i in time t in the U.S.;

P_{it}^{W*} = Oregon wholesale price of grass seed i in time t;

P_{it}^{F*} = Oregon farm price of grass seed i in time t;

P_{jt}^{W*} = Oregon wholesale price of grass seed j in time t;

Z_t = demand shift variables in U.S. retail markets in time t;

(1) Domestic new housing starts.

(2) Domestic per capita personal disposable income.

(3) Number of cattle in southeast U.S.

(4) Acreage on which REAP payments were made.

The demand for grass seed at the farm level is believed to be influenced by farm and wholesale prices and the same variables that influence the demand for grass seed in wholesale markets. For example, the farm demand for orchardgrass is hypothesized to be influenced by the farm and wholesale prices of orchardgrass, the wholesale prices of tall fescue and the ryegrasses (which are substitutes for orchardgrass), cattle in the southeastern United States, and REAP acreages. These variables should be expected to have the same general influences on farm demand that they exert on wholesaler demand, although the magnitude of their influences may differ substantially in the two markets because of the level of services provided by wholesalers in cleaning, processing, blending, and packaging of grass seed for intermediate and retail markets.

This formulation allows the direct calculation of demand elasticities at the farm level by estimating changes in quantity demanded resulting from changes in farm price.

<u>Farm Supply</u>

As with the formulation of the wholesaler supply function, the construction of the farm supply relation assumes that farmers have the option of selling or storing the grass seed they produce. The quantity of seed farmers are willing to sell is hypothesized to be a function of the quantity available for sale, and farmer expectations concerning price. The general form of the farm supply equation is:

$$\left(Q^{FS*}_{it}, \; P^{F*}_{it} \; ; \; Q^{TFA}_{it} \; , \; P^{F}_{it-s} \right) \tag{7}$$

where Q^{FS*}_{it} = quantity supplied by U.S. farmers of grass seed i in time t;

P^{F*}_{it} = Oregon farm price of grass seed i in time t;

Q_{it}^{TFA} = quantity of grass seed i available to U.S. farmers in time t; it includes Q_{it}^{FP} (quantity produced by farmers) and K_{it-1}^{F} (farmer carry in stocks at the beginning of the year);

P_{it-s}^{F} = Oregon farm price of grass seed i in previous periods.

The quantities farmers supply depend on production in the current time period and stocks available for sale in this period. Because of limited storage facilities, farmers are assumed to supply greater quantities when production increases. Farmers also are assumed to sell greater quantities at higher prices. The lagged farm prices are used as a measure of farmer expectations about current price. Net changes in inventories result from farmers' sell or store decision.

Farm Market Equilibrium

Equilibrium in the farm market is established by the identity:

$$Q_{it}^{FD*} = Q_{it}^{F} = Q_{it}^{FS*} \tag{8}$$

where Q_{it}^{FD*} = quantity of grass seed i purchased from U.S. farmers in time t;

Q_{it}^{F} = farm equilibrium quantity in time t;

Q_{it}^{FS*} = quantity of grass seed i sold (farm supply) by U.S. farmers in time t.

The equilibrium condition establishes that the quantity of each grass seed that is available to the farmer is either sold or held as stocks, and the quantity farmers sell is the same quantity that wholesalers purchase.

Identities

Several identities are required in using the simultaneous equation model to analyze each grass seed type. They are:

$$K_{it}^{F*} = Q_{it}^{FP} + K_{it-1}^{F} - Q_{it}^{FS*} \quad (9)$$

$$Q_{it}^{TFA} = Q_{it}^{FP} + K_{it-1}^{F} \quad (10)$$

$$= K_{it}^{F*} + Q_{it}^{FS*}$$

$$K_{it}^{W*} = Q_{it}^{WP*} + K_{it-1}^{W} - Q_{it}^{WS*} \quad (11)$$

$$Q_{it}^{TWA*} = Q_{it}^{WP*} + K_{it-1}^{W} \quad (12)$$

$$= K_{it}^{W*} + Q_{it}^{WS*}$$

where K_{it}^{F*} = U.S. farm stocks of grass seed i at the end of time t;

Q_{it}^{FP} = quantity of grass seed i produced by U.S. farmers in time t;

K_{it-1}^{F} = U.S. farm stocks of grass seed i at the beginning of time t;

Q_{it}^{FS*} = farm supply (quantity of grass seed i sold in time t by U.S. farmers);

Q_{it}^{TFA} = quantity of grass seed available to farmers in time t;

K_{it}^{W*} = wholesaler stocks of grass seed i in the U.S. at the end of time t;

Q_{it}^{WP*} = wholesaler purchases of grass seed i in the U.S. from farmers in time t;

K_{it-1}^{W} = wholesaler stocks of grass seed i in the U.S. at the beginning of time t;

Q_{it}^{WS*} = wholesaler supply of grass seed i in the U.S. in time t;

Q_{it}^{TWA*} = total quantity of U.S. grass seed i available to wholesalers in time t.

The first identity establishes that farmers hold as stocks at the end of the year quantities of each grass seed type that they do not sell. The second identity assures that total farm sales do not exceed the total quantity available for sale which includes current production and farm carry-over stocks from the previous year. The third identity establishes that wholesalers hold as stocks at the end of the year those quantities of each grass seed type that they do not sell. The fourth identity establishes that total quantity available for sale is comprised of carry-in stocks from the previous year, plus purchases from farmers.

The supply and demand equations were estimated using two-stage least squares regression. The simultaneous equation model consisted of 37 behaviorial equations, 16 equilibrium equations, and 40 identities. A total of 93 endogenous and 79 exogenous variables were involved. All behaviorial equations were over-identified. All estimated equations are on a per capita basis with exception of the export demand equations which are on a total basis.

Model 2: Long-Run Willamette Valley Supply Response

The purpose of Model 2 as a long-run farm supply response model is to identify and evaluate those forces which have occurred over a relatively long time that influence current production rather than treat current production as a predetermined variable as done with Model 1. This section of the study will be concerned only with Willamette Valley production of grass seed so policies affecting the production decisions of the Willamette Valley grass seed industry can be evaluated more carefully.

Production in any time period is equal to the yield per acre times the number of acres:

$$Q_{it}^{FP*} = Y_{it} \cdot A_{it} \tag{13}$$

where Q_{it}^{FP*} = quantity of grass seed i produced by Willamette Valley farmers in time t;

Y_{it} = yield per acre of grass seed i in time t in Willamette Valley;

A_{it} = acreage of grass seed i harvested in time t in Willamette Valley.

The quantity of each grass seed type produced on Oregon farms is separated into two component parts--yield per acre and acreage allotted to production.

Yield per acre is expected to be influenced primarily by the favorability of the growing season and technological developments (new varieties, improved cultural practices, etc.), while the acreage allocated to grass seed production depends on the price, yield, cost, and ultimately, the profitability expectations of producers. Since it is not possible to obtain supply response based on farmer profit expectations at the time of stand establishment, about all that can be said about profit expectations is that they are based on many factors, including prior prices, costs, and yields. Consequently, it is hypothesized that for quantitative purposes, prior prices, production costs, and yields serve as proxies for expected profitability in influencing the acreage allocation decisions of grass seed producers. For each grass seed type, an equation was estimated for yield as well as acreage grown.

The general form of the yield per acre equations for each grass seed type is:

$$\left(Y^*_{it}; \quad \text{TIME}, W_t \right) \tag{14}$$

where Y^*_{it} = yield per acre of grass seed i in time t in Willamette Valley;

TIME = time trend variable (1959 = 1, ..., 1974 = 16)

W_t = weather variable in current production in Willamette Valley.

The time variable was included as a proxy for the effect of all technological changes in grass seed production. There is no reliable way to measure change in yields over time arising from changes in cultural practices, new variety adaptation, and other yield-affecting changes.

Weather may be an important determinant of yield. Agronomists report that grass seed yield is influenced by weather principally from (1) physiological stress upon plant growth, tillering, heading, and maturity, and (2) machine harvest capability. The physiological stress generally occurs during specific growing periods. Low rainfall in the fall, until about November 15, may reduce subsequent year seed yield. This is especially true of annual ryegrass which is vulnerable to fall drought. Low temperatures of about 25°F., or less, for two consecutive days in the fall, may reduce production, especially when it follows excessively warm weather. Winter is the dormancy period for grass seeds. Sub-zero temperature readings over a period of several days may reduce production, especially with ryegrass. During the heading period in the spring, high temperatures over 80°F., combined with low humidity, may have an adverse yield effect since hot weather dries up the stigmas for pollination. Low soil moisture during heading is known to shrivel kernels and produce blank heads. Dry weather in early summer deters kernel fill. Intermittent rains in late summer may hamper harvesting operations and continuous rain for an extended period can prevent harvest entirely, as occurred in 1968.

Current production is determined both by yields per acre and the total acreages allotted to the production of grass seed. Acreage allocations especially are considered to be influenced primarily by the long-run expectations of grass seed producers. The general form of the acreage allocation equations is:

$$\left(A^{*}_{it};\ P^{F}_{it-s},\ C^{F}_{it-s},\ Y_{it-s},\ I_{t} \right) \tag{15}$$

where A^{*}_{it} = acres allotted to the production of grass seed i in time t in Willamette Valley;

P^{F}_{it-s} = past Oregon farm prices of grass seed i;

C^{F}_{it-s} = past farm production costs of grass seed i in Willamette Valley;

Y_{it-s} = past yields of grass seed i in Willamette Valley;

I_{t} = political constraint expressed as a burning fee in time t.

An increase in farm price expectations, as a result of higher previous prices, is expected to increase the acreage of grass seed stand established.

An increase in the operating cost component of past total production costs for any grass seed type is expected to initially result in a decrease in the acres planted of that grass seed. Implicit in the relationship is the assumption that the fixed or overhead cost component of production costs is not significantly different between grass seed production and other agricultural enterprises which are viable alternatives for the grass seed producer. Past prices, costs, and yields combine to indicate expected profitability in the current period.

The institutional constraints variable was included as a measure of acreage adjustment responsiveness by Willamette Valley farmers to political pressure intended to reduce field burning which, until 1980, was feasible only through reduced acreages. To assist in the orderly phaseout of open burning, the Oregon Legislature assessed a per-acre fee to acreages open burned, with the collected assessments being earmarked for research and development of alternatives to open burning. The charge per acre is presented in Table 1. This burn charge per acre is hypothesized to represent the political pressure on producers to reduce open burning and, therefore, is considered to influence the acreages allotted to grass seed production. The graduated burning fee is designed both as an economic disincentive to farmers for open burning and a means for generating a relatively stable research funding base in the face of declining burning acres.

Table 1. Schedule of Acreage to be Burned and Associated Burning Fees Established by the 1975 Oregon Legislature in Senate Bill 311

Year	Maximum Valley acres to be burned	Burning fee per acre
1971	-	$ .50
1972	-	.50
1973	-	1.00
1974	-	1.00
1975	234,000	3.00
1976	195,000	4.00
1977	95,000	5.50
1978	50,000	8.00

Ordinary cost squares estimating procedures were used with Model 2 in solving each of the single equation components.

Data Requirements

Time series data for price and quantity are required for each grass seed type studied at farm and wholesale levels in both domestic and foreign markets.

Grass Seed Prices

Farm gate prices received by Oregon farmers for the 1957-1975 period, used in this study, are listed in Appendix Table 12 of Circular of Information 689 for each of the eight grass seed types. These prices are utilized in evaluating supply-demand relationships at the farm level.

Ideally, consumer prices should be represented by retail prices. However, since grass seed usually is sold as a mix combining several grass seed types, complete time series data for retail prices of grass seed in the United States are available in published form for only four grass seed types (Appendix Table 14, Circular of Information 689). It was possible, however, to obtain unpublished wholesale price data from several Oregon grass seed wholesalers for each grass seed type.[2/] These data, on an adjusted basis for the 1957-1975 period, were used as a proxy for retail prices (Appendix Table 13, Circular of Information 689). Wholesale price is expected to be a reasonable substitute for retail price in cases where value added by processing in the marketing chain is not large and is fairly constant from one year to another. Observation suggests that both conditions prevail in grass seed marketing. These wholesale prices also were used as the proxy for retail prices in foreign countries, since no published retail price information on export markets is available. All prices used both in Models 1 and 2 were deflated by the consumer price index so real, rather than nominal, prices would be utilized.

Grass Seed Quantities

Quantities of each grass seed type produced in the United States, and farm and wholesale level grass seed stocks for the 1958-1975 period, are presented in Appendix Tables 1, 7, and 8, respectively, of Circular of Information 689.

2/ Grass seed wholesaler, for this study, is defined as the first handler or dealer of grass seed after it has been sold by the farmer. Thus, wholesale price, in this study, is the price recorded at the first handler level in the grass seed marketing sequence.

The time series for U.S. domestic consumption was estimated indirectly, and presented in Appendix Table 11, Circular of Information 689. The result is a calculation of the net disappearance of grass seed in the United States in each year.

Grass seed quantities sold by farmers were calculated by taking grass seed production in a given year, adding to it the farmer stocks carried from the previous year, and subtracting stocks on hand at the end of the year. The data are presented in Appendix Table 1. Similarly, grass seed quantities sold by dealers were estimated as the quantities purchased from farmers in a given year, which is identical to the quantities farmers sell (Appendix Table 1), plus dealer stocks carried in from the previous year, minus the quantities dealers choose to hold as stocks at the end of that year. These values are presented in Appendix Table 2.

For evaluating the long-run Willamette Valley producer supply equations, the quantities produced in the Willamette Valley of Oregon for each grass seed type, Willamette Valley acres harvested, and Willamette Valley yields per acre for the 1958-1978 period were used. These data are presented in Appendix Tables 3, 4, and 5 of Circular of Information 689.

Demand Shift Variables

Time series estimates of new housing starts in the United States were obtained from the Economic Report of the President [12]. Per capita disposable income data were obtained from the Statistical Abstract of the United States [10]. Income data were deflated by the consumer price index to reflect real rather than monetary purchasing power. The number of cattle and calves in the southeastern United States was obtained from Livestock and Meat Statistics [9], and Agricultural Statistics [5]. States included in the Southeast are Florida, Georgia, South Carolina, North Carolina, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas. Data on the number of cattle in Italy, Netherlands, Japan, and Argentina were obtained from Agricultural Statistics [5]. The number of acres on which Rural Environmental Assistance Program payments were made for establishing or improving permanent pasture were taken from Agricultural Statistics [5]. Data on housing starts, income, cattle numbers, and REAP acreages are presented in Appendix Table 3.

Time series data on Danish production of each grass seed type were provided by the Office of the Agricultural Attache, Foreign Agricultural Service, USDA, American Embassy in Copenhagen, Denmark. The Netherlands, Canada, New Zealand, France, and England also produce and export substantial quantities of grass seed. Danish production was selected as a demand shift variable since data obtained from Denmark were most consistent with the time period under analysis in this study. Data on Danish production of grass seeds are presented in Appendix Table 6, Circular of Information 689.

Supply Shift Variables

The quantities available for sale by farmers were determined as the quantities produced in a given year, plus farm stocks at the beginning of that year. Quantities available to dealers were calculated as dealer purchases from farmers in a given year, plus dealer stocks carried in from the previous year.

Also utilized as supply shifters are farm and dealer prices in previous time periods and quantities of grass seed imported.

Production Costs

Direct operating costs were selected as that set of total production costs which most directly influence supply response within a production year. Average operating costs per acre for each grass seed type, exclusive of Merion Kentucky bluegrass, were obtained from the Conklin-Fisher study [2], with the cost data reflecting Willamette Valley grower conditions in 1969. Operating costs for Merion Kentucky bluegrass were obtained from an enterprise analysis prepared by Oregon State University Extension Farm Management Specialists and Linn County Extension personnel in 1969 [13]. To obtain time series estimates of production costs for each of the 17 years, the 1969 data were adjusted using price indices from Agricultural Statistics [5]. The 1969 operating costs were separated into three components: labor, machinery, and fertilizer-herbicides. U.S. price indices for each of these three cost components were used to estimate costs each year for the 1959-1975 period from the 1969 data base. Each cost component was summed each year to obtain total annual operating costs which, in turn, was divided by the reported acreage harvested for each grass seed type to obtain cost per acre, which is reported in Appendix Table 4. No adjustment was made for changes in relative factor prices or operating costs relative to total costs over time.

Weather Variables

Weather data for the 1959-1975 period were obtained from the Salem Climatological Station [11]. Individual weather variables were not used. Rather, a proxy system was devised to represent a set of weather conditions which, by agronomic standards, were perceived as being "adverse" or "not adverse" in terms of potential effect upon grass seed production. Seasonal conditions considered to be "adverse" include:

1. Fall - Average daily temperatures below 25° F. for two or more consecutive days from September 1 to December 15, and less than 5 inches of cumulative rainfall from September 15 to November 15.

2. Winter - Subzero average daily temperature for one or more days from April 15 through June 15, and relative humidity below 30 percent for several hours on two or more consecutive days from April 15 through June 15.

3. Spring - Daytime high temperatures over 80°F. for one or more days from April 15 through June 15, and relative humidity below 30 percent for several hours on two or more consecutive days from April 15 through June 15.

4. Summer - Two or more consecutive days of rainfall during harvest from July 1 through September 15.

RESULTS

The estimated domestic (United States) wholesale demand equations are presented in Table 2, followed by export demand equations in Table 3. Table 4 presents the estimated farm demand equations. Tables 5 through 9 show degree of price responsiveness using price elasticity measures. Tables 10 and 11 present the wholesale and farm level short-run supply equations, respectively. Table 13 presents mean yield and dispersion for Willamette Valley production. Tables 14 and 15 show present Willamette Valley yield and acreage equations for estimating long-run supply response.

Wholesale Level Demand in U.S. Markets

Results of the estimation for domestic demand at the wholesale level are presented in Table 2. Acreages on which REAP payments are made (to establish and improve permanent pasture) were rejected as an explanatory variable for pasture and multipurpose grass seed types. It is suspected the probable reasons for this are that (1) seed costs form a small percentage of the total cost of establishing or improving permanent pasture, and (2) conservation subsidies may no longer be needed to encourage grass-fed livestock operations in the southeastern United States because of more favorable market conditions in recent years which have encouraged the substitution of grass feeding for grain feeding in the beef cattle sector.

Otherwise, the results presented in Table 2 generally are consistent with the *a priori* theoretical conceptualization of the model. In each of the seven demand relationships evaluated for the United States, the quantity demanded of a grass seed type was negatively related to the price of that seed type. This indicates that the demand curves for these grass seed types are negatively sloped, as economic theory hypothesizes that they should be.

U.S. per capita real income generally served as a positive demand shifter, indicating that, for a given price, consumers purchase more grass seed as incomes rise. However, income had a negative effect on the ryegrasses and orchardgrass, implying a shift in consumer preferences toward better quality mixes at higher real income levels.

Where they effected a change in demand, cattle numbers in the southeastern United States, and new housing starts, both served as positive influences indicating that, for any given price, the demand for grass seed was increased by increases in either of these exogenous forces.

Table 2. Estimated U.S. Demand Equations at the Wholesale Level for Selected Grass Seed Types, 1959-1975

Seed type	Degrees of freedom	Constant	P^W_{it}	P^W_{FFT}	P^W_{MKt}	P^W_{OKt}	P^W_{TFt}	P^W_{ARt}	P^W_{PRt}	$INCOME_t$	CTT^{SE}_{t-1}	NHS_t
Fine fescue	11	100.81 (24.75)	-1.00* (.50)	X		+.90* (.42)	N.A.		-2.17* (.57)			+2.77 (2.99)
Merion Ky. bluegrass	9	-4.34 (26.65)	-.18* (.04)	+.40* (.17)	X	+.32* (.23)	N.A.	+1.70* (1.04)	-1.70* (.68)	+.001 (.0008)		
Other Ky. bluegrass	12	147.14 (54.15)	-1.39* (.56)		+.15 (.21)	X	N.A.			+.013 (.017)		
Tall fescue	12	-250.35 (129.72)	-3.14* (2.25)	N.A.	N.A.	N.A.	X	+4.81* (2.14)		+.21* (.05)		
Orchard-grass	12	231.11 (86.58)	-.76 (1.40)	N.A.	N.A.	N.A.	+1.11 (.97)		+1.64* (1.02)	-.06 (.02)		
Annual ryegrass	10	-512.52 (332.65)	-7.98 (14.48)			-2.62 (3.00)		X		-.42* (.308)	+.006* (.003)	+50.94* (20.19)
Perennial ryegrass	12	286.84 (71.51)	-2.90* (1.16)						X	-.03* (.008)	+.002* (.0007)	

* A starred coefficient indicates that it is statistically significant. Items in parentheses represent the estimated standard error (S.E.) for the coefficient. The S.E. test is a test of significance but only an approximate one because the ratio of the estimated coefficient to its standard error is not distributed exactly as a student t. In such cases a standard rule of thumb, as is done in this study, is applied where the coefficient must be more than twice its S.E. to be deemed significantly different from zero. The standard error is defined as S.E. =

$$\frac{\text{estimated coefficient value}}{\text{student t}}$$

EXPLANATORY VARIABLES:

P^W_{it} = wholesale price of grass seed i in time t (i is grass seed considered in the equation).

P^W_{FFT} = wholesale price of fine fescue in time t.

P^W_{MKt} = wholesale price of Merion Kentucky bluegrass in time t.

P^W_{OKt} = wholesale price of other Kentucky bluegrass in time t.

P^W_{TFt} = wholesale price of tall fescue in time t.

P^W_{ARt} = wholesale price of annual ryegrass in time t.

P^W_{PRt} = wholesale price of perennial ryegrass in time t.

$INCOME_t$ = U.S. per capital disposable income in time t.

CTT^{SE}_{T-1} = cattle in the southeastern U.S. in time t.

NHS_t = new housing starts in time t.

Wholesale Level demand in Foreign Markets

Results of the estimation of export demand at the wholesale level are presented in Table 3. For the six grass seed types that are exported, the quantity of each type exported was negatively related to its price, again implying a negatively sloped demand curve. In most cases, low t-values[3/] indicate that the relationship is rather weak, suggesting (1) that institutional forces abroad may be of greater importance than price in determining import-export regulations, and (2) specification buying on the basis of purity, germination, seed used, and inert matter levels, is known to be important in influencing marketing of grass seeds in foreign countries. Price was found to strongly influence the export demand for the ryegrasses and bentgrass, however. This is perhaps because of the less important role of proprietary variety development in these grass seed varieties, as well as the role the ryegrasses play globally as a base and filler in grass seed mixes. General global uniformity of these grass seed types may make them acceptable substitutes for foreign-produced seed, resulting in their having a price-competitive position on the world market.

Danish production of grass seed generally was found to be negatively related to U.S. exports, supporting the hypothesis that EEC institutional constraints are relaxed somewhat during unfavorable European growing seasons and tightened when EEC production is high. This also suggests that, on the world market, grass seed is viewed as a homogeneous commodity, with little preference shown for seed on the basis of production location.

The positive coefficients on the time variable indicate a definite increase in the use of U.S.-produced grass seed overseas through time. With the exception of perennial ryegrass, time was strongly significant as an explanatory variable, indicating that market influences, other than prices, appear to be important forces in the international markets.

The number of cattle in Argentina, the Netherlands, Italy, and Japan were included in the tall fescue and ryegrass equations and were found to exert

3/ The t-values estimated in simultaneous equation models are not distributed according to student's-t and, consequently, statements based upon these values here are only suggestive.

Table 3. Estimated Export Demand Equations at the Wholesale Level for Selected Grass Seed Types. 1959-1975

Seed type	Degrees of freedom	Constant	P^W_{it}	DQ_{ARt}	DQ_{PRt}	DQ_{FFt}	DQ_{BLt}	TIME	$CTFORN_t$	P^W_{PRt}	P^W_{OKt}
Fine fescue	10	7,769.6 (2,152.6)	-53.71 (51.23)	-.25* (.13)		+.13 (.15)	+.24 (.25)	+889.89* (179.91)	N.A.		
Bentgrass	10	140.92 (1,087.66)	-52.95* (11.56)				+.24* (.07)	+846.42* (69.21)	N.A.	-267.9* (47.02)	+121.13* (23.94)
Other Ky. bluegrass	12	2,301.7 (3,777.37)	-38.39 (59.68)				-.46* (.30)	+935.93* (167.09)	N.A.		
Tall fescue	11	-79.51 (3,551.02)	-56.14 (46.16)		-.09 (.04)			+366.53* (93.94)	+.05 (.09)		
Annual ryegrass	11	-19,411.0 (8,511.0)	-776.58* (272.01)	-.22* (.15)				+1,047.51* (242.25)	+.51* (.21)		
Perennial ryegrass	10	-36,901.0 (12,111.0)	-284.31* (149.83)		-.32* (.10)	+.94* (.22)			+2.34* (.61)		+246.32* (94.00)

* A starred coefficient indicates that it is statistically significant. Items in parentheses represent the estimated standard error (S.E.) for the coefficient. The S.E. test is a test of significance but only an approximate one because the ratio of the estimated coefficient to its standard error is not distributed exactly as a student t. In such cases a standard rule of thumb, as is done in this study, is applied where the coefficient must be more than twice its S.E. to be deemed significantly different from zero. The standard error is defined as S.E. =

$$\frac{\text{estimated coefficient value}}{\text{student t}}$$

EXPLANATORY VARIABLES:

P^W_{it} = wholesale price of grass seed i in time t (i is grass seed considered in the equation).

DQ_{ART} = Danish production of annual ryegrass in time t.

DQ_{PRt} = Danish production of perennial ryegrass in time t.

DQ_{FFT} = Danish production of fine fescue in time t.

DQ_{BLt} = Danish production of bluegrass in time t.

TIME = trend variable (1959-1960 = 1, ···, 1974-1975 = 16).

$CTFORN_t$ = number of cattle in selected foreign countries in time t.

P^W_{PRt} = wholesale price of perennial ryegrass in time t.

P^W_{OKt} = wholesale price of other Kentucky bluegrass in time t.

a positive influence on the level of exports. Domestic prices of other grass seed types were significant in the export demand for bentgrass.

Farm Level Demand

Wholesalers purchase grass seed from farmers to meet current and anticipated demand for seed in retail markets by adjusting their inventories. The demand facing farmers was generally found to be influenced by those same variables which affect the demand for grass seed at the wholesale level. The estimated farm demand equations are presented in Table 4.

Grass seed quantities demanded were negatively related to farm price, implying that farmers also are confronted with a negatively sloped demand curve. Wholesale prices served as positive influences on quantities purchased from farmers, indicating that dealers are willing to buy more grass seed at higher resale prices. The wholesale price influence was positive, with the exception of orchardgrass.

The wholesale prices of other Kentucky bluegrass, annual ryegrass, and perennial ryegrass also affected the farm level demand for some grass seed types. Annual and perennial ryegrasses were not influenced by the wholesale prices of any other grass seed types.

Income was positively related to the bluegrasses and negatively related to the ryegrasses, implying that the shift from lower to higher quality mixes, as consumer real incomes rise, is also felt at the farm level. Cattle in the southeastern United States, new housing starts, Danish production of bluegrass, and cattle numbers in foreign countries effected a change in demand at the farm level for some grass seed types.

Demand Response in Grass Seed Markets

To measure the relative price responsiveness of demand for each grass seed type at farm and dealer levels in the U.S. and foreign markets, price elasticity of demand was calculated. Price elasticity of demand quantifies the percentage change in quantity demanded per unit change in price [3, 4, 13].

Table 4. Estimated Farm Demand Equations for Selected Grass Seed Types, 1959-1975

Seed type	Degrees of freedom	Constant	P^F_{it}	P^W_{it}	P^W_{OKt}	P^W_{ARt}	P^W_{PRt}	P^W_{TFt}	$INCOME_t$	CTT^{SE}_{t-1}	NHS_t	TIME	$DQBLUE_t$	$CTFORN_t$
Fine fescue	10	63.45 (16.33)	-1.74 (1.44)	+.98 (1.24)	+.63* (.33)		-.47 (.37)				+.91 (1.84)			
Bentgrass	10	8.70 (13.18)	-.22 (.19)	+.79* (.28)			-1.45* (.53)					+2.29* (.82)	+.001 (.0006)	
Merion Ky. bluegrass	10	-.02 (15.04)	-.17* (.03)		+.44* (.13)	-.96* (.57)	-.49 (.38)		+.01* (.005)					
Other Ky. bluegrass	12	-180.95 (68.93)	-2.24* (.86)		X				+.17* (.03)				-.005 (.004)	
Orchard-grass	10	202.28 (117.33)	-1.93 (1.72)	-1.87 (1.37)			+.96 (1.07)	+1.62 (1.31)	-.01 (.02)					
Tall fescue	12	-293.90 (154.99)	-2.50 (3.48)				+5.76* (2.34)		+.22* (.05)					
Annual ryegrass	10	-1,181.2 (245.91)	-45.30* (12.16)			X			-.73* (.25)	+.08* (.02)	+48.61* (.13.99)			+.02* (.008)
Perennial ryegrass	12	474.59 (57.69)	-15.83* (7.68)	+9.12* (5.05			X		-.07* (.02)					

* A starred coefficient indicates that it is statistically significant. Items in parentheses represent the estimated standard error (S.E.) for the coefficient. The S.E. test is a test of significance but only an approximate one because the ratio of the estimated coefficient to its standard error is not distributed exactly as a student t. In such cases a standard rule of thumb, as is done in this study, is applied where the coefficient must be more than twice its S.E. to be deemed significantly different from zero. The standard error is defined as S.E. =

$$\frac{\text{estimated coefficient value}}{\text{student t}}$$

EXPLANATORY VARIABLES:

P^F_{it} = farm price of grass seed i in time t (i is grass seed type considered in the equation).

P^W_{it} = wholesale price of grass seed i in time t.

P^W_{OKt} = wholesale price of other Kentucky bluegrass in time t.

P^W_{ARt} = wholesale price of annual ryegrass in time t.

P^W_{PRt} = wholesale price of perennial ryegrass in time t.

P^W_{TFi} = wholesale price of tall fescue in time t.

$INCOME_t$ = U.S. per capita personal disposable income in time t.

CTT^{SE}_{t-1} = cattle in the southeastern U.S. in time t-1.

NHS_t = new housing starts in time t.

TIME = time trend variable (1959-1960 = 1, ···, 1974-1975 = 16).

$DQBLUE_t$ = Danish production of bluegrass in time t.

$CTFORN_t$ = number of cattle in selected foreign countries in time t.

Price elasticity of demand is defined mathematically as:

$$\eta_i = \frac{\frac{\Delta q_i}{q_i}}{\frac{\Delta p_i}{p_i}} = \frac{\Delta q_i}{q_i} \cdot \frac{p_i}{\Delta p_i} = \frac{\Delta q_i}{\Delta p_i} \cdot \frac{p_i}{q_i} \qquad (16)$$

where η_i = price elasticity of demand for grass seed i;

q_i = quantity demanded of grass seed i;

p_i = price of grass seed i;

Δq_i, Δp_i = change in quantity and price, respectively.

The statistical model used here allows ready calculation of these elasticities. Since the model assumes a linear relationship between the dependent variable (quantity) and explanatory variables (price, etc.), the term $(\frac{\Delta q_i}{\Delta p_i})$ is the regression coefficient associated with price for each grass seed type. This value, because of the linearity of the model, is a constant. Price elasticity of demand can be calculated for any price and quantity combination along a demand curve. The elasticities shown here were calculated at the mean values for all prices and quantities over the 16-year period from 1959 to 1975. Since regression analysis evaluates the coefficient on each explanatory variable as the effect it has on the dependent variable when all other explanatory variables in the model are held constant at their means, the use of mean values of quantities and prices seems reasonable.

Because several coefficients on price were not statistically significant in the demand equations, confidence intervals were calculated with upper and lower limits on price elasticity of demand to evaluate their reliability. These limits are based on a 90 percent confidence interval on the regression coefficients, utilizing the standard errors of these coefficients and appropriate t-values to determine upper and lower confidence limits on the coefficients. These upper and lower limits were then multiplied by the ratio of mean price to mean quantity to determine bounds on the elasticity coefficients.

Buyer Response in Foreign Markets

The price elasticity of demand in foreign markets for each grass seed type is shown in Table 5. Each of the six grass seed types sold internationally (orchardgrass and Merion Kentucky bluegrass are exported in relatively insignificant quantities) showed a price elasticity of demand less than one in foreign markets. These elasticities ranged from -.228 for fine fescue to -.764 for annual ryegrass. The upper limit on the price elasticity of demand in foreign markets exceeded one for annual ryegrass (-.1.233), other Kentucky bluegrass (-.1.186), and perennial ryegrass (-1.061).

Table 5. Buyer Response in Foreign Markets Measured by Price Elasticity of Demand by Grass Seed Type

Grass seed type	Export demand elasticity[b/]	Boundary limits on export elasticities[a/]	
		Upper	Lower
Fine fescue......................	-.228	-0.610	0[c/]
Bentgrass........................	-.363	-0.501	-.224
Other Kentucky bluegrass.........	-.319	-1.186	0[c/]
Tall fescue......................	-.361	-0.880	0[c/]
Annual ryegrass..................	-.764	-1.233	-.296
Perennial ryegrass...............	-.552	-1.061	-.043

[a/] Coefficients for confidence limits of price elasticities of demand were calculated from the upper and lower limits of a 90 percent confidence interval on the coefficient of price in each export demand equation estimated.

[b/] Export demand relationships for Merion Kentucky bluegrass and orchardgrass were not considered.

[c/] The lower bound of the confidence interval was a positive number, and was not used to compute the elasticity since it implies a positively sloped demand curve.

A comparison of price elasticity of demand in foreign markets with that in the United States market (Table 6) indicates that price has been a more important determinant of grass seed exports than generally perceived. With the exceptions of fine fescue and other Kentucky bluegrass, the price elasticity of demand is greater in export markets than in the United States. This supports the contention that grass seed traded internationally has a greater number of substitutes than that consumed domestically. While annual ryegrass consumed in the United States has few substitutes, that which moves into foreign markets competes with seed produced in Denmark, Netherlands, and elsewhere. This lends emphasis to the statement that grass seed, within seed types, is viewed generally as a homogeneous commodity on the world market, and seed produced in the United States competes with foreign-produced seed on the basis of price.

Table 6. Buyer Response in U.S. Markets Measured by Price Elasticity of Demand at the Wholesale Level by Grass Seed Type

Grass seed type	U.S. wholesale demand elasticity b/	Boundary limits on U.S. wholesale elasticities a/	
		Upper	Lower
Fine fescue c/	-.299	-0.553	-.045
Merion Kentucky bluegrass	-.732	-1.01	-.456
Other Kentucky bluegrass	-.347	-0.584	-.109
Tall fescue	-.171	-0.380	0 d/
Orchardgrass	-.359	-1.484	0 d/
Annual ryegrass	-.083	-0.337	0 d/
Perennial ryegrass	-.196	-0.330	-.063

a/ Coefficients for confidence limits of price elasticities of demand were calculated from the upper and lower limits of a 90 percent confidence interval on the coefficients of price in each demand equation estimated in the study.

b/ Wholesale level, as defined in the study, is at the point of first handler of grass seed after leaving the farm.

c/ United States demand relationships for bentgrass were not considered.

d/ The lower bound of the confidence interval was a positive number, and was not used to compute the elasticity, since it implies a positively sloped demand curve.

The disparity in price elasticities is most dramatic in the case of the ryegrasses. The price elasticity of demand in U.S. markets was -.083, and -.764 in foreign markets. For perennial ryegrass, the domestic and export coefficients were -.196 and -.552, respectively. It would appear that demand in the export market is considerably more responsive to price than it is in the domestic market.

However, Table 5 also indicates that the reliability of export price elasticities is less than in domestic markets, because of the larger range of confidence limits on these coefficients. For example, in the U.S. market, perennial ryegrass has an estimated price elasticity of demand of -.196. Statistically, we can be 90 percent certain that the true value of this coefficient is between -.063 and -.330. In the export market, we can be 90 percent confident that the true value of the export price elasticity is between -.043 and -1.061, a substantially greater range of possible values.

As stated earlier, tariff and other non-price barriers appear to influence the export demand for grass seed. These institutional forces may account for the lower reliability of the price elasticity of demand coefficients in foreign markets. The results indicate that, in the absence of these restraints on trade, particularly in low production years in Europe, U.S.-produced seed, particularly annual and perennial ryegrass, does compete with foreign-produced seed on the basis of price.

Buyer Response at Wholesale Level in U.S. Markets

The price elasticity of domestic demand at the dealer level is shown in Table 6 for six grass seed types. Bentgrass is excluded from the analysis since less than 5 percent of total production is consumed domestically. The coefficients ranged from a low of -.083 to a high of -.732. Confidence limits at the 90 percent level exceeded -1.00 for only two grass seed types. Such results provide a strong indication that the price elasticity of demand for cool season grass seed at the wholesale level is inelastic; i.e., less than one.

Merion Kentucky bluegrass, orchardgrass, and other Kentucky bluegrass had the largest price elasticity coefficients, -.732, -.359, and -.347, respectively. This indicates a higher demand sensitivity to price changes than the other grass seeds. The demand for annual ryegrass was the least responsive to price changes, as implied by the elasticity coefficient of .083. It is reported by the seed trade that lawn and turf mixes sold to supermarkets and chain stores generally contain a high and relatively fixed proportion of low-cost filler grass, usually annual and/or perennial ryegrass seed, which varies from 40 to 60 percent of the mix. The remainder contains high-valued specialty turf grasses, with the percentage of each being a function of price. For a given volume of packaged retail seed mix, the composition of the high-valued turf grasses is reported to vary greatly over time, to maintain a stable and competitive package net price. This situation is not perceived as the result of direct consumer demand, but rather a derived demand resulting from seed trade adjustment in package mixes to price fluctuations at the wholesale level. This study suggests that this type of pricing policy may occur with Merion and other Kentucky bluegrass as turf grasses, but is less important with fine fescue.

Orchardgrass and tall fescue are viewed by the seed trade as specialty grasses used in pasture and covercrop mixes. The high demand price elasticity of orchardgrass (-.359), relative to the tall fescue elasticity coefficient (-.171), tends to confirm the specialty role of tall fescue. It also supports the contention that the recent trend in pasture grass seed mixes is toward tall fescue and away from orchardgrass. The price elasticities indicate that orchardgrass will be substituted for tall fescue in these mixes, but only for a substantially larger price decrease. The low price elasticity of demand for tall fescue, relative to orchardgrass, suggests that it is used in combination with legumes and other grass seeds in the mix in relatively fixed proportions, as determined by climatic factors rather than price. The greater adjustment to changing market conditions appears to be in the total price of the packaged mix rather than seed content proportion.

The wholesale price elasticities of demand for annual and perennial ryegrass were -.083 and -.196, respectively. These coefficients are relatively small, probably largely because of the large volume of these two seed types traded, relative to the aggregate of grass seeds. These results lend emphasis to the role of the ryegrasses as fillers in grass seed mixes for various purposes. Their prices, particularly that of annual ryegrass, are generally low, relative to other grass seed types. These prices would have to increase considerably to make the specialty seed types competitive with the ryegrasses for filler purposes.

The demand for virtually all grass seed types was relatively less price responsive (more price inelastic) than most other U.S.-produced agricultural commodities. This may be caused partly by the small volume of the grass seed market, relative to that of most agricultural products. This also supports the hypothesis, stated earlier in the study, that grass seeds collectively have few substitutes. A general conclusion is that, for most purposes for which grass seed can be used, whether for lawn, turf, or pasture, the grass seed component of production costs is low, relative to other stand establishment costs and, therefore, large fluctuations in grass seed prices result in only nominal changes in the total cost of establishing or improving a permanent lawn or pasture.

Buyer Response at Farm Levels in U.S. Markets

The methodology used in this study allows the calculation of the farm price elasticity of demand directly from the estimated equations presented in the section on farm demand (Table 4) and is presented in Table 7. These coefficients are not directly comparable to either wholesale price elasticity or export price elasticity in terms of identifying the value of services added, whether domestic or foreign. Rather, the farm price elasticities calculated here indicate the changes in quantity purchased from farmers as a result of a change in farm price. Whether these quantities are ultimately consumed in domestic or foreign markets, or held in storage by the dealer, is not identified. The farm price elasticities ranged from -.080 for tall fescue to -.784 for orchardgrass.

The highest farm price elasticities for grass seeds occurred with seed types used predominantly in domestic lawn and turf mixes. Merion Kentucky bluegrass, fine fescue, and other Kentucky bluegrass had elasticities of -.678, -.671, and -.530, respectively. The magnitude of these values, compared with price elasticities in export markets (Table 5) and wholesale markets (Table 6), supports the contention that dealers, to a limited extent, make adjustments in their stocks of these seed types when the price spread warrants.

Table 7. Buyer (Wholesaler) Response at Farm Level in U.S. Markets Measured by Price Elasticity of Demand by Grass Seed Type

Grass seed type	Farm demand elasticity	Boundary limits on farm elasticities a/	
		Upper	Lower
Fine fescue	-.671	-1.643	0 b/
Bentgrass	-.214	-0.536	0 b/
Merion Kentucky bluegrass	-.678	-0.916	-.438
Other Kentucky bluegrass	-.530	-0.883	-.176
Tall fescue	-.080	-0.206	0 b/
Orchardgrass	-.784	-2.695	0 b/
Annual ryegrass	-.382	-0.561	-.202
Perennial ryegrass	-.765	-1.415	-.116

a/ Coefficients for confidence limits of price elasticities of demand were calculated from the upper and lower limits of a 90 percent confidence interval on the coefficient of price in each farm demand equation.

b/ The lower bound of the confidence interval was a positive number and was not used to compute the elasticity since it implies a positively sloped demand curve.

The coefficient for bentgrass, -.214, was relatively low at both farm and export levels (-.363), with the difference attributable largely to increased value by wholesalers and retailers in the form of transportation services before bentgrass reaches its point of final utilization in export markets.

Coefficients for the pasture specialty grasses, orchardgrass and tall fescue, were -.784 and -.080, respectively. These results lend emphasis to the statement made earlier that tall fescue is becoming the predominant pasture grass, and hence is not influenced greatly by market price. Conversely, farmer utilization of orchardgrass is influenced greatly by market price.

The farm price elasticity for annual ryegrass (-.382) was lower than the export elasticity (-.764), but higher than the domestic wholesale price elasticity (-.083). The farm coefficient for perennial ryegrass (-.765) was higher than wholesale elasticity in domestic (-.196) and export (-.552) markets. The results for the ryegrasses may be partly caused by their primary roles as fillers in grass seed mixes. Changes in the percentage of ryegrass seed in mixes may vary with fairly small changes in farm price. Increased role of proprietary perennial ryegrasses under direct farm contract also may be a factor.

As stated earlier, the demand for grass seed at the farm level depends on factors affecting the domestic retail demand, the level of exports, and inventory adjustments of dealers. Because of these added complexities, caution should be placed on use of the values presented here. The boundary limits on the farm price elasticity of demand coefficients, presented in Table 7, indicate that for fine fescue, bentgrass, tall fescue, and orchardgrass, we cannot be 90 percent confident, in a statistical sense, that there is a relationship between price and quantity demanded at the farm level. Although the values of these coefficients should be interpreted cautiously, it would appear safe to conclude that the price elasticity of demand at the farm level is less than one for most grass seed types.

Substitution and Complementarity in Demand Markets

The degree to which grass seed types compete against, or complement with, each other on the basis of price is evaluated directly from Tables 3 and 4 for export and domestic markets, respectively. The cross-price elasticity of demand coefficients, calculated for domestic markets, is presented in Table 8; those determined for export markets are presented in Table 9.

Cross-price elasticity of demand coefficients indicate the percentage change in demand for one commodity, relative to a unit change in the price of another. If two goods are substitutes in use, the cross-price elasticity of demand is positive, ceteris parabis. That is, an increase in the price of one good is expected to increase the demand for a good that can substitute for it. Conversely, if two goods complement each other in consumption, e.g., automobiles and gasoline, their cross-price elasticity of demand is expected to be negative, ceteris parabis.

On the left side of Table 8 are listed the grass seed types for which the cross-elasticity coefficients were calculated. The coefficient in each subsequent column indicates the percentage change in demand for the grass seed listed, relative to a unit change in the price of the grass seed type specified in each column.

Table 8: Buyer Response Between Seed Types at the Wholesale Level in U.S. Markets by Grass Seed Type Measured by Cross-Price Elasticity of Demand

	Cross price elasticity					
grass seed type	Fine fescue	Merion Kentucky bluegrass	Other Kentucky bluegrass	Tall fescue	Annual ryegrass	Perennial ryegrass
Fine fescue[a/].........	X		+0.332			-0.283
Merion Kentucky bluegrass.............	+1.763	X	+1.739		+1.733	-2.727
Other Kentucky bluegrass.............		+.092	X			
Tall fescue...........				X		+0.201
Orchardgrass..........				+.220		+0.249
Annual ryegrass.......			-0.144		X	

[a/]Perennial ryegrass demand was insensitive to price changes in other seed types and is not included.

Table 9. Buyer Response Between Seed Types at the Wholesale Level in Foreign Markets by Grass Seed Type Measured by Cross-Price Elasticity of Demand

	Cross price elasticity	
Grass seed type	Perennial ryegrass	Other Kentucky bluegrass
Bentgrass............................	-.519	+0.664
Perennial ryegrass....................	X	+1.353

The lawn and turf grass seed types were generally found to substitute for each other in mixes. Greater quantities of fine fescue were demanded at the higher prices of other Kentucky bluegrass. The demand for Merion Kentucky bluegrass was increased by higher prices of fine fescue, other Kentucky bluegrass, and annual ryegrass. High Merion Kentucky bluegrass prices increased the domestic demand for other Kentucky bluegrass. Perennial ryegrass was found to complement fine fescue and Merion Kentucky bluegrass in lawn and turf mixes. The magnitudes of these coefficients indicate the extent to which grass seed types substitute for each other. For example, a 10 percent increase in the price of other Kentucky bluegrass increases the demand for fine fescue 3.32 percent and Merion Kentucky bluegrass 17.39 percent. This indicates that Merion Kentucky bluegrass competes strongly with other lawn and turf seed types on the basis of price. Fine fescue and other Kentucky bluegrass also compete, but to a lesser extent.

Orchardgrass was found to be a substitute for tall fescue on the basis of price. The small cross-price elasticity coefficient of .220 indicates a weak price relationship, however.

Annual and perennial ryegrasses are viewed as multipurpose grasses by the seed trade. The results indicate that perennial ryegrass is complemented by fine fescue and Merion Kentucky bluegrass in lawn and turf mixes, but is substituted for by both orchardgrass and tall fescue in pasture mixes. The demand for perennial ryegrass was not affected by price changes of any other grass seed type, perhaps because of the multiple purposes it serves.

Annual ryegrass was found to be substituted for Merion Kentucky bluegrass in lawn and turf mixes, while it complemented other Kentucky bluegrass in these same mixes. The complementary relationship between other Kentucky bluegrass and annual ryegrass is consistent with the role of annual ryegrass as a nurse crop to protect the higher valued turf grass which is slower growing and more difficult to establish without the inclusion of annual ryegrass.

Table 9 indicates that domestic price of various grass seed types has little influence on the export demand for other grass seed types. The export level of bentgrass was decreased by price increases in perennial ryegrass, and increased by price increases of other Kentucky bluegrass. Of other grass seed types, only perennial ryegrass exports, which substituted for other Kentucky bluegrass, were found to be affected by another grass seed. The relative insignificance of domestic price in international markets is consistent with the earlier contention that U.S.-produced grass seed competes with foreign-produced seed on the basis of international price. For example, U.S.-produced annual ryegrass competes on the international market with ryegrass produced in Denmark and the Netherlands, not with tall fescue produced in the United States.

Short-Run Supply Relationships

The short-run wholesale supply results are presented in Table 10; Table 11 presents the estimated short-run farm supply equations. In all equations, the quantity supplied was statistically significant and positively influenced by the total quantity of that grass seed type available from stocks and current production. Quantity supplied was generally positively related to price, but the strength of this relationship was much weaker than that between quantity supplied and quantity available. These results indicate that, while farmers and wholesalers do respond to changes in existing market prices, and are willing to increase supply of a given grass seed type at higher prices by reducing inventories, they are constrained in their ability to respond to these price changes by storage capacity limitations.

Supply in Wholesale Markets

The estimated short-run wholesale level supply equations are presented in Table 10. Generally, wholesale price in any time period was found to positively influence supply in that time period. This result is consistent with the theoretical economic concept of a positively sloped supply curve.

Quantity supplied was negatively affected, both by wholesale price in the previous period and by farm price in the current period. This implies that, at higher wholesale prices last year, wholesalers tended to reduce inventories, resulting in smaller stocks available for sale this year, regardless of price. The negative coefficient on farm price implies that wholesalers have reduced incentive to supply grass seed for retail markets when they are facing higher purchase prices at the farm level.

In all cases, the total quantity available served as a significant positive supply shifter, indicating that wholesalers will supply greater quantities in years of increased production, regardless of the price at which these quantities are sold. This result supports the hypothesis that grass seed wholesalers are price-takers in a market where price is determined by forces largely beyond their control.

The quantity supplied was negatively related to imports of fine fescue and other Kentucky bluegrass, indicating that wholesalers of these grass seed types were willing to supply smaller quantities in years when the level of imports was high. This supports the contention that imports of these grass seed types compete with U.S.-produced seed in the U.S. market, and an increase in imports sufficiently depresses price to the extent that domestic wholesalers supply smaller quantities of the available stocks.

Supply in Farm Markets

The estimated short-run farm supply equations are presented in Table 11. The quantity of each grass seed type that farmers supply was hypothesized to be related to current and previous farm prices and the total farm quantity available for sale which includes the current year's production plus carry-in stocks from the previous year.

Quantities farmers are willing to supply generally were found to be positively related to current price and negatively related to the previous year's price. The total quantity available was even more important in explaining farm supply than the equivalent variable was in explaining wholesale

Table 10. Estimated Wholesale Level Supply Equations for Selected Grass Seed Types, 1959-1975

Seed type	Degrees of freedom	Constant	P^W_{it}	P^W_{it-1}	P^F_{it}	Q^{TWA}_{it}	$IMPORTS_{it}$
Fine fescue	10	79.13 (44.64)	+.43 (.37)	-.46 (1.24)	-.51 (.24)	+.35* (.20)	-.55*
Bentgrass	12	9.45 (2.98)	+.05 (.04)		-.16 (.06)	+.68* (.04)	
Merion Kentucky bluegrass	12	0.88 (8.72)	+.03 (.03)	-.02 (.02)		+.58* (.17)	
Other Kentucky bluegrass	11	94.34 (54.35)	+.73 (1.89)		-2.05 (2.29)	+.50* (.17)	-.46 (.35)
Tall fescue	12	19.89 (26.13)	+.46 (.92)	-1.22 (.91)		+.84* (.04)	
Orchardgrass	14	10.90 (6.43)				+.65* (.06)	
Annual ryegrass	13	-110.51 (53.50)	+7.41* (3.39)			+.91* (.06)	
Perennial ryegrass	14	-15.64 (22.46)				+.88* (.07)	

* A starred coefficient indicates that it is statistically significant. Items in parentheses represent the estimated standard error (S.E.) for the coefficient. The S.E. test is a test of significance but only an approximate one because the ratio of the estimated coefficient to its standard error is not distributed exactly as a student t. In such cases a standard rule of thumb, as is done in this study, is applied where the coefficient must be more than twice its S.E. to be deemed significantly different from zero. The standard error is defined as S.E. =

$$\frac{\text{estimated coefficient value}}{\text{student t}}$$

EXPLANATORY VARIABLES:

$P^W_{it,\ t-1}$ = wholesale price of grass seed i in times t and t-1.

P^F_{it} = farm price of grass seed i in time t.

Q^{TWA}_{it} = total quantity of grass seed i available to wholesalers in time t.

$IMPORTS_{it}$ = imports of grass seed i in time t.

Table 11. Estimated Farm Level Supply Equations for Selected Grass Seed Types, 1959-1975

Seed type	Degrees of freedom	Constant	P^F_{it}	P^F_{it-1}	P^F_{it-2}	Q^{TFA}_{it}
Fine fescue	12	-2.53	+.28*	-.22*		+.94*
		(9.62)	(.14)	(.12)		(.10)
Bentgrass	13	0.39	+.06			+.88*
		(5.09)	(.08)			(.09)
Merion Kentucky bluegrass	11	-6.48	+.05*	-.03*	-.02	+1.10*
		(3.91)	(.02)	(.02)	(.02)	(.01)
Other Kentucky bluegrass	14	-3.62				+.97*
		(1.51)				(.01)
Tall fescue	12	3.84	+1.23*	-1.19*		+.94
		(12.07)	(.54)	(.53)		(.02)
Orchardgrass	13	-2.22	+.06			+.98*
		(5.93)	(.12)			(.04)
Annual ryegrass	13	42.79	+.76			+.86*
		(46.47)	(4.54)			(.05)
Perennial ryegrass	14	1.82				+.91*
		(11.71)				(.05)

* A starred coefficient indicates that it is statistically significant. Items in parentheses represent the estimated standard error (S.E.) for the coefficient. The S.E. test is a test of significance but only an approximate one because the ratio of the estimated coefficient to its standard error is not distributed exactly as a student t. In such cases a standard rule of thumb, as is done in this study, is applied where the coefficient must be more than twice its S.E. to be deemed significantly different from zero. The standard error is defined as S.E. =

$$\frac{\text{estimated coefficient value}}{\text{student t}}$$

EXPLANATORY VARIABLES:

P^F_{it}, P^F_{it-1}, P^F_{it-2} = current and lagged farm prices of grass seed i.

Q^{TFA}_{it} = total quantity of grass seed i available to farmers in time t.

level supply, suggesting that farmers are less flexible than wholesalers in adjusting inventories to meet current market prices. The degree to which on-farm grass seed storage facilities limit farmer responsiveness to farm price changes is illustrated in Figure 4 of Circular of Information 689, which shows on-farm stocks as a percentage of total farm quantity available (stocks plus production), as well as farm-held stocks as a percentage of total (farm plus dealer) stocks. It appears that grass seed farmers collectively have storage facilities for less than 10 percent of the total quantity they have available for sale. Of all stocks held, wholesalers hold the largest share in storage for every grass seed type. The percentage of total stocks held by wholesalers ranged from an average of 70 percent for annual ryegrass to an estimated 90 percent for other Kentucky bluegrass.

In addition to the constraint of limited storage facilities, farmers may be forced to sell seed at unfavorable prices to pay operating expenses and long-term debt obligations.

Short-Run Supply Response to Price Changes

The degree of farmer and wholesaler responsiveness to price changes is measured quantitatively by the price elasticity of supply. Conceptually, price elasticity of supply relates the percentage change in quantity supplied to a unit change in price. Price elasticity of supply coefficients calculated for each of the eight grass seed types at the farm and wholesale levels is presented in Table 12. These coefficients represent the relative responsiveness of farmers and wholesalers to change in price. For example, the farm supply elasticity of .108 for fine fescue indicates that a 10 percent increase in farm price will result in farmers collectively supplying 1.08 percent more fine fescue.

The short-run price elasticity of supply was less than one ($\varepsilon_s < 1$) for each of the eight grass seed types. Only in the case of other Kentucky bluegrass does the coefficient exceed .20. This indicates that short-run (1-2 years) supply adjustment of grass seed at both the farmer and wholesale level responds very sluggishly and to a very limited degree to price changes. These results lend emphasis to previous assertions that seed producers and wholesalers are suppliers in markets where price largely is determined by forces beyond their control, at least in the short run.

Price elasticity of supply coefficients for grass seed types range from .05 to .30. These values lie within the range of supply elasticity coefficients calculated for other agricultural commodities produced in the

Table 12. Average Short-Run Supply Response to Price Measured by Price Elasticities of Supply by Grass Seed Type at the Farm and Wholesale Levels, 1959-1975

Grass seed type	Short-run supply elasticity Farm	Short-run supply elasticity Wholesale
Fine fescue	.108	.184
Bentgrass	.058	.058
Merion Kentucky bluegrass	.199	.136
Other Kentucky bluegrass	.291	.190
Tall fescue	.050	.023
Orchardgrass	.020	0
Annual ryegrass	.006	.072
Perennial ryegrass	0	0

United States [1 and 13]. Thus, the low supply response by growers to price changes is not a purely grass seed industry phenomena. It is characteristic of agricultural production in the United States generally.

Long-Run Supply Relationships

Changes in the long-run supply of any grass seed type depend on changes in per acre yields and changes in the number of acres allocated to the production of that grass seed type. The short-run supply relationships evaluated in the previous section were national in scope. To permit a focus on the implications of the phaseout of open field burning in the Willamette Valley, an analysis of long-run yield and acreage allocation relationships is confined to Willamette Valley producers.

Yield and acreage relationships are analyzed separately, rather than combined as total production, since those factors affecting yields are not considered the same as those affecting acreages.

Willamette Valley Grass Seed Yield Response

The average annual yield for each grass seed type grown in the Willamette Valley is shown graphically in Figure 7 of Circular of Information 689. Visual inspection of Figure 7 suggests that there is substantial year-to-year variation in grass seed yields for each seed type. Table 13 provides descriptive statistics of the yield data in terms of mean, standard deviation, and coefficient of variation for the yield data for each grass seed type. The mean represents the average yield for each grass seed type for the period of analysis. The standard deviation is a measure of dispersion of the yearly yield about the average for the period. The coefficient of variation expresses the standard deviation as a percentage of the mean.

Table 13. Mean Yield and Dispersion Characteristics for Selected Grass Seed Types, Willamette Valley, Oregon, 1959-1975

Grass seed type	Mean Yield (lbs./acre)	Standard deviation	Coefficient of variation a/
Fine fescue......................	447.2	61.6	13.78
Bentgrass........................	280.1	36.3	12.95
Merion Kentucky bluegrass.........	323.4	77.2	23.88
Other Kentucky bluegrass..........	596.6	111.9	18.76
Tall fescue......................	658.1	90.4	13.74
Orchardgrass.....................	659.4	108.2	16.41
Annual ryegrass..................	1271.1	169.4	13.32
Perennial ryegrass...............	866.4	97.9	11.30

a/ Coefficient of variation expressed in percentage terms.

Average yields ranged from a low of 280.1 pounds per acre for bentgrass to 1,271.7 pounds per acre for annual ryegrass. The coefficient of variation provides insight into the relative variability of annual yield about the 17-year yield mean for each grass seed type. Generally, the ryegrasses and bentgrass showed the least relative variability in yield from year to year. The fescues were somewhat more variable, with nearly identical coefficients of variation. Orchardgrass and the bluegrasses exhibited the most relative variability in yield.

These statistics indicate that there is substantial variation in yield of most grass seed types from year to year. The following analysis attempts to identify those factors which most strongly influence this variability. As stated earlier, yield in any year is hypothesized to be a function of weather and technological change. The estimated Willamette Valley yield equations are presented in Table 14.

Time, as a proxy for a number of factors, including technology, was found to be positively correlated with yields. Two measures of time were employed, TIME (1959-60 = 1, 1960-61 = 2,...., 1975-76 = 17, and the square of this variable, $TIME^2$ (1959-60 = 1, 1960-61 = 4,...., 1975-76 = 289), so the effect of technology was not required to be linear through time.

Adverse weather conditions at some time during the year were negatively related to yield for each grass seed type. Winter weather was excluded as an independent variable, since at no time during the analysis was the temperature at sub-zero levels for two or more days. It is also recognized that a complex set of variables, such as snow cover, existence of a new stand, level of fall fertilization, and a number of management practices, also combines with weather to determine the degree to which weather becomes an important adverse factor on grass seed yields. The general industry sentiment is that the Willamette Valley enjoys a biological comparative advantage over most areas of the world with climatic conditions for grass seed growth, maturation, and harvest being better here than elsewhere throughout the world. The study results indicate that, while the Willamette Valley may indeed have the best climate for producing cool season grass seeds anywhere in the world, the climate is not always conducive to maximum grass seed yields.

The percentage of total variation in grass seed yields explained by the combined weather and time trend variables ranged from 23 percent for bentgrass to 71 percent for annual ryegrass. Aggregation of the technological change variables into a TIME variable may also cloud the importance of changes specific to one grass seed type.

Willamette Valley Grass Seed Acreage Response

The long-run Oregon producer response model hypothesizes that the acreage allocation decisions of grass seed producers are influenced by a number of factors, including expected prices, costs, and yields. Figure 6 in Circular of Information 689 shows Willamette Valley acreages (in thousands of acres) on which grass seed was produced for the period 1959-1978.

Table 14. Estimated Willamette Valley Yield Response Equations for Selected Grass Seed Types, 1959-1976

Seed type	Degrees of freedom	Constant	Weather: $Fall_t$	Weather: $Spring_t$	Weather: $Summer_t$	$Time_t$	$Time_t^2$	R^2	Durbin-Watson
Fine fescue	14	431.54 (21.44)		-48.32** (26.03)			-.39*** (.14)	.39	3.15[b]
Bentgrass	12	277.48 (217.00)	-58.30 (137.40)	-288.00* (162.22)	-136.09 (173.30)	+43.94 (54.96)	-1.96 (2.73)	.23	2.58[b]
Merion Kentucky bluegrass	12	249.08 (70.09)	-75.81*** (33.89)			+20.84 (16.07)	-.84 (.82)	.45	1.98[a]
Other Kentucky bluegrass	7	250.21 (445.48)	-131.47* (85.76)	-64.61 (73.98)		+73.72 (84.84)	-2.98 (3.60)	.30	1.93[a]
Tall fescue	13	599.45 (46.20)	-42.20 (44.53)	-34.30 (42.74)		+9.92*** (4.30)		.32	3.03[b]
Orchardgrass	8	1,256.9 (326.54)			-36.54 (57.53)	-123.5** (59.63)	+5.79** (2.57)	.46	1.87[a]
Annual ryegrass	13	951.25 (83.77)		-131.51*** (52.62)		+71.86*** (21.92)	-2.45** (1.16)	.71	2.49[a]
Perennial ryegrass	13	987.78 (41.72)	-43.82 (40.21)	-112.88*** (38.60)		-5.42* (3.88)		.53	1.50[a]

* = significant at .10 level (one-tailed test).

** = significant at .05 level (one-tailed test).

*** = significant at .025 level (one-tailed test).

[a] Reject the hypothesis that autocorrelation is present (.05 level).

[b] The Durbin-Watson test for the presence of autocorrelation is inconclusive (.05 level).

EXPLANATORY VARIABLES:

$Fall_t$, $Spring_t$ $Summer_t$ represents adverse growing conditions for these seasons, with assigned values of 1 = adverse conditions, 0 = otherwise.

$Time_t$ = time trend variable (1959-1960 = 1,···, 1975-1976 = 17).

$Time_t^2$ = squared value of time trend variable (1959-1960 = 1,···, 1975-1976 = 289).

Note the difference in scales for each grass seed type. Acreages allotted to the production of Merion Kentucky bluegrass ranged from a high of 4,230 in 1967 to a low of 1,550 in 1976; annual ryegrass acreages varied from a low of 75,000 acres in 1967 to a high of 145,000 acres in 1970. Casual observation of these graphs indicates that acreages allotted to the production of most grass seed types have declined in the 1970s.

The estimated Willamette Valley acreage response equations attempt to identify those forces effecting changes in the number of acres allocated to grass seed production. Results of the analysis are presented in Table 15. Generally, farmers increase their grass seed acreages in response to higher price expectations and higher yields. Acres devoted to grass seed production are reduced in response to rising costs and increased burn fees, which was the proxy variable for political pressure against open field burning. There was a very high correlation between cost and burn fee for most grass seed types because of substantial estimated cost increases in recent years, which have occurred simultaneously with political pressure to reduce the acreages open burned. Correlation between these two variables violates the assumption of independence of explanatory variables required for ordinary least squares estimation procedures. Inclusion of both burn fee and cost in any estimating equation resulted in confusion as to the influence and significance of each as an explanatory variable. For that reason, either burn fee or cost was selected for each equation on the basis of its value as an explanatory variable in that particular equation. The results indicate that recent reduction of grass seed acreages may be caused more by cost increases dictated by inflationary forces on input prices than by pressure to reduce the number of acres open burned. That is, farmers may be reducing grass seed acreages more in response to lower expected profit than from regulations on the number of acres that can be open burned. For all seed types, the acres of seed grown in any time period were positively related to acres allotted to grass seed production in the past time period. Because of the life of an established grass seed stand, acres allocated to grass seed production can be altered only gradually over time, except for annual ryegrass.

The percentage of the observed variation in acreages allocated to the production of each grass seed type explained by the equation ranged from 64 percent for Merion Kentucky bluegrass to 97 percent for tall fescue.

Table 15. Estimated Willamette Valley Acreage Response Equations for Selected Grass Seed Types, 1959-1975

Seed type	Degrees of freedom	Constant	P^F_{it-1}	P^F_{it-2}	$Yield_{it-1}$	$Cost_{it-1}$	$Burn_{it}$	$Acres_{it-1}$	R^2	Durbin-Watson
Fine fescue	13	18,609.0 (7,102.8)		+81.52*** (40.73)		-123.81*** (33.24)		+.48*** (.20)	.87	1.36[b/]
Bent-grass	12	-8,536.8 (3,348.9)		+144.10*** (37.87)	-37.07***		-3,355.90*** (442.79)	+.76*** (.09)	.94	3.15[b/]
Merion Ky. bluegrass	13	784.68 (856.71)		+11.26*** (3.96)		-9.14** (4.48)		+.68*** (.19)	.64	1.15[b/]
Other Ky. bluegrass	8	6,593.4 (3,640.67)		+131.95** (73.31)		-135.42*** (37.80)		+.83*** (.19)	.96	1.77[a/]
Tall fescue	13	2,747.8 (2,044.8)			+5.41* (3.56)	-74.49*** (17.46)		+.86*** (.08)	.96	1.77[a/]
Orchard-grass	8	18,689.0 (3,850.25)	-656.08*** (172.73)				-1,754.00*** (385.32)	+.84*** (.09)	.92	3.20[b/]
Annual ryegrass	12	-36,777.0 (26,241.5)	+4,754.2*** (1,748.0)		+44.66*** (19.84)	-452.57** (243.37)		+.78*** (.15)	.80	1.63[a/]
Perennial ryegrass	13	15,348.0 (9,415.98)	+178.38 (220.89)			-165.63** (83.60)		+.80*** (.16)	.72	1.13[b/]

* = significant at .10 level (one-tailed test).

** = significant at .05 level (one-tailed test).

*** = significant at .025 level (one-tailed test).

[a/] Reject the hypothesis that autocorrelation is present (.05 level).

[b/] The Durbin-Watson test for the presence of autocorrelation is inconclusive (.05 level)

EXPLANATORY VARIABLES:

P^F_{it-1}, P^F_{it-2} = farm price of grass seed i in the preceding two time periods (i is grass seed type considered in the equation).

$Yield_{it-1}$ = yield per acre of grass seed i in the preceding period.

$Cost_{it-1}$ = cost per acre of grass seed i in the preceding period.

$Burn_{it}$ = burn charge per acre in time t.

$Acres_{it-1}$ = acres allocated to the production of grass see[d] i in the preceding period.

Producer Response to Price Changes

The degree of Willamette Valley producer responsiveness to price changes, referred to in the previous section, is measured quantitatively by price elasticity of acreage response. This empirically measures the percentage change in acreage allotted to the production of each grass seed type, resulting from a unit change in the farm price of that seed type. These calculations are presented in Table 16 for those grass seed types for which price served as a positive influence in the estimated acreage response equations of Table 15. These calculations should be interpreted cautiously as being long-run price elasticities of supply, since the quantity produced by farmers is determined both by the number of acres under production and the yield per acre, and the prices used are lagged only one or two years. The elasticities presented here are truly supply elasticities only if the yield per acre is constant through time. In that case, bringing acreage into production reflects the grower's actual desire to increase total grass seed output as a result of expected increases in grass seed prices.

Table 16. Willamette Valley Producer Acreage Response to Price for Selected Grass Seed Types Measured by Price Elasticities of Acreage Response, 1959-76[a/]

Grass seed type	Price elasticity of acreage response	Bound limit[b/] Lower	Bound limit[b/] Upper
Fine fescue[c/]	.083	.010	.157
Bentgrass[c/]	.208	.111	.305
Merion Kentucky bluegrass[c/]	.324	.122	.525
Other Kentucky bluegrass[c/]	.465	.104	.826
Annual ryegrass[d/]	.263	.091	.436
Perennial ryegrass[d/]	.039	0[e/]	.125

[a/] In the case of tall fescue and orchardgrass, positive coefficients on price in the acreage response equations were not obtained, so elasticities were considered zero and confidence intervals could not be calculated.

[b/] Using a 90 percent confidence interval.

[c/] Calculations based on price lagged two years.

[d/] Calculations based on price lagged one year.

[e/] A lower bound of 0 was used in the case where a negative coefficient, implying a reduction in acreage in response to higher prices, resulted.

The acreage response elasticity was less than one for each of the eight grass seed types. For all seed types, the boundary limits, using a 90 percent confidence interval, indicate that the probability is very low that the elasticity coefficients in any case exceed 1.0. These results simply lend emphasis to the contention that not only do grass seed growers respond slowly to acreage changes, but also that the adjustment process involves one or more years to take place.

The range of elasticity values calculated of .039 to .465 lies within the range of more broadly determined supply elasticity coefficients calculated for other agricultural commodities produced in the United States [1 and 13]. The inability of producers to respond to price changes is not entirely a grass seed industry phenomenon, but is characteristic of considerable agricultural production in the United States generally.

Perennial ryegrass and fine fescue were the least price responsive with elasticity coefficients of .039 and .083, respectively. The low coefficient for perennial ryegrass may be partially caused by the increasing significance of proprietary varieties where higher prices result from contracted acreages being devoted to the production of these varieties. Nearly all the U.S. production of fine fescue is centered in the Waldo Hills-Silverton Hills areas of Marion County where stand establishment costs are higher for fine fescue than for any other seed type. Much of the extra cost can be attributed to a two-year fallow requirement preceding stand establishment to control perennial weeds. This factor also may have contributed to the low response to price of fine fescue acreages.

Annual ryegrass acreage, as expected, was somewhat more price responsive than most other grass seed types. As an annual crop, it is somewhat easier to put into and take out of production than the perennial grasses. Bentgrass acreage had an elasticity coefficient of .208, which was surprising, given the industry sentiment that it is difficult to convert bentgrass acreage to other seed types because of its creeping properties. Perhaps adjustment is to crops other than grass seeds.

Acreages devoted to bluegrass production were the most highly responsive to price changes. This is probably because bluegrass is generally produced on better drained soils which have more alternative uses in agricultural production.

With exception of land devoted to bluegrass production, the existence of few cropping alternatives available to farmers on the quality of land traditionally devoted to grass seed production in the Willamette Valley is thought to contribute to the generally low responsiveness of grass seed acreages to price changes. Additionally, low operating costs relative to total costs and the perennial nature of grass seed production are considered factors characteristic of Willamette Valley grass seed production influencing producer acreage allocation decisions.

Producer Response to Cost Changes

Cost elasticities of acreage response were calculated for each of the grass seed types to measure the quantitative response of producer decisions to reduce acreages in light of rising costs. Operating costs per acre, from Appendix Table 4, and the cost coefficients from the acreage response equations of Table 15, were used to calculate the cost elasticities of acreage response presented in Table 17.

For all grass seed types, except other Kentucky bluegrass, the cost elasticity of acreage response was between zero and negative one, indicating that a one percent increase in cost in one time period led to an acreage reduction of less than one percent in the subsequent year.

Table 17. Willamette Valley Producer Acreage Response to Cost for Selected Grass Seed Types Measured by Cost Elasticities of Acreage Response, 1959-1976[a/][b/]

Grass seed type	Cost elasticity of acreage response	Bound limit[c/] Lower	Upper
Fine fescue	-.257	-.135	-.380
Merion Kentucky bluegrass	-.274	-.036	-.511
Other Kentucky bluegrass	-1.026	-.626	-1.426
Tall fescue	-.309	-.178	-.439
Annual ryegrass	-.222	-.009	-.435
Perennial ryegrass	-.148	-.016	-.280

[a/]Cost elasticities measured the percentage change in acreage allotted to the production of each grass seed as a result of unit change in variable cost of production in the preceding period.

[b/]In the case of bentgrass and orchardgrass, negative coefficients on cost in the acreage response equations were not obtained. so elasticities were considered zero and confidence intervals could not be calculated.

[c/]Using a 90 percent confidence interval.

The acreages used to produce other Kentucky bluegrass were most responsive to cost changes. This may be partially caused by the shorter time other Kentucky bluegrass acreage data have been available. For the bulk of this shorter time span, acreages have been steadily declining and costs have been increasing.

The cost elasticities of acreage response were lowest for annual ryegrass and perennial ryegrass, supporting the contention that the ryegrasses are grown on Dayton "Whiteland" soil where alternative cropping opportunities are essentially non-existent thereby minimizing the ability of producers of ryegrasses to adjust to changes in the cost of production on a collective or industrywide basis.

The generally low producer response to changes in operating costs is thought to be strongly influenced by two factors. Operating costs account for about 40 percent of the total cost of producing grass seed. Overhead costs in land and machinery account for another 45 percent, amortized stand establishment cost, and general overhead [12]. The high percentage of total cost in land and machinery overhead costs also helps explain why acreage expansion appears to occur in years when grass seed price is increasing, and, to a lesser extent, acreage contraction occurs when price is stable or declining. Cost variability is also high between growers producing the same grass seed type [12]. This means that individual growers feeling the greatest economic stress from increased costs and/or decreased prices may adjust output quite rapidly. Those producers with lower unit cost than their neighbors are less inclined to cut production during periods of economic stress. The result is that, taken collectively, all growers appear to be relatively insensitive to cost changes.

Analytical Limitations

Any economic study abstracts from reality in its process of simplification. In so doing, some dimensions of a more complex reality are omitted, either purposely or by accident. This study is no exception. Consequently, the reader needs to be aware explicitly of several limitations.

(1) Sixteen observations, one for each year from 1959-1960 through 1974-1975, were available for the demand analysis of each grass seed type. For the Oregon producer supply response equations, 17 observations, including 1975-1976 data, were available for all seed types except orchardgrass and other Kentucky bluegrass. Data for these seed types were not reported until 1964-1965, so these were restricted to 12 observations. This limited number of observations may have contributed somewhat to the low explanatory power exhibited by some equations, as well as the low t-values associated with individual explanatory variables. In such cases, other variables, not identified by this study, may be exerting some influence on the supply and demand relationships. This is not an uncommon problem with quantitative supply and demand studies because of the complexity and interrelatedness of a multitude of dynamic forces involved in the reality of market price determination.

(2) The study is one of partial equilibrium analysis. As such, it evaluates supply and demand forces which result in a market equilibrium solution across given time intervals. It does not allow ready analysis of the processes involved in moving from one time period equilibrium solution to that of a different time period equilibrium solution.

(3) The data, particularly prices and incomes, are determined as averages for a given time. The analysis, however, treats them as constants for that time period. The statistical procedures involved, for example, do not account for the effect of intra-year price variability on quantities supplied and demanded. Perhaps this could be alleviated if data were available on a quarterly or monthly basis. Such shortening of the data time period base, however, would increase the probability of correlation of observations through time, which violates the assumption of the modeling procedure utilized, thereby reducing explanatory power of the analysis.

(4) The coefficients calculated in the regression equations evaluate the effect of the explanatory variables on the dependent variable when all other explanatory variables in the equation are held constant at the mean values. This implies that the effect of each explanatory variable is constant through time, and estimates that effect in terms of conditions which never existed; that is, when all other variables were equal to their averages for the duration of the study period.

(5) No data are available which permit a distinction between public and private varieties of grass seed by type, either for production or consumption. Yet, price differentials may be significant on the demand side. For example, the public varieties of perennial ryegrass used for pasture may bring only 8 cents per pound, while the finely textured proprietary varieties for turf purposes may bring 35 cents per pound. This price differential is greater in a buyer's market when general market prices are low, and lower in a seller's market when the general market price is high.

(6) This study only peripherally evaluates the role of institutional forces which influence market utilization of grass seeds. While institutional forces were identified as probably being very important in the export market for grass seeds, the quantitative impact of market contracts, barriers to entry in foreign markets, and market concentration in the seed trade were not estimated. The imposition of a field burning ban was not quantitatively evaluated in terms of its impact on grass seed prices and outputs. Rather, the study evaluates only the cost impact of Senate Bill 311.

(7) The degree of market demand competition between grass seed and legumes was not evaluated. While seed trade personnel suggest that the relationship between legumes and grasses is complementary in terms of price, this study suggests they may be competitive, at least in pasture and covercrop mixes. A specific study would be required to answer that issue.

(8) Production and cost data were confined to Willamette Valley production. Whether these data can be extropolated to other grass seed producing areas of Oregon, Washington, and Idaho is not known. Hence, the extent which these areas might be capable of increasing production, in response to higher prices resulting from declining Willamette Valley production, is not known.

(9) The linearity assumption of the two models used will generate biased results to the extent that non-linear supply and demand relationships exist. The extent to which this is the case is not known. Other studies suggest that this is not a serious limitation.

(10) The effect of a decline in the volume of Willamette Valley grass seed production on the general economy of the state was not evaluated. That is, losses to input suppliers, the Port of Portland, and other economic agents in the state were not evaluated.

(11) The extent to which factor substitution in grass seed production has occurred over time was not accounted for directly in the analysis. Existence of technology influences is recognized in the yield equation with the time trend variable, but the degree to which the relative importance of land, labor, machinery, and other inputs have changed through the period of analysis is not known. The estimated costs assumed that inputs were used in the same proportion for the entire period, and all cost changes resulted from changing factor prices.

(12) Because retail prices for grass seed types were not available, first handler wholesale prices were used as a proxy. The extent to which those prices were reasonably accurate reflections of retail price could not be evaluated directly.

SUMMARY AND CONCLUSIONS

The primary purpose of this study is to analyze market forces, both domestic and foreign, which historically have influenced the Oregon grass-seed industry. To the extent that history repeats itself, which is more often than we care to admit, past actions can be modeled to predict future effects from alternative policy choices being considered. In the case of Willamette Valley grass seed producers, federal market orders which have been proposed for dampening price variability and production of grass seed are important policy considerations.

Policy Implications for Market Orders

Results of this study suggest that federal market orders proposed for controlling bentgrass and perennial ryegrass would not necessarily have served their intended purpose of restricting supply, increasing market price to bentgrass producers and dampening price variability over time. Price in the export market for bentgrass is much more important than previously assumed. Consequently, supply reductions of bentgrass would result initially in relatively large initial price increases for bentgrass, followed by market substitution with other grass seed types, resulting finally in decreased demand for bentgrass and lower price than without the market order. Supply control for perennial ryegrass in the domestic market would be frustrated by price competition from other seed types, primarily orchardgrass and tall fescue, in pasture grass mixes. Complementarity between perennial ryegrass and fine fescue and Merion Kentucky bluegrass also suggests a downward pressure on price for those seed types, if supply control to increase price of perennial ryegrasses were implemented.

Industrywide market orders would appear to be a more effective means of controlling supply rather than singling out one or a few grass seed types. To be effective for Willamette Valley growers, however, grass seed imports would have to be tightly controlled, and barriers to entry for other potential U.S. grass seed-producing regions implemented, to assure that price increases were captured by Willamette Valley growers.

rather than growers elsewhere. Initiating such broad based controls appears unlikely as it runs counter to the dominant open market philosophy characteristic of most sectors of U.S. agriculture.

Some desire for market orders appears to have evolved from the perception that economic problems of growers stem in part from monopoly powers which grass seed wholesalers possess. This study indicates that such belief is unfounded. Although wholesaler stocks generally are three to ten times larger than farm-held stocks, those levels do not appear to be of sufficient magnitude to permit wholesale level manipulation of market price.

Policy Implications for Reduced Field Burning

Historically, the degree to which consumers have been willing to pay higher prices for scarcer amounts of grass seed has been quite high. For most grass seed consumption, whether establishing a pasture or landscaping a home, cost of the grass seed is an insignificant percentage of the total cost of the project for which it is used, and, except for other grass seeds, there are few substitutes in use. For these reasons, the price of grass seed might increase substantially before consumers decide that it is no longer a worthwhile investment. The interaction of supply and demand, as outlined above, indicates that a field burning ban would result in less total production of grass seed in the Willamette Valley, but the percentage increase in price would be greater than the percentage decrease in total production, so gross returns to Oregon grass seed producers taken collectively would increase. Net profitability, however, would depend on whether the increase in gross returns offset the increase in production costs associated with the field burning ban. The extent to which Oregon grass seed profitability would be affected would depend on changes in comparative advantage that the Willamette Valley possesses in the production of grass seed when compared with other producing areas. However, the effect upon consumer demand of field burning policy which would drastically reduce Willamette Valley production, resulting in previously unknown high prices for grass seed, cannot be evaluated with confidence, since that phenomenon has never occurred. The extent to which reduced supplies could be translated into higher market prices depends upon (1) the level of imports allowed, resulting in income transfer for Willamette Valley producers to those in other countries, (2) the degree of grass seed quality reduction affecting acceptability of Oregon-produced seed in domestic and foreign markets, (3) the extent to which the comparative advantage in Oregon grass seed production would be shifted to other areas, both domestically and globally, and (4) the degree to which consumers are willing to pay higher prices for scarcer amounts of grass seed. All other things being equal, an increase in the price of grass seed would apply pressure to increasing acres, not only in the Willamette Valley, but other regions as well. The extent to which this would occur in other regions is not known, but is capable of being investigated. On the consumer demand side, the price of grass seed probably would have to increase substantially before consumers would shift to substitute products, since cost of grass seed is a minor component of pasture and turf establishment.

BIBLIOGRAPHY

[1] Brandow, G. E. "Interrelations Among Demands for Farm Products and Implications for Control of Market Supply." Pennsylvania Agricultural Experiment Experiment Station Bulletin 680, August 1961.

[2] Conklin, Frank S., and Douglas E. Fisher. "Economic Characteristics of Farms Producing Grass Seed in Oregon's Willamette Valley." Oregon Agricultural Experiment Station Circular of Information 643, Corvallis, November 1973.

[3] George, P. S., and M. G. King. "Consumer Demand for Food Commodities in the United States with Projections for 1980." Giannini Foundation Monograph 26, University of California, Division of Agricultural Science, March 1971.

[4] Tomek, William G., and K. L. Robinson. Agricultural Product Prices. Cornell University Press, Ithaca, New York, 1972.

[5] U. S. Department of Agriculture. Agricultural Statistics. Washington, D.C., 1959-1977.

[6] U. S. Department of Agriculture, Foreign Agricultural Service. Foreign Agricultural Circular: Seeds. (FFVS), Washington, D.C., 1962-1977.

[7] U. S. Department of Agriculture, Foreign Agricultural Service. Foreign Crops and Markets; World Summaries Supplement. Washington, D.C., 1959-1977.

[8] U. S. Department of Agriculture, Foreign Agricultural Service. World Agricultural Production and Trade: Statistical Report. Washington, D.C., 1963-1977.

[9] U. S. Department of Agriculture. Livestock and Meat Statistics and Supplements. Statistical Bulletin No. 333, Washington, D.C., 1963-1977.

[10] U. S. Department of Commerce, Bureau of the Census. Statistical Abstract of the United States, Washington, D.C., 1959-1977.

[11] U. S. Department of Commerce, Weather Bureau. Local Climatological Data, Salem, Oregon, January 19, 1958 through December 1973.

[12] U. S. President. Economic Report of the President. Washington, D.C., 1978.

[13] Waugh, Fred. Demand and Price Analysis. Technical Bulletin 1316. U. S. Department of Agriculture, Washington, D.C., 1970.

[14] Wilson, W. Robert and Frank S. Conklin. "Supply and Disposition of Cool Season Grass Seed in U. S. and Overseas Markets." Oregon Agricultural Experiment Station Circular of Information 689, March 1981.

APPENDIX

Appendix Table 1. Calculated Quantities of Grass Seed Sold by U. S. Farmers by Seed Type, 1959-1976

Year	Fine Fescue	Bentgrass	Merion Kentucky Bluegrass	Other Kentucky Bluegrass	Tall Fescue	Orchard Grass	Annual Ryegrass	Perennial Ryegrass
	1,000 pounds							
1959	14,646	6,946	2,975	36,510	28,990	10,413	118,237	41,944
1960	16,074	4,973	3,219	28,427	35,750	13,301	113,217	43,679
1961	12,026	5,996	3,410	6,219	35,394	12,718	96,521	47,430
1962	14,281	6,280	4,101	9,369	28,302	15,837	126,767	55,339
1963	12,248	7,715	3,476	14,193	37,758	7,888	95,798	48,649
1964	13,471	9,699	3,354	19,458	59,466	14,704	118,755	56,849
1965	12,156	7,171	3,535	22,806	57,923	13,627	110,890	45,246
1966	12,940	8,390	5,038	30,047	74,790	9,976	117,170	41,973
1967	16,648	8,012	6,306	34,355	55,192	7,037	95,802	44,585
1968	12,327	6,884	4,692	33,893	56,526	6,534	123,820	42,358
1969	14,262	6,074	3,033	33,849	64,175	8,017	147,609	32,805
1970	13,629	7,364	3,400	36,687	78,842	8,650	166,312	37,428
1971	16,377	10,303	5,185	48,294	94,991	8,287	220,475	42,878
1972	13,447	9,418	4,963	46,411	90,455	18,790	204,896	34,738
1973	14,027	9,170	4,130	35,111	126,970	20,180	150,613	35,774
1974	11,872	7,857	2,979	48,002	101,106	14,967	182,341	42,136
1975	15,163	8,357	2,664	31,293	125,152	11,643	183,075	41,816
1976	12,140	7,343	1,783	43,789	90,814	11,689	203,851	35,726

SOURCE: Calculated from U. S. grass seed production and U. S. farm-level stocks in the following manner. To farmer stocks carried in from the previous year (Appendix, Table 7, Circular of Information 689) are added U. S. farm production (Appendix, Table 1, Circular of Information 689) and subtracted are farmer stocks on hand at the end of the year (Appendix, Table 7, Circular of Information 689).

Appendix Table 2. Calculated Quantities of Grass Seed Sold by U. S. Wholesalers by Seed Type, 1959-1976

Year	Fine fescue	Bentgrass	Merion Kentucky bluegrass	Other Kentucky bluegrass	Tall fescue	Orchard-grass	Annual ryegrass	Perennial ryegrass
1959	11,615	7,874	2,647	45,597	32,579	10,500	93,367	41,244
1960	7,461	5,776	2,670	19,674	29,808	13,976	120,294	43,404
1961	16,357	6,275	3,045	12,149	38,280	12,524	97,598	44,077
1962	17,946	6,158	4,071	9,983	30,659	15,099	131,263	54,231
1963	15,463	6,711	3,795	15,772	32,414	8,256	92,030	50,439
1964	15,259	9,183	3,094	21,438	56,869	12,737	115,687	60,658
1965	7,411	7,252	3,916	22,565	57,565	13,232	118,281	43,773
1966	13,986	9,076	3,878	28,246	67,015	8,876	115,010	44,699
1967	15,326	8,007	4,560	31,687	64,152	8,157	110,278	42,970
1968	12,906	7,097	5,822	32,315	60,968	6,608	120,860	36,658
1969	15,233	6,493	4,360	35,242	55,640	7,880	146,531	34,287
1970	13,314	7,191	3,862	38,394	79,587	8,273	158,835	40,532
1971	17,872	9,536	3,585	44,776	98,485	7,412	189,587	41,882
1972	15,619	9,237	5,542	44,301	90,351	18,475	218,289	35,030
1973	10,882	9,011	3,822	27,636	112,732	18,730	158,298	34,534
1974	12,408	8,450	3,612	42,870	122,954	15,558	184,883	41,991
1975	15,931	8,637	2,553	38,203	118,337	11,026	172,902	35,583
1976	8,480	7,513	2,780	44,499	105,984	13,149	213,947	39,531

SOURCE: Calculated from U. S. wholesaler purchases and U. S. wholesaler stocks in the following manner. To wholesaler stocks carried in from the previous year (Appendix Table 8, Circular of Information 689) are added wholesaler purchases which are assumed to be identical to farmer sales (Appendix Table 1) and subtracted are wholesaler stocks at the end of the year (Appendix Table 8, Circular of Information 689).

Appendix Table 3. Selected Demand Shift Variables for Cool Season Grass Seed in U.S. Retail Markets, 1959-1977

Year	Domestic new housing starts a/	Domestic per capita personal disposable income b/	Number of cattle in southeast U.S. c/	Number of cattle in selected foreign countries d/				Acreages on which R.E.A.P. payments made c/	
				Italy	Netherlands	Japan	Argentina	Establishing permanent cover	Improving permanent cover
	-1,000 units-	-1967 dollars-	--------1,000 head--------					----1,000 acres----	
1958	--	--	27,905	8,507	2,866	915	48,711	--	--
1959	1,553.5	1,904	27,794	8,992	3,015	3,118	40,733	2,462	1,713
1960	1,296.0	1,936	28,364	9,399	3,164	3,163	43,398	2,517	1,870
1961	1,365.0	1,982	29,093	9,845	3,228	3,198	43,200	2,834	1,954
1962	1,492.4	2,060	30,146	9,650	3,338	3,332	43,300	2,809	1,923
1963	1,642.0	2,136	31,139	9,189	3,521	3,482	40,112	2,775	2,002
1964	1,561.0	2,272	31,438	8,974	3,226	3,444	40,500	3,373	2,274
1965	1,509.0	2,430	32,771	9,226	3,317	2,175	45,000	5,064	5,606
1966	1,195.0	2,599	32,906	9,600	3,549	2,887	47,048	4,816	5,260
1967	1,321.9	2,745	33,581	9,700	3,633	2,928	51,227	5,358	5,381
1968	1,545.5	2,933	34,419	9,582	3,663	3,455	51,465	4,187	4,210
1969	1,499.6	3,097	35,697	10,067	3,768	3,458	52,000	3,970	4,036
1970	1,462.7	3,348	36,486	9,612	3,953	3,593	48,400	4,028	3,890
1971	2,085.0	3,589	36,830	8,776	3,850	3,615	49,786	2,219	3,623
1972	2,379.0	3,837	38,149	8,669	3,783	3,568	52,312	3,186	4,567
1973	2,057.5	4,292	40,632	8,738	4,117	3,569	54,771	1,697	2,662
1974	1,352.5	4,642	43,243	8,408	4,772	3,650	56,500	309	554
1975	1,171.4	5,039	47,562	8,243	4,754	3,525	58,000	1,066	2,041
1976	1,548.0	5,493	45,533	8,529	4,606	3,723	59,050	1,137	2,471
1977	--	6,010	43,910	8,900	4,523	3,875	58,350	--	--

Sources: a/ Economic Report of the President, 1978

b/ Statistical Abstracts of the United States, 1959-1977

c/ Agricultural Statistics, 1959-1977; States included are Florida, Georgia, South Carolina, North Carolina, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas.

d/ Agricultural Statistics, 1959-1977.

Appendix Table 4. Estimated Operating Costs Per Acre for Producing Selected Grass Seed Types in Willamette Valley of Oregon, 1959-1977

Year	Fine fescue	Bentgrass	Merion Kentucky bluegrass	Other Kentucky bluegrass	Tall fescue	Orchardgrass	Annual ryegrass	Perennial ryegrass
	dollars per acre							
1959	44.27	38.35	73.84	54.06	45.14	46.14	40.66	34.40
1960	44.91	39.40	74.31	54.72	45.59	46.69	41.31	34.81
1961	45.70	40.90	75.41	55.67	46.34	47.49	42.13	35.43
1962	46.05	40.38	75.42	55.98	46.48	47.76	42.47	35.62
1963	46.38	40.66	75.40	56.28	46.63	47.99	42.85	35.80
1964	36.80	41.02	75.43	56.67	46.84	48.32	43.32	36.06
1965	47.80	41.86	76.48	57.77	47.63	49.24	44.33	36.75
1966	49.02	42.90	77.43	59.05	48.49	50.32	45.60	37.55
1967	50.62	44.27	78.95	60.78	49.69	51.79	47.23	38.64
1968	51.52	45.01	78.32	61.49	49.87	52.36	48.36	39.07
1969	52.61	45.92	77.61	62.33	50.09	53.03	49.70	39.59
1970	55.37	48.30	81.33	67.23	52.59	55.71	52.37	41.61
1971	58.54	51.04	85.50	69.19	55.46	58.87	55.40	43.96
1972	61.48	53.57	88.45	72.44	57.82	61.59	58.35	46.03
1973	67.28	58.66	97.70	79.45	63.56	66.18	63.77	50.46
1974	92.84	82.65	151.38	112.55	94.30	97.76	90.92	73.56
1975	105.98	93.51	166.92	127.27	104.99	101.10	102.71	81.95
1976	105.59	92.00	152.15	124.54	99.53	105.84	100.11	79.21
1977	110.78	96.48	154.26	129.71	102.69	110.15	105.78	82.57
1978	116.65	101.41	158.04	135.89	106.72	115.21	111.92	86.45

Source: Data prepared from Conklin, Frank S., and Douglas E. Fisher. "Economic Characteristics of Farms Producing Grass Seed in Oregon's Willamette Valley," Oregon Agricultural Experiment Station Circular of Information 643, December 1973, for all the grass seed types except Merion Kentucky Bluegrass. For Merion Kentucky bluegrass, the data were prepared from Enterprise Data Sheet, "Merion Kentucky Bluegrass," Oregon State University Extension Farm Management and Linn County Extension Agent cooperating, 1969. Average yields. The 1969 operating costs for the Conklin-Fisher study were separated into labor, machinery, and fertilizer components. U.S. price indices for each component were used to estimate these costs each year for the 1959-1978 period from the 1969 data base. Each component was summed each year to obtain annual operating costs.