AN ABSTRACT OF THE THESIS OF

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Title: AN ECONOMIC ANALYSIS OF FARMS PRODUCING GRASS SEED IN THE WILLAMETTE VALLEY, WITH SPECIAL ATTENTION TO THE CULTURAL PRACTICE OF FIELD BURNING

Abstract approved: ______________________
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Grass seed producers in Oregon's Willamette Valley have employed the cultural practice of post-harvest open field burning since the mid-1940's for purposes of field sanitation and crop residue disposal This practice creates environmental quality problems of air pollution during the late summer Recent public concern over the valley's environmental quality has focused attention on the grass seed industry, resulting in measures passed by the 1971 state legislature to ban open field burning in Oregon by January 1, 1975.

Several economic issues are raised by the prospect of field burning curtailment. These include identification of: (1) alternatives to open burning, and their associated costs; (2) income effects resulting from possible increases in production costs, reduction in seed

yields and changes in seed quality; (3) possible loss of comparative advantage now enjoyed by Willamette Valley farmers; and, (4) possible organizational adjustments by farm operators including prospects for increased farm size and reduced farm numbers. This thesis is designed as a base study to provide descriptive information and an economic rationale as necessary precursors for evaluating possible and probable economic consequences of a burning ban to the grass seed industry. The Willamette Valley was separated into five seed-production regions, based on soil characteristics and urban influences. A ten percent random sample was drawn from the population of farm operators raising grass seed. Major grass seed types studied include Highland bentgrass, Kentucky bluegrass, fine fescue, tall fescue, orchard grass, annual ryegrass, and perennial ryegrass. Descriptive data includes farm family characteristics, income sources, age, family labor, farm organization, and resource returns.

Analysis of data identified wide variability in resource use. A significant component involved large differences in operating costs for machinery, labor, fertilizer, and chemicals within each seed type. This suggests internal adjustments in resource use efficiency and cost management are necessary for high-cost farms to survive in the short run regardless of whether or not a burning ban threat exists. Some farms are successfully competing now and will continue to do so with limited operating resource adjustments. Orchardgrass and Kentucky bluegrass generally provided highest net returns, while ryegrasses earned lowest returns of the seven seed types, suggesting some adjustment opportunities for substitution between seed types. Inter-enterprise adjustments will be determined by the number of grass seed crops, other non-grass crops, and livestock choices available. Cost advantages of complementary enterprises were evident, with adjustments in this direction determined by market accessibility, soil limitations, and managerial constraints. These limitations suggest limited adjustment, in general, toward non-grass and livestock enterprise choices.

Pronounced cost advantages occurred to farms over 300 acres in size, suggesting that long run adjustments will likely include farm enlargement and reduction of farm numbers. Farm location, topography, and proximity to urban areas are also expected to affect direction and magnitude of adjustments. Farms in Region 1, Clackamas and Multnomah counties, faced with topography limitations and urban pressures, will likely shift resources to more intensive farm and non-farm uses. Linn, Benton, and Lane county grass seed producers are expected to intensify specialization in grass seed production with an increase in average farm size. In Washington and Yamhill counties where grass seed production serves primarily as complementary and/or supplementary enterprises, the trend toward production of proprietary grass seed varieties is expected. In Polk and Marion counties where soil and topographical characteristics dominate resource use and enterprise choices, probable adjustment impacts are less obvious and are expected to vary widely from farm to farm.

Imposition of a burning ban, felt primarily in the form of increased production costs, will undoubtedly hasten the farm organizational adjustments specified above.

An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley, With Special Attention to the Cultural Practice of Field Burning

by

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CHAPTER I

INTRODUCTION

The Willamette Valley grass seed industry, like other segments of the agricultural scene in the United States, is not immune from the cost-price squeeze so characteristic of the competitive structure of American agriculture. To stay apace, each farmer competes with all other farmers to produce his output more economically. In doing so he chooses those cultural practices which lower unit production costs, increase production per unit of input, or both. In the production of grass seed, field burning is such a practice. Post-harvest burning of field residue from grass seed production accomplishes several culturally desirable benefits including residue removal, weed and disease control, and plant growth stimulation. All other technically feasible choices are more costly.

Field Burning History

The grass seed industry of Oregon began around 1935 with introduction of ryegrass for pasture and covercrop seed production and commercial acceptance of native highland bentgrass as a turf grass. Bentgrass, native to Western Oregon, was considered a serious weed grass to that time. The fescues were introduced some two years later (U.S.D.A. SRS., 1954). All of these grasses experienced dramatic acreage increases during the 1940's and 1950's as shown in Figure 1.

As seed yields increased with heavier applications of commercial fertilizers, residue or aftermath volume also increased. Unless removed the residue retarded plant growth and provided a medium for disease transmission from one year to the next. It was discovered quite accidentally in the early 1940's that field burning removed the undesirable crop residue, both quickly and cheaply. The practice expanded slowly at first because of suspected damage to perennial grasses. However, research in 1948 by Dr. John Hardison, USDA plant pathologist, Oregon State University, verified the significant role of burning for control of blind seed disease in ryegrass, nemotode in fine fescue, and several disease pathogens in all grasses (Hardison, 1965). With this documentary proof farmers quickly turned to open field burning. By 1950 burning in grass seed and small grain fields had become a widely adopted cultural practice and has continued its prominence to the present.

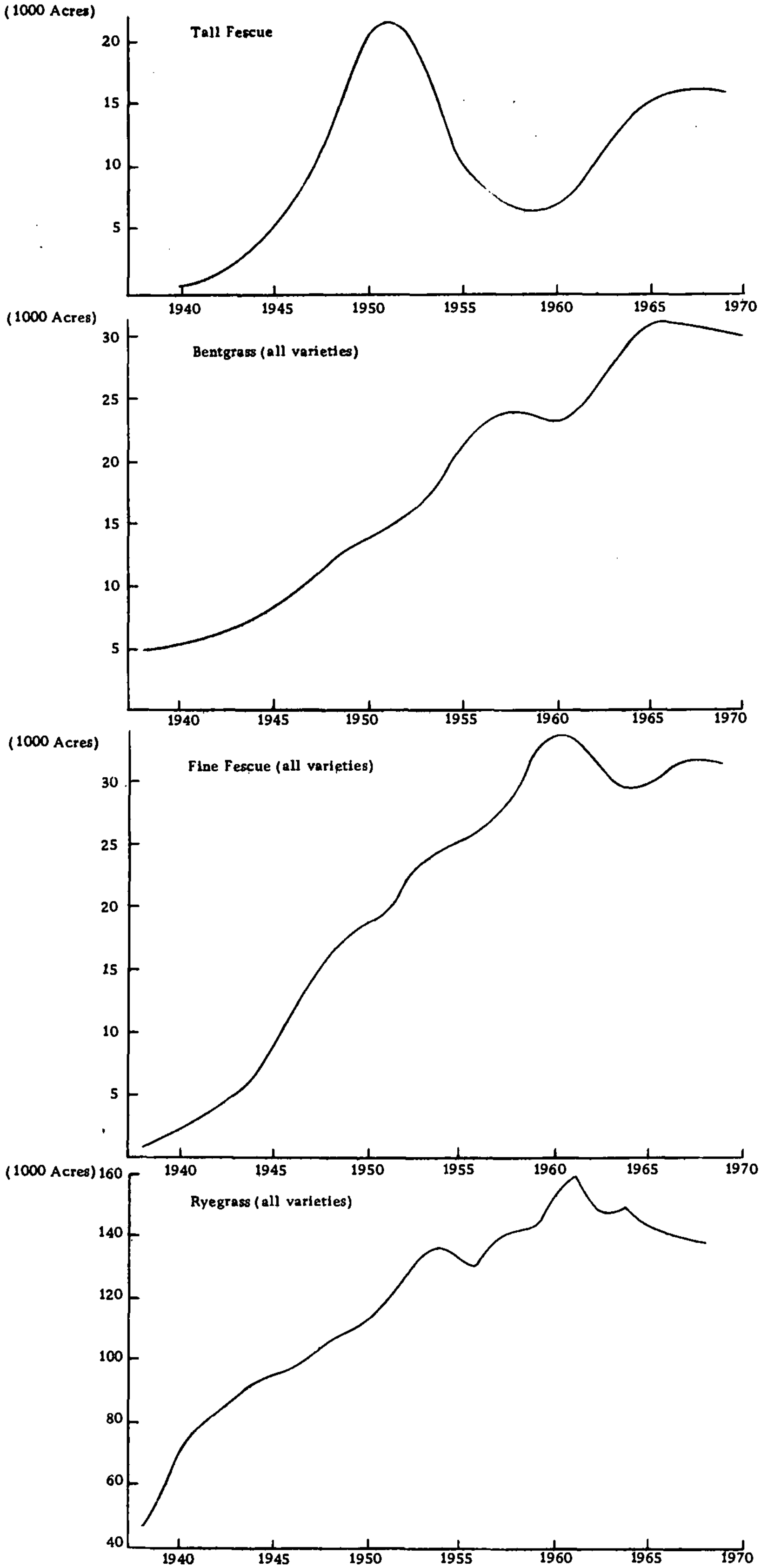

Figure 1. Grass seed acreage by year; Oregon; 5-year weighted average.

Further evidence suggests that field burning provides additional benefits, including (1) increased yields through reduced sod-binding effects, plant growth stimulation, and improved fertilizer efficiency; and (2) improved weed control through actual thermal damage to weed seeds and plants and increased effectiveness of herbicides (Air Resources Center, 1969).

The Burning Practice

Open field burning is conducted in July, August, and September of each year following grass seed harvest. Dry summers favoring seed maturation also produce dry, highly combustible aftermath and stubble, a necessary condition for effective burns. Fire control usually requires four to six men and three to five water tanks pulled by tractors. Crew size varies according to field size and the presence of nearby fire hazards including buildings, trees, and unburned fields. A plowed strip four to eight feet wide around the field is usually maintained as a fire break for safety. This strip is cultivated periodically to control vegetative growth.

Wind direction and velocity direct the burning operation. The fire is ignited on the leeward edge of the field and allowed to burn as a backfire (against the wind). When the backfire has burned a safe distance away from all hazards, the fire is carried around the field with a torch or pitchfork. Once the field is encircled with fire, the rising heat creates a draft which draws the fire together from all sides, completing the operation in a matter of minutes.

Whirlwinds and other unpredictable wind shifts constitute the primary danger when burning, necessitating constant patrol of the fire perimeter. The hazard is particularly acute when the backfire is started since a wind shift could easily make it the main burn often sweeping across a field with disastrous results. Although smoke dispersion is optimal when wind levels are fairly high, this paradoxically produces the most difficult conditions for controlling a burn.

The Grass Seed Industry Today

Grass seed production in Western Oregon is confined almost entirely to the Willamette River basin (Middlemiss and Coppedge, 1970). The valley enjoys an economic advantage over most areas of the world due to ideal climatic conditions for seed development. Grass growth is prompted by consistently mild temperatures and wet falls, winters, and springs. Summers which are usually dry permit seed development, maturation and harvest without danger of destroying seed viability.

The Willamette River basin extends from the Eugene-Springfield metropolitan area northward along the Willamette River to Portland. The valley's width increases from less than ten miles at its southern extremity near Eugene to 40 miles at its northern end near the city of Portland. The valley is bounded on the east by the Cascade Mountains and on the west by the Coast Range. Portions of nine counties -- Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill are contained within the geographical boundaries of the basin. An Oregon map showing the locations of the nine counties and the relative positions of the Willamette Valley seed producing areas in those counties is presented in Figure 2.

Estimated grass seed acreage in the Willamette Valley in recent years has ranged from 231,000 acres in 1968 to 260,000 in 1970. All but some 6,000 acres of the total consists of seven major seed types: highland bentgrass, Kentucky bluegrass, fine fescue, tall fescue, orchardgrass, annual ryegrass, and perennial ryegrass. The valley produces essentially all U. S. grown ryegrass seed, 90 to 95 per cent of bentgrass and fine fescue seeds, 40 to 50 per cent of orchardgrass seed, and 10 to 25 per cent of Kentucky bluegrass and tall fescue seed. The remaining 6,000 acres contain varying quantities of Merion bluegrass, wheatgrass, bromegrass, and sudan grass.

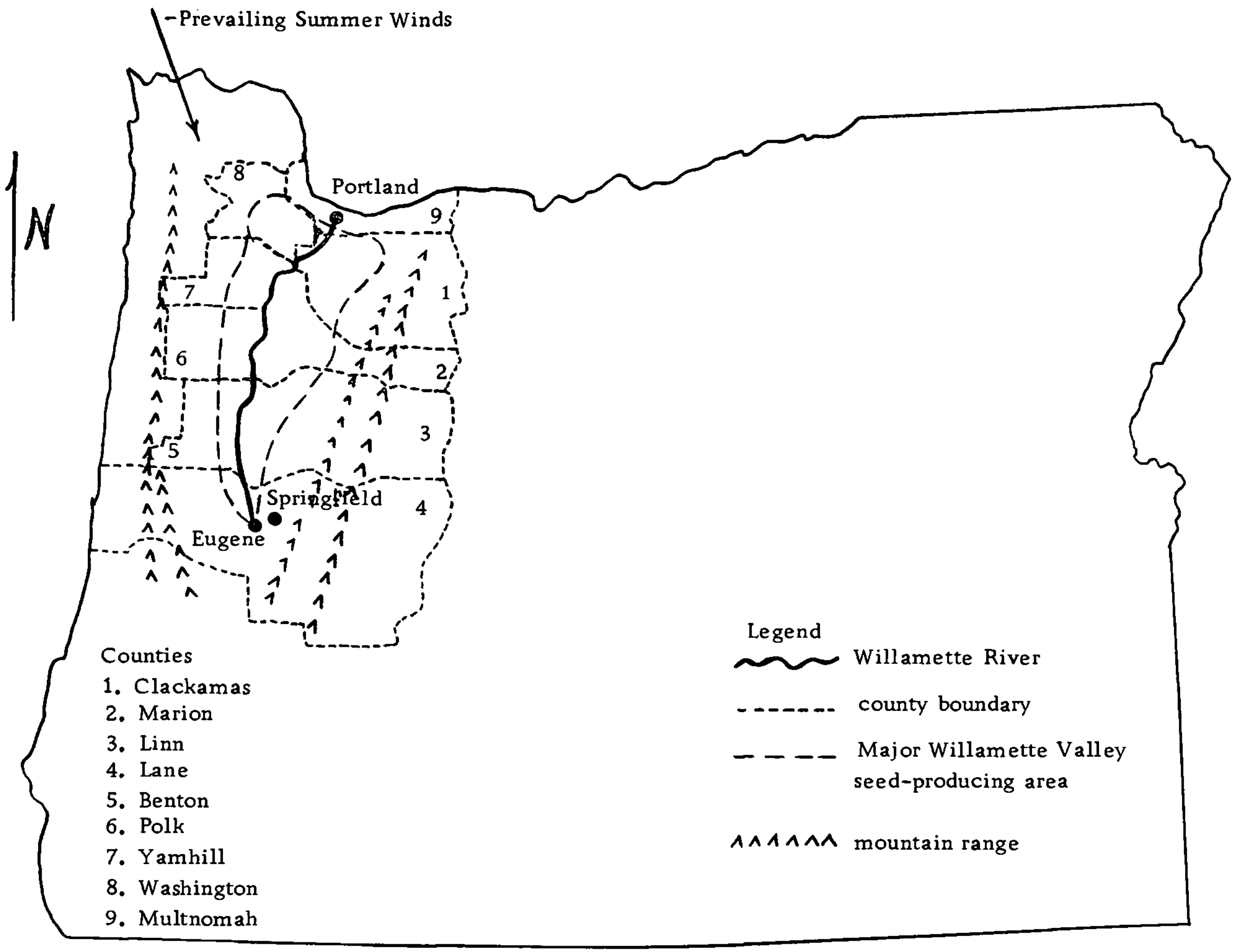

Figure 2. Geographic characteristics of the grass seed area of Western Oregon.

Willamette Valley acreage statistics are shown in Table 1. Annual and perennial ryegrass accounted for nearly 60 per cent of total acreage with fine fescues and bentgrasses in distant second and third positions respectively.

Distribution of grass acreage by seed type and county location for 1969 is shown in Table 2. Linn county contained some 60 per cent of total valley acreage devoted to grass seed. Benton, Lane, Marion, and Polk were also major grass seed producing counties.

In value of total grass seed sales in the valley by seed type, annual and perennial ryegrass account for some 56 per cent, as shown in Table 3. Bentgrass, bluegrass, fine fescue, and orchardgrass each account for around ten per cent. Nearly 50 per cent of grass seed sales originated from Linn county, as shown in Table 4. Marion county followed a distant second with 12 per cent.

Significance of grass seed production to land use in the Willamette Valley[1] is illustrated in Table 5. In Linn County, grass seeds were by far the most important farm enterprises in terms of land use. Nearly 131,000 acres or 67 per cent of total harvested cropland produced grass seed. Tables 2 and 5 point out that grass seeds are not major farm enterprises in Multnomah, Washington and Yamhill counties.

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[1] Land use data provided by the 1969 Census of Agriculture.

Table 1. Willamette Valley grass seed acreage by major seed type, 1968-70.

Seed Type	Acreage			Percentage of total by seed type		
	1968	1969	1970[1]	1968	1969	1970
Bentgrass[2]	23, 360	28, 450	29, 500	10. 0	11. 5	11. 3
Bluegrass[3]	13, 500	13, 280	12, 050	5. 8	5. 4	4. 6
Fine Fescue[4]	28, 480	29, 300	28, 570	12. 3	11. 8	11. 0
Orchardgrass	8, 600	11, 300	13, 550	3. 7	4. 6	5. 2
Tall Fescue	15, 425	15, 920	16, 500	6. 7	6. 4	6. 4
Ryegrass[5]	134, 000	149, 000	160, 000	58. 0	60. 3	61. 5
All other grasses grown for seed	8, 105	n. a.	n. a.	3. 5	n. a.	n. a.
TOTAL	231, 470	247, 250[6]	260, 170[6]	100. 0	100. 0[6]	100. 0[6]

Source: Cooperative Extension Service, Oregon State University, Corvallis, and the Oregon Crop and Livestock Reporting Service, USDA, Portland, cooperating.

[1] Preliminary estimates

[2] Includes all bentgrasses with Highland being the principal type.

[3] Includes all bluegrasses with Merion Kentucky and other Kentucky bluegrasses being the principal types.

[4] Includes all fine fescues with creeping red and chewings being the principal types.

[5] Includes both annual and perennial ryegrass.

[6] Includes only major grass seed types since statistical data for 1969 and 1970 was not available for the minor grasses grown for seed.

Table 2. Grass seed acreage by major seed type and county location, Willamette Valley, 1969[1].

Seed Type	Benton	Clackamas	Lane	Linn	Marion	Polk	Yamhill	Washington	Total
Bentgrass	2,400	---	540	3,900	19,400	200	1,900	110	28,450
Bluegrass	650	700	300	10,000	1,000	150	330	150	13,280
Fine Fescue	900	8,000	500	2,300	15,400	1,200	900	100	29,300
Orchardgrass	3,750	200	1,250	4,100	1,000	800	200	---	11,300
Tall Fescue	2,200	850	2,200	8,000	1,700	800	---	170	15,920
Ryegrasses	12,700	100	12,500	106,900	4,200	9,600	2,750	250	149,000
TOTAL	22,600	9,850	17,290	135,200	42,700	12,750	6,080	780	247,250

SOURCE: Estimates by Cooperative Extension Service, Oregon State University, Corvallis and Oregon Crop Reporting Service, USDA, Portland.

[1] Very small acreage levels precluded reporting of data for Multnomah County.

Table 3. Farm price and value of farm sales by major seed types for Willamette Valley, 1968 and 1969.

Seed Type	Average Farm Price per cwt			Value of Farm Sales: Dollars (1,000)		Value of Farm Sales: Percent by Seed Type	
	1968	1969	1970[1]	1968	1969[1]	1968	1969
Bentgrass[2]	34.20[2]	50.00[2]	47.00[2]	1,912	2,457	8.5	9.3
Kentucky Bluegrass	28.50	27.00	30.00	2,374	1,796	10.3	6.8
Fine Fescue	21.50	24.50	34.00	2,424	3,101	11.0	11.8
Orchardgrass	26.75	25.80	25.20	1,925	2,421	8.3	9.2
Tall Fescue	13.50	18.50	13.00	1,230	2,006	5.3	7.6
Annual Ryegrass	6.93	7.30	5.70	8,643	10,262	37.7	39.2
Perennial Ryegrass	10.59	11.50	10.40	4,382	4,225	19.0	16.1
TOTAL				22,890	26,268	100.0	100.0

SOURCE: Estimates by Cooperative Extension Service, Oregon State University, Corvallis and Oregon Crop Reporting Service, USDA, Portland.

[1] Preliminary estimates.

[2] Price includes Astoria and Seaside bentgrasses grown in coastal areas. Farm prices of these varieties are substantially higher than that of Highland bentgrass grown in the Willamette Valley.

Table 4. Value of sales by county for grass seed grown in the Willamette Valley, 1968.

	Acreage	Production 1,000 lbs.	Value $1,000	Value Percent
Oregon	250,207	215,994	$26,136	100.0
Willamette Valley Counties[1]				
Linn	130,760	141,056	13,024	49.8
Marion	41,300	15,051	3,190	12.2
Benton	15,275	14,852	2,272	8.7
Lane	16,850	15,801	1,567	6.0
Clackamas	9,465	4,253	909	3.5
Polk	11,070	10,101	876	3.4
Yamhill	6,295	3,788	527	2.0
Washington	455	208	43	---
VALLEY TOTAL	231,470	204,110	$22,408	85.7

SOURCE: Middlemiss, Willis E. and Coppedge, Robert O., "Oregon's Grass and Legume Seed Industry in Economic Perspective", Special Report 284. Cooperative Extension Service, Oregon State University, Corvallis, April 1970.

[1] Data for Multnomah County was not separated from state totals.

Table 5. Willamette Valley farms and farmland by county, 1964 and 1969.

County	Farmland Acreage[2]		Total Harvested Cropland[2]		Grass Seed Acreage[3]	Percent of Harvested Cropland Devoted to Grass Seed
	1964	1969	1964	1969	1969	1969
Benton	207633	129034	51232	50814	22600	44
Clackamas	261812	210055	83245	67634	9850	15
Lane[1]	416195	270587	86506	79403	17290	22
Linn	467276	374826	207413	203321	135200	67
Marion	333624	302065	172684	159575	42700	27
Multnomah	66728	70792	19433	16989	n. a.	--
Polk	215054	213108	102505	99763	12750	13
Washington	200343	172055	99313	92525	780	1
Yamhill	254970	227555	108822	94128	6080	6

[1] A majority of Lane County farms are outside the area defined as the Willamette Valley.

[2] Obtained from Bureau of the Census, 1964 Census of Agriculture, Vol. 1, part 47, and 1969 Census of Agriculture, preliminary reports. Department of Commerce, Washington, D. C., 1967 and 1971.

[3] Estimates by Cooperative Extension Service, Oregon State University, Corvallis, and Oregon Crop Reporting Service, USDA, Portland.

Knowledge of topography and soil characteristics is useful in explaining the wide variation of crop and livestock enterprises produced in the Willamette Valley and the role of grass seed production in it. In Marion County over 150 different crop enterprises are produced each year. Vegetables and fruits including green beans, sweet corn, strawberries, cane berries, and cherries predominated on the fertile, well-drained river bottom soils. Dryland hill areas are devoted extensively to the production of highland bentgrass and fine fescue grasses.

Between the well-drained river bottom soils and hill soils are thousands of acres of bench land which contain soils comparable in quality to the river bottom soils except for inclusion of an impermeable hardpan some 16 to 24 inches below the surface which severely restricts drainage. These soils are primarily of the Amity and Dayton soil series and commonly referred to as "Whiteland Soils". High water table during winter months makes these soils unsuitable for cultivation of most crops unless drainage systems are installed. Ryegrass is one of the few crops which tolerate the adverse winter conditions. Cool moist springs and dry summers favor their seed development and maturation.

Tall fescue, orchardgrass, and bluegrass, are not as tolerant to "Whiteland" soil conditions as the ryegrasses and are generally grown on the better-drained bench soils of the Woodburn series.

CHAPTER II

THE PROBLEM

An estimated 230,000 acres of grass residue and stubble are burned annually in the Willamette Valley as a post-harvest cultural practice. Straw residues range from 1.5 tons per acre on bentgrass, fine fescue, and bluegrass to as much as seven tons per acre on annual ryegrass. With an estimated average residue yield of 3.8 tons per acre, the volume of residue burned approaches one million tons annually. An extended rainy spring season in 1971 produced substantially higher average residue levels.

It has become apparent in recent years that consequences of field burning are not all beneficial, as a 1969 statement from the Air Resources Center, Oregon State University, indicates:

> Field burning involves major side effects in the form of air pollution. Like pollution generally, these side effects are passed on to others -- in this instance, in the form of visibility loss, soiling and other damage to property, and a possible factor in harm to health. (Air Resources Center, 1969).

Residents of the Willamette Valley are exposed to the smoke produced by field burning each summer. The pollution problem is aggravated by meteorological and geological characteristics of the Willamette Valley. The Cascade Mountains and the Coast Range bound the valley on the east and west, respectively. These ranges form effective barriers which retain air currents within the valley. The southern boundary is a series of foothills which form a semicircle around the east, south, and west sides of the Eugene-Springfield area. This metropolitan area has been described as a "catcher's mitt" for the prevailing north-northwesterly air currents through the Willamette Valley during the summer months when field burning occurs, as shown by the map in Figure 2. During the burning season, winds are from the north-northwest approximately 90 per cent of the time.

Meteorological conditions in summer favor development of temperature inversion layers characterized by stratified air currents with very little mixing of upper and lower levels. Smoke rises only a few hundred feet, is retained at that elevation by the inversion, pushed by the prevailing winds to the southern end of the valley, and contained by foothills and the Cascade Range to ultimately settle upon the Eugene-Springfield metropolitan area of some 100,000 inhabitants. These people have been the principal recipients of air pollution from Willamette Valley field burning.

Although field burning contributes but 17 per cent of air pollutant emission annually in Oregon, its concentration in July, August and September in the Willamette Valley makes its presence obvious to the most casual observer. Visibility recorded at Mahlon-Sweet airport outside Eugene dipped below six miles for at least one hour on 18 days between July 16 and September 21 in 1969 (Oregon, DEQ, 1970), and to 200 feet at times. The smoke intensity on many of these days reached a level within Eugene sufficient to cause stinging of the eyes, a condition similar to that experienced from smog in Los Angeles. Such conditions are not taken lightly by Oregonians who boast of "livability", "clean environment", and "views of distant mountains". Over 4,000 complaints were registered against field burning during the summer of 1969. Visibility loss was the most frequently-mentioned complaint (Oregon, DEQ, 1969).

Serious problems of driver visibility occur when fields adjacent to highways are burned. This is particularly true with heavily-trafficked Interstate Freeway I-5, which runs north-south through the heart of the valley. At least two deaths on Oregon highways have been attributed to the smoke hazard.

Another frequently-mentioned characteristic of smoke is its hazard to human health. A cursory study by several doctors in the Eugene area during the late summer of 1969 when most field burning was being conducted indicated an increase in office calls from patients with respiratory problems when visibility was at low levels (Service, 1970). Results of the study were inconclusive since comparisons with atmospheric conditions throughout the year were not made.

Field Burning Regulations

Increasing concentration and magnitude of smoke emissions have made field burning a primary target for public efforts toward its regulation in recent years. Prior to 1969 a farmer wishing to burn could obtain a permit merely by phoning his local fire district official and agreeing to meet specified manpower and water supply standards.

The 1969 state legislature granted the State Department of Environmental Quality (DEQ) jurisdiction over field burning, but provided no funds for control and enforcement of regulations (Conklin, 1970). On August 12, 1969, dubbed "Black Tuesday" by Eugene residents, a heavy burn, a low inversion layer, and a strong northwesterly wind combined to produce an oppressive smoke condition in Eugene. Burning was banned by Governor McCall for seven days.

After the seven-day ban, burning was restricted by the Department of Environmental Quality to days when meteorological conditions were favorable for smoke dispersion. Acreage limitations were established for each fire district to control the amount burned each day. The DEQ authorized deviations from the schedule, such as allowing a double acreage quota to be burned when meteorological conditions were unusually favorable.

In 1970, more detailed acreage quotas were established, based on the total acreage to be burned within each district. Whether or not any burning was allowed depended on various meteorological conditions each day, as in 1969. Smoke dispersal predictions proved to be more reliable in 1970, due to the previous year's research and experience. Farmers in the southern portion of the valley were allowed to burn only when a southerly wind prevailed, in order to keep the city of Eugene smoke-free. Burning in the northern portion was allowed only when northerly winds prevailed, to protect Portland. Priority areas were established around cities of 3,000 population or more, and areas within one-fourth mile of a major highway. Fields in these priority areas could be burned only when the wind would carry smoke away from the city or road concerned.

As a result of these new regulations, residents of the eastern mid-valley were burdened with smoke to a greater degree in 1970 than in previous years, and residents of Eugene-Springfield to a lesser degree, due to the usual westerly tendency of both north and south winds in the valley. Unfortunately, smoke-shifting from one portion of the valley to another appears to be an unacceptable solution since relatively heavy urban population densities exist throughout the valley.

Due to the biennial nature of Oregon's state legislature, the 1971 session was the first since the smoke crisis of 1969. Increased public awareness of problems caused by air pollution plus the unique elements of visibility and health have led the 1971 state legislature to declare a phased reduction of field burning, with a complete ban by January 1, 1975.

CHAPTER III

OBJECTIVES

The projected ban on open field burning raises economic questions regarding its possible effect upon grass seed producers. These include: (1) Will some grass seed farmers be forced by economic conditions to change their farm organization, and if so what would be the nature of these changes and their impact upon the economic well-being of the grass industry? (2) Would some producers leave the industry as a result of more stringent burning regulations? If so, which farmers and how many would leave, and how long would the necessary adjustment period be? What impacts would such exits have on the aggregate production of the valley's seed industry? Would the various grass seed types be affected equally and if not, why? (3) What technically feasible alternatives exist for residue disposal, field sanitation, seedbed preparation, and yield maintenance, and what costs are associated with these alternatives? (4) Field burning stimulates seed yield and improves seed quality through disease and weed control and reduced sod-binding effects. How would changes in yield and seed quality as a consequence of shifting away from field burning be manifested in the income structure of farms? (5) How would changes in the cost structure of producing grass seed affect the comparative advantage in grass seed production now enjoyed by Willamette Valley producers? This advantage is being challenged by increased world seed production and more stringent import marketing regulations in Western Europe.

The Thesis Problem

There are two basic objectives of this study. The first is to identify and describe physical and economic characteristics of farms which produce grass seed in the Willamette Valley. This requires a determination of principal factors which influence profitability and resource use among grass seed growers.

The second objective is to use information acquired under Objective One to establish benchmarks of profitability for existing grass seed operations.

A specification of current conditions on farms is prerequisite to describing possible consequences of a burning ban. It is this need for descriptive analysis at the farm level which this research attempts to meet.

CHAPTER IV

RESEARCH METHODOLOGY

Economic theory provides clues to the explanation of real-world phenomena. It has been stated, "The heart of economic research is economic theory," (Madden, 1967, p. 2). Examination of theory prior to research analysis serves not only to direct empirical efforts in a meaningful direction but alsotö stimulate rigor in the analysis and to provide a basis for interpreting results.

This chapter includes an examination of literature which discusses farm profitability and resource use. Both theoretical and empirical considerations are presented. The chapter concludes with an outline of analytical methods used in this study including sampling procedure and data collection requirements.

Production and Cost Theory

Neoclassical theory of the firm, refined by recent developments, suggests several factors which influence efficiency and profitability of farm operations. These include: (1) resource organization, (2) cost structure, (3) level of resource utilization, (4) farm size, and (5) managerial objectives. Discussion of these factors is developed by examining basic production and cost theory, then refining the theory by presentation of empirical evidence pertaining to agriculture.

Neoclassical theory of the firm contains the following fundamental postulates: (1) rational behavior; the firm operator attempts to optimize by maximizing output at a given cost or resource level ; or minimizing costs for a given output or income level, (2) several factors of production are available which can be combined in varying proportions, or input combinations, to produce varying levels of output, and (3) due to economic scarcity, products or output can be sold for a positive price.

Technical relationships between various input quantities and resulting output levels are specified by a production function:

$$Y = f(x_1, x_2, \ldots, x_n).$$

Output, denoted by Y, is a function of inputs represented by x_1, x_2, ..., x_n, of which there are n in number.

The nature and form of the production function is determined by the nature and combination of factor inputs. Existence of at least one fixed factor or input assures that certain characteristics of diminishing returns will exist. With some inputs at constant levels, initial additions of variable inputs may produce increasing marginal output, but eventually the factors held constant become limiting so that additional input units will produce decreasing marginal output, as illustrated in Figure 3.

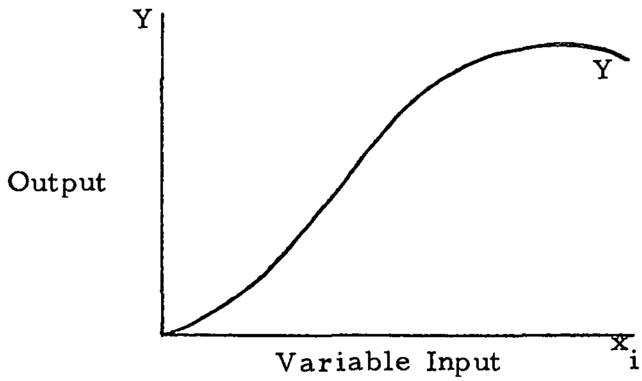

FIGURE 3. A Production Function, Assuming Some Fixed Inputs

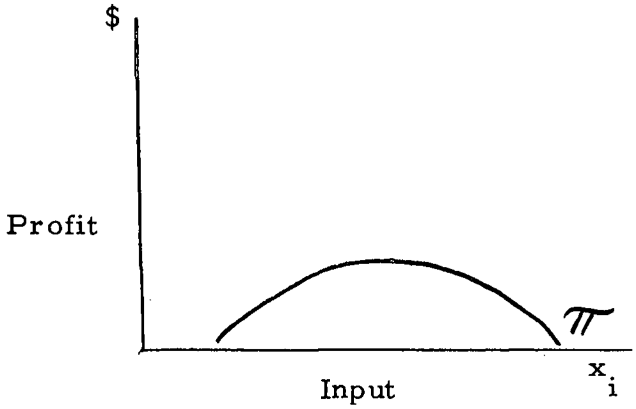

FIGURE 4. The Profit Function in the Input Space.

The production function, product price, and input prices are combined to yield a profit function:

$$\text{CASE 1} \quad \pi(x_1, x_2, \ldots x_n) = P_y\, f(x_1, x_2, \ldots x_n) - \sum_{i=1}^{n} P_{x_i} x_i$$

The profit function is expressed graphically in Figure 4.

Optimization of the profit function with unlimited capital in the input space involves setting each partial derivative equal to zero to assure an extremum. These are represented as shown:

$$\frac{\partial \pi}{\partial x_1} = P_Y \frac{\partial f}{\partial x_1} - P_{x_1} = 0$$

$$\frac{\partial \pi}{\partial x_2} = P_Y \frac{\partial f}{\partial x_2} - P_{x_2} = 0$$

$$\cdot \qquad \cdot \qquad \cdot$$

$$\frac{\partial \pi}{\partial x_n} = P_Y \frac{\partial f}{\partial x_n} - P_{x_n} = 0$$

$$\therefore \quad P_Y \frac{\partial f}{\partial x_i} = P_{x_i}$$

This states that the marginal productivities of each x_i ($\frac{\partial f}{\partial x_i}$) multiplied by the price of the product (P_Y), or VMP, must be equal to the factor cost P_{x_i} as a necessary condition for profit maximization. It follows that the ratio of VMP for each x_i relative to its price P_{x_i} must be equal for all x_i, and the entire identity is equal to unity with unlimited capital.

$$\frac{P_Y \frac{\partial f}{\partial x_i}}{P_{x_1}} = \frac{P_Y \frac{\partial f}{\partial x_2}}{P_{x_2}} = \ldots. = \frac{\frac{P_Y \partial f}{\partial x_n}}{P_{x_n}} = 1$$

The sufficiency condition for profit maximization insures that the extremum for the profit function is a maximum. This requires that principal minors of the related Hessian determinant alternate in sign:

$$\frac{\partial^2 \pi}{\partial x_i^2} < 0 \; ; \quad \begin{vmatrix} \frac{\partial^2 \pi}{\partial x_i^2} & \frac{\partial^2 \pi}{\partial x_i \, x_j} \\ \frac{\partial^2 \pi}{\partial x_j \, x_i} & \frac{\partial^2 \pi}{\partial x_j^2} \end{vmatrix} > 0 \, , \quad \text{etc.}$$

For the constrained optimization case of limited capital in the input space, the equations are limited by the amount of capital available, designated as C^o. The profit equation becomes:

$$\text{CASE 2:} \; \pi \, (x_1, x_2, \ldots, x_n) =$$

$$P_Y f(x_1, x_2, \ldots, x_n) - \mu(C^o - \sum_{i=1}^{n} P_{x_i} x_i)$$

Optimizing the constrained profit function involves setting each partial derivative equal to zero to assure an extremum, with the additional condition that C^o must not be exceeded.

$$\frac{\partial \pi}{\partial x_1} = P_Y \frac{\partial f}{\partial x_1} - \mu P_{x_1} = 0$$

$$\frac{\partial \pi}{\partial x_2} = P_Y \frac{\partial f}{\partial x_2} - \mu P_{x_2} = 0$$

$$\cdot \qquad \cdot \qquad \cdot$$

$$\frac{\partial \pi}{\partial x_n} = P_Y \frac{\partial f}{\partial x_n} - \mu P_{x_n} = 0$$

$$\frac{\partial \pi}{\partial \mu} = C^o - \sum_{i=1}^{n} P_{x_i} x_i = 0$$

$$\therefore \quad P_Y \frac{\partial f}{\partial x_i} = \mu P_{x_i}$$

It follows that the marginal physical product of each x_i multiplied by the product price P_Y, or VMP, must be equal to the factor price P_{x_i} for all x_i, and that the identity is equal to μ with limited capital.

$$\frac{P_Y \frac{\partial f}{\partial x_1}}{P_{x_1}} = \frac{P_Y \frac{\partial f}{\partial x_2}}{P_{x_2}} = \ldots = \frac{P_Y \frac{\partial f}{\partial x_n}}{P_{x_n}} = \mu$$

The sufficiency condition for constrained profit maximization to assure a maximumum requires that the bordered Hessian determinants alternate in sign:

$$(-1)^n \begin{vmatrix} f_{11} & f_{12} \cdots & f_{1n} & - & P_1 \\ \vdots & \vdots & \vdots & & \vdots \\ f_{n1} & f_{n2} \cdots & f_{nn} & - & P_n \\ -p_1 & -p_2 \cdots & -p_n & - & 0 \end{vmatrix} > 0.$$

Similar procedures are used in determining optimum product combinations when producing two or more products. In the one input and m product case the profit equation becomes:

CASE 3: $\pi (Y_1, Y_2, \ldots, Y_m) =$

$$\sum_{i=1}^{m} P_Y Y_i - P_x f(Y_1, Y_2, \ldots, Ym)$$

shown graphically in Figure 5, in which Y_i's represent the products, x the input and P_{Y_i}'s and P_x the respective unit prices. Optimization of the unconstrained profit equation produces:

$$\frac{\partial \pi}{\partial Y_1} = P_{Y_1} - P_x \frac{\partial f}{\partial Y_1} = 0$$

$$\frac{\partial \pi}{\partial Y_2} = P_{Y_2} - P_x \frac{\partial f}{\partial Y_2} = 0$$

$$\frac{\partial \pi}{\partial Y_m} = P_{Y_m} - P_x \frac{\partial f}{\partial Y_m} = 0$$

$$\therefore \quad P_{Y_i} = P_x \frac{\partial f}{\partial Y_i}$$

It follows that the incremental cost of adding more product ($P_x \frac{\partial f}{\partial Y_i}$)

for each Y_i must be equal to its price P_{Y_i} for each product. Sufficiency or second order condition for maximization requires that the bordered Hessian determinants alternate in sign:

$$(-1)^m \begin{vmatrix} f_{11} & f_{12} & \cdots & f_{1m} & f_1 \\ f_{21} & f_{22} & \cdots & f_{2m} & f_2 \\ \vdots & & & \vdots & \vdots \\ f_{m1} & f_{m2} & \cdots & f_{mm} & f_m \\ f_1 & f_2 & \cdots & f_m & 0 \end{vmatrix} > 0$$

For the constrained maximum in optimum product combinations with limited capital, the profit equation becomes:

$$\text{CASE 4: } \pi (Y_1, Y_2, \ldots, Y_m, \mu) = \sum_{i=1}^{m} P_{Y_i} Y_i + \mu [C^o - P_x f(Y_1, Y_2, \ldots, Y_m)].$$

Optimizing the constrained profit function produces:

$$\frac{\partial \pi}{\partial Y_1} = P_{Y_1} - \mu P_x \frac{\partial f}{\partial Y_1} = 0$$

$$\frac{\partial \pi}{\partial Y_2} = P_{Y_2} - \mu P_x \frac{\partial f}{\partial Y_2} = 0$$

$$\cdot \qquad \cdot \qquad \cdots$$

$$\frac{\partial \pi}{\partial Y_m} = P_{Y_m} - \mu P_x \frac{\partial f}{\partial Y_m} = 0$$

$$\frac{\partial \pi}{\partial \mu} = C^o - P_x f(Y_1, Y_2, \ldots, Y_m) = 0$$

$$\therefore \; P_{Y_i} = \mu P_x \frac{\partial f}{\partial Y_i}$$

It follows that the ratios of the marginal costs of producing another unit of Y_i ($P_x \frac{\partial f}{\partial Y_i}$) relative to their prices P_{Y_i} are equal for all Y_i's, and that the entire identity is equal to μ under a constrained maxima.

$$\frac{P_{Y_1}}{P_x \frac{\partial f}{\partial Y_1}} = \frac{P_{Y_2}}{P_x \frac{\partial f}{\partial Y_2}} = \dots = \frac{P_{Y_m}}{P_x \frac{\partial f}{\partial Y_m}} = \mu$$

Second order conditions require the related bordered Hessian determinants alternate in sign, insuring a maxima:

$$(-1)^m \begin{vmatrix} -\mu f_{11} & -\mu f_{12} & \dots & -\mu f_{1m} & -f_1 \\ -\mu f_{m1} & -\mu f_{m2} & \dots & -\mu f_{mm} & -f_m \\ -f_m & -f_2 & \dots & -f_m & 0 \end{vmatrix} > 0.$$

All the optimization procedures above (see Henderson and Quandt, 1971, pgs. 63-75) can be generalized to any number of inputs and outputs by stating the production function in implicit form:

$$F\ (Y_1, Y_2, \dots, Y_m, x_1, x_2, \dots x_n) = 0\ ,$$

with the Y_i's being positive output levels and the x_j's being negative input levels. Resulting optimization procedures yield marginal conditions identical to those described above.

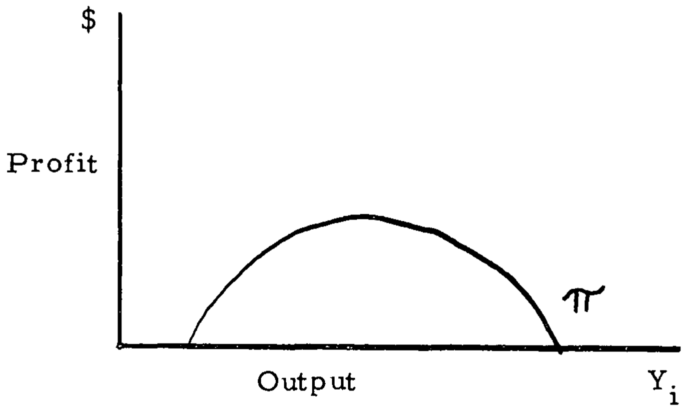

FIGURE 5. The Profit Function in the Output Space.

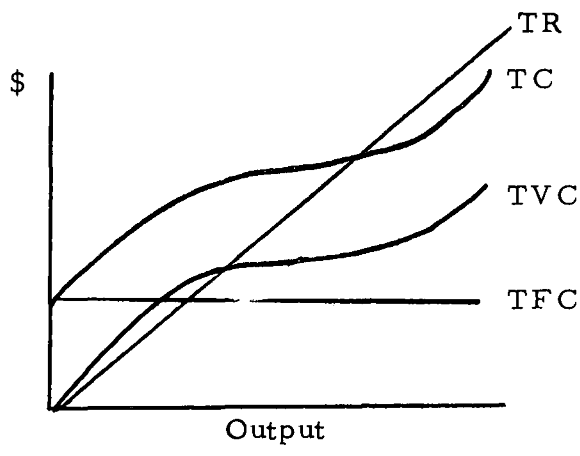

FIGURE 6. Components of the Profit Function in the Output Space.

COST CHARACTERISTICS OF THE FIRM

Profit functions in the output space (see Cases 3 and 4) are composed of two elements -- revenue and costs. Revenue ($\sum_{i=1}^{m} P_{Y_i} Y_i$) is determined by output (generated from the production function) and product price, yielding a linear total revenue function demonstrated graphically by TR in Figure 6. Costs contain variable and fixed components as determined by the conceptual time framework in which production occurs. Costs shown in Cases 3 and 4 are represented by the $P_x f(Y_1, Y_2, \ldots, Y_m)$ portion of the equations. Only variable costs are included. The total variable cost component is shown graphically as TVC in Figure 6.

Theory identifies three conceptual time periods - the market period, the short run, and the long run. Within the market period, input and product supplies are fixed. Decision-making concerns only marketing decisions since production has been completed. All production costs have been incurred and are termed fixed costs.

The short run is a period within which some inputs are variable and some inputs are fixed. The long run is a conceptual period during which all inputs or resources can be changed to attain various production levels, hence all costs are variable costs.

In the short run, the fixed bundle of inputs represents a fixed cost component which does not change as production level varies during the relevant production period. Total fixed costs are shown graphically as TFC in Figure 6.

Summation of total variable and total fixed costs results in total costs indicated as TC in Figure 6. The nature of the production function, as an important component of the TVC curve, and the magnitude of total fixed costs determine the nature and form of the total cost curve.

In cost theory, for convenience, these total cost relationships are usually expressed as average costs per unit of output, where output Y is the independent variable. Average costs are separated into average variable, average fixed, average total, and marginal cost components.

Average fixed costs are a decreasing function of output (mathematically a rectangular hyperbola) since a constant value of total fixed cost is divided by an ever-increasing value of output, as shown by AFC in Figure 7. Average variable cost characteristics are dependent upon the character of the production function but appear as a dish-shaped curve if the attributes of a classic production function are assumed, i. e., increasing, decreasing, and negative marginal physical products are exhibited.

Average total production costs are the summation of average variable and average fixed costs, as shown by ATC in Figure 7. Characteristics of average total costs are determined by respective proportions and magnitude of AVC and AFC. Average long run

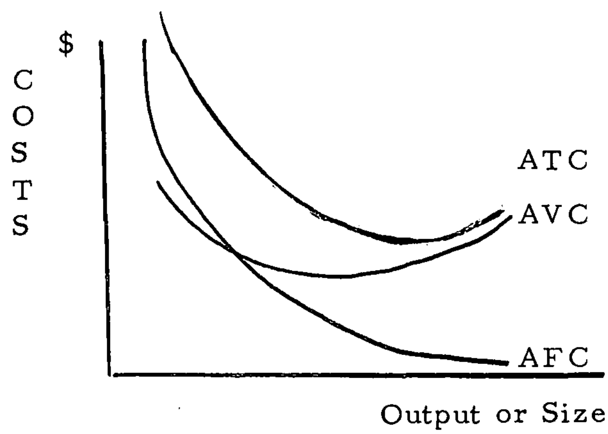

FIGURE 7. Short Run Average Costs

total costs, composed entirely of variable costs, are determined by the nature of the long-run production function.

Empirical Evidence of Cost Characteristics of the Agricultural Firm

Analysis of actual industry cost characteristics often includes aggregation of cross-sectional data involving innumerable causal factors associated with each firm. Individual cost curves are replaced by observations since each firm is operating at a specific output level at the time of observation. Aggregate curves are then fitted to the numerous observations to determine existing average industry costs.

Empirical cost studies of U. S. agriculture have indicated, in the main, that over the observed range of output levels, a firm's long run average total cost of production curve will be U-shaped due to several identifiable internal economies and diseconomies associated with changes in farm size or output.[2] Size economies are associated with reductions in average total costs as output increases, while diseconomies involve increases in average total costs as output increases.

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[2]Recent studies which have supported the existence of some form or portion of a U-shaped cost curve in agriculture are by Stippler and Castle (1961), Richards and Korzan (1964), Hunter and Madden (1966), Barker and Heady (1960), and Moore (1965).

According to Raup (1969) most empirical studies involve at least one fixed factor since management is considered a fixed cost or "fixed residual" over the size ranges studied. Consequently these studies cannot be equated directly with theoretical long run average cost curves which assume no fixed factors.

Causes of size economies generally include three types: (1) technical economies derived from input relationships; (2) pecuniary economies; and, (3) vertical integration. Technical relationships exist among inputs such as large indivisible machine units and fixed labor resources which can be more fully utilized at higher output levels with resulting lower average total costs. Farmers are often unable to obtain divisible resources in the required amounts for their output levels. Several empirical studies have pointed out the significance of indivisible resources such as fixed family labor and machine units (Ihnen and Heady, 1964).

Pecuniary economies result in savings from the purchase of large quantities of input factors at discount prices and selling large output volumes at premium prices, both of which are seldom enjoyed by smaller firms (Buxton and Jensen, 1968).

A third economy is vertical integration, the process of adding to the firm a supplier of an input or a customer for the output. Large firms are sometimes able to integrate, thereby avoiding the cost of middleman profits on inputs and realizing higher net prices for products sold (Faris, 1961).

Diseconomies of size are difficult to observe in U. S. agriculture (Raup, 1969, pp. 1277-8). Theoretically they do not exist if all inputs are allowed to vary. In reality, inadequate management coordination or some other factor limitation may be involved as the firm becomes larger. U. S. farms usually have only one manager or person in a management position who makes decisions. The owner-operator in many cases has no other job, so his entire labor and management income is derived from the farm. By expanding the farm <u>within</u> his labor and management capabilities, the operator may experience economies of size if additional labor and/or management is not hired. However, hazards develop when the operator's managerial capacity is surpassed. Then average costs increase due to the limitations of management, i. e., the farmer's inability to consistently coordinate resource use and make optimum decisions.

Realistically such farm situations are seldom observed, not because they do not occur, but because competition in the industry soon forces these operators to readjust their cost structure or go out of business.

EFFECTS OF UNCERTAINTY

Uncertainty is a complicating factor which must be added to the theoretical framework already discussed (which assumed a static and perfect knowledge situation) to help explain real world behavior. Uncertainty appears in several forms. Unknown weather conditions and other vagaries of nature prevent exact specification of output level resulting from a given resource combination in agriculture. Probability distributions of output level and product prices result rather than parametric values. In accounting for this reality farmers exhibit risk preference or aversion characteristics. Some farmers may prefer to gamble for higher gains at the risk of incurring high losses, while others select conservative strategies to minimize losses while also foregoing prospects for large gains.

Uncertainty in the real world often restricts resource use by limiting capital usage:

> The firm is handicapped in situations of uncertainty because with limited resources one cannot be sure that luck will balance out since an initial loss may severely handicap or destroy the opportunity to engage in further activities. Hence the poultryman may tend toward conservative practices and restrict the amount of capital ventured. (Morrison and Judge, 1955, p. 652-53.)

While marketing contracts, government programs, and vertical integration have tended to reduce uncertainty problems in poultry and several other agricultural sectors,[3] these problems still handicap many farm sectors.

Some types of risk increase with farm size measured in terms of asset value or net worth (Heady, 1952, p. 538-49). While greater profit levels are possible with large farm units, greater losses are also possible. For example, if a farmer has a $10,000 mortgage payment due annually, he may choose a production alternative which maximizes prospects for covering this debt, family living, and other fixed cost commitments. Such decision-making strategy may maximize short run economic viability but contribute little to long run expected income.

The risk-bearing ability of a farm is also related to farm cost composition (Skold, 1966). In the short run, returns must cover variable costs to encourage continued production. If a high proportion of total costs are variable, then adjustments can be more readily made in response to short run uncertain prices and other factors in a one or two year production framework. However, in U. S. agriculture a high proportion of fixed costs due to machinery components may result in a greater long run competitive cost advantage.

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[3] In poultry production for example, uncertainty regarding output levels and prices have been largely eliminated by contracts and environmental housing. Therefore, a specific production function can yield precise input combinations for profit maximization.

EFFECTS OF TECHNOLOGICAL ADVANCE

Many technological advances in agriculture provide economies of size which encourage greater machine investment and firm enlargement. The high price of labor relative to machine technology has favored labor substitution in U. S. agriculture for many years. However, higher proportions of fixed costs to total costs make short run adjustments more difficult. Edwards (1959) utilized the concept in explaining the non-reversibility of supply response in agriculture. As machine investment increases, these new resources become fixed because their alternative use (salvage) value is lower than their present use value. A study by Barker (1961) supports this idea. He concluded,

> ... the results support the contention that the elasticity of expansion under rising prices exceeds the elasticity of contraction under falling prices (p. 658).

The concept is illustrated in Figure 8 where Q_1 represents the optimum level of production given the current level of fixed factors and their associated fixed costs. This theory provides an explanation of the observation that aggregate supplies of farm crops plagued by low prices cannot be reduced as readily as they were expanded when indivisible technological inputs are employed.

Such advances in technology tend to move the long run average cost curve for some firms to the right and downward, as shown in

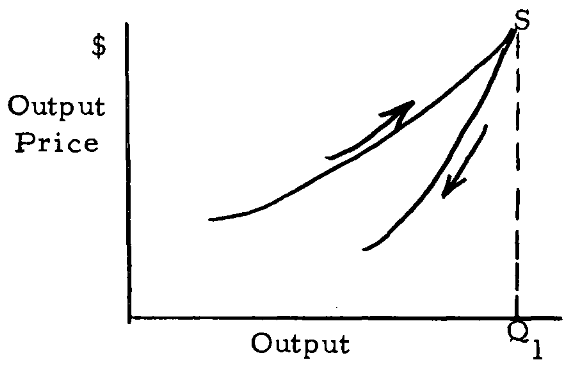

FIGURE 8. Supply Response of a Firm, Expansion vs. Contraction.

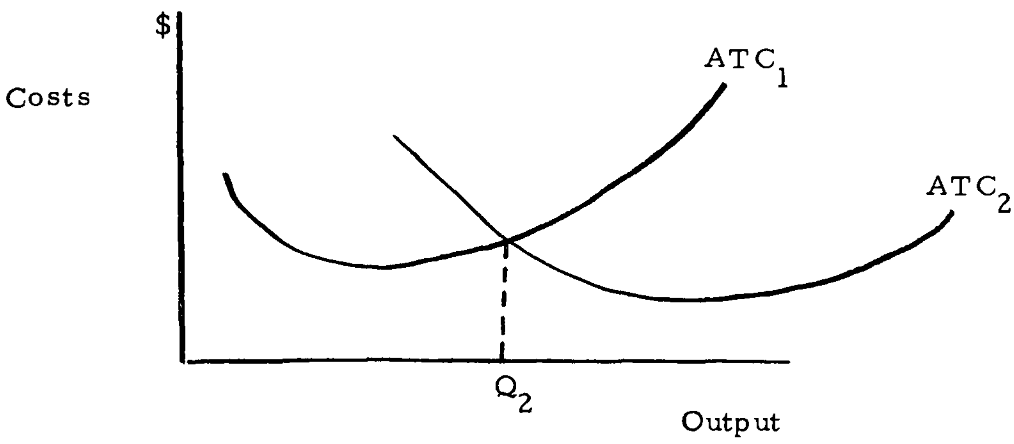

FIGURE 9. Average Total Cost Curves of a Firm Before and After Adoption of New Technology.

Figure 9. Average total cost curves ATC_1 and ATC_2 represent size and efficiency levels available to a firm before and after a technological advance. However, such external economies do not assure reduced costs for farmers (Miller and Back, 1958). When associated farm size increases are not adopted simultaneously, unit costs may increase because: (1) the expected increase in output does not materialize (or other uncertainties); (2) lack of available alternative forces the farmer to invest in more costly equipment with excess capacity; (3) non-monetary values (satisfaction) may take precedence over economic considerations. These situations are represented in Figure 9 where adoption of new technology causes a shift from curve ATC_1 to curve ATC_2 while remaining at the same output level Q_2.

Analytical Methods

Several factors causing profitability and efficiency level variations among farms have been discussed. These issues and the nature of apparent problems facing Willamette Valley grass seed growers suggest several topics for analytical inquiry.

It is hypothesized that farms producing grass seed in the Willamette Valley exhibit variations in profitability and resource use in seed production. As a consequence, some farm organizations would be better able to survive probable increased costs associated with a field burning ban than other farms. Within the general hypothesis there exist several sub-hypotheses; that variations in profitability and efficiency are primarily caused by:

(1) type of seed produced,

(2) size of farm,

(3) fixed cost vs. variable cost structure,

(4) resource combination and use,

(5) considerations associated with production uncertainties including risk preference and managerial ability.

Attempts to identify various causes, or independent variables, affecting some dependent variables are challenged by several econometric problems. For this study of grass seed production the dependent variable involves profitability of farming associated with grass seed production. Review of theoretical considerations suggests certain factors which cause variation in income generation among farms. Each of these factors (listed above) will be examined through the collection and analysis of data from a sample of Willamette Valley farms producing grass seed. Comparative analysis will be made of cost and return data collected. The sample farms will be grouped according to farm size and grass seed type. Profitabilities of subgroups will be compared. Further stratification of sample data will include (1) soil type; (2) farm type; and, (3) cost composition.

DATA COLLECTION

A survey was conducted to obtain physical and economic data for the 1969 production year from Willamette Valley farms producing grass seed. Temporal and financial limitations permitted drawing an estimated ten percent of the valley's grass seed grower population.

Grower lists available at time of sample selection indicated that approximately 1800 farm operators were producing grass seed in the Willamette Valley.[4] This population was stratified by seed type and farm size with an estimated ten percent sample drawn from each substrata. Intent of stratification was to insure that variation in costs and returns attributable to seed type and farm size differences would be recorded. Seed type sub-strata included annual and perennial ryegrasses, fine fescue, highland bentgrass, Kentucky bluegrass, tall fescue, and orchardgrass. Four farm size strata were used: 0 to 150, 151 to 300 acres, 301 to 900 acres, and over 900 acres. Farm size was based on total land operated[5] which included rented and owned cropland and non-cropland.

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[4]Publicly-distributed seed grower lists were obtained from Seed Certification Specialists, Department of Farm Crops, OSU. Revisions were made under the supervision of the grass seed commodity commissions in Oregon.

[5]Farm size data was obtained from various County Directories, Tscheu Publishing Co., for Willamette Valley counties, 1960-69.

Usable records were obtained from 147 farm operators. Locations of the sample farms appear in the Appendix. The initial sample contained names of 204 farm operators. Of this total, 35 either no longer raised seed or had rented their operation to other farmers whose names were included in the sample. Another 22 growers could not be contacted or refused to cooperate.

Farm data was recorded on field schedules from each of the sampled farm operators interviewed. Information collected included type of farm organization, recent organizational changes, capital investment, resource use, farming practices, costs and returns, enterprise combination, and enterprise analysis by seed type. A field schedule is presented in the appendix.

SAMPLE COVERAGE

A comparison was made between total grass seed acreage by grass seed type and by producing regions in the Willamette Valley and that obtained from the 147 sample farms which were estimated to account for ten percent of the total grass seed producer population in the valley. This was done to determine if sample coverage appeared adequate with the stratification procedures used. Results of the comparison are shown in Table 6. The sample of 147 farms accounted for 26 percent of the estimated total grass seed acreage in the Willamette Valley in 1969. Stratification by

Table 6. Total Grass Seed Acreage[2] Reported from 147 Willamette Valley Farms Producing Grass Seed, by Seed Type and Producing Region, 1969.

Seed Type	Region 1 Multnomah, Clackamas	Region 2 Linn, Benton, Lane	Region 3 Marion	Region 4 Polk	Region 5 Yamhill, Washington	Total Sample Acreage by seed type	Total Willamette Valley acreage by seed type[1]	Sample as percent of total acres by seed type
Bentgrass	---	3,203	4,023	---	1,057	8,283	28,450	29.1
Bluegrass	---	4,093	421	18	105	4,637	13,280	35.8
Fine Fescue	214	942	4,960	573	251	6,940	29,300	24.1
Tall Fescue	7	3,622	110	---	---	3,739	15,920	23.4
Orchardgrass	---	4,847	283	234	30	5,394	11,300	48.4
Annual Ryegrass	---	22,314	514	3,240	396	26,464	104,200	25.6
Perennial Ryegrass		7,150	310	598	9	8.067	44,800	18.0
Total Sample Acreage by Region	221	46,171	10,621	4,663	1,848	63,524	---	
Estimated Total grass seed acreage[1]	9,850	175,090	42,700	12,750	6,860	---	247,250	---
Sample as percent of total grass seed acres by region	2.2	26.5	25.3	36.5	29.0	---	---	26.0

[1] USDA Crop Reporting Board and OSU Extension Service Estimates, 1969.

[2] Includes seven major seed types only.

seed type provided uniform and far greater-than-expected overall coverage, with the sample accounting for at least 18 percent of total valley acreage within each seed type and nearly 50 percent on orchardgrass. Stratification by region was also quite uniform with exception of Region 1 where the sample accounted for only two percent of reported 1969 acreage. In all other regions the sample accounted for over 25 percent of total acreage in each region. Scope of sample coverage indicates that the grass seed farm population is smaller than that implied by the population listings from which the sample was drawn. Several possible reasons may be advanced to explain the discrepancy.

(1) Aggregate acreage estimates are reported in terms of harvested acres.[6] A portion of total acreage reported by sample growers was seeded to a perennial grass the previous season but not harvested. Although only incomplete seedling acreage data was available, a cursory examination indicated some five to fifteen percent of the sampled perennial crop acreage was newly seeded and not harvested. Assuming a ten percent rate of unharvested seedling acreage for all perennial grasses, the total harvested sample would be some 59,800 acres, or 23 percent of the estimated valley total after this adjustment is taken into account.

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[6] All seed production reports issued by USDA Crop Reporting Board list "harvested acres". See Seed Crops; Annual Summary (1969) By States, USDA Statistical Reporting Service, Crop Reporting Board, Statistical Bul. No. 206, April, 1970.

(2) Population lists of grass seed growers in the valley, from which the sample was drawn possibly overstates the actual population. The total population was constructed by compiling seed grower lists from several sources which totalled some 2,400 names, with duplicate names of farmers producing several seed types eliminated, resulting in the population level of 1,800 growers. However, periodic revision of such lists, while including addition of new names, apparently fails to remove names of operators no longer raising seed. In sampling from the initial population of 1,800 names, 35 of the initial sample of 204 seed growers no longer raised seed. This suggests a possible overstating of the population by as much as 17 percent or 300 growers. The 1969 Census of Agriculture reports a total of some 1,600 grass seed growers, including duplication of those growers raising two or more seed types.[7]

(3) There may exist more acres of seed in the Willamette Valley than estimated. It is known that some farmers are reluctant to report seed production statistics to the USDA Statistical Reporting Service which calculates and publishes estimates. The 1969 Census of Agriculture lists some 255,000 acres of grass seed harvested, compared to 247,250 in Table 6, a 3.5 percent discrepancy.

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[7] Census data combines annual and perennial ryegrass, thus eliminating duplication of growers raising these two seed types, but separates fine fescue into red and chewings types, thus including duplication of growers raising both types.

(4) The random selection of sample farms may have resulted in a disproportionate number of large farms. Comparison of average grass seed acreage per farm by seed type reported by sample farm and by the 1969 Census of Agriculture is shown in Table 7. Wide discrepancies in acreages per farm are evident, particularly with ryegrass for which sample farms reported an average of 356 acres per farm, while Census data reports an average of 252 acres per farm. Using Census averages per farm for each seed type, it is estimated that 147 farms would report some 49,000 harvested acres of grass seed, or about 20 percent of total estimated acreage. This suggests a total population of some 740 growers in the Willamette Valley.

(5) The population may have been underestimated since only seed seller names were used. Some small farmers, possibly ten percent of the population,[8] simply deliver seed to neighboring processors who clean and sell the seed in their own names. Thus the growers' names would be excluded from the population used in this study. While suggesting that this factor may involve some 150 to 180 growers, it also suggests possible validity of number 4 above.

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[8]Several Willamette Valley Agricultural Extension personnel suggested this factor.

Table 7. Comparison of average grass seed acreage per farm, by seed type; sample data and 1969 census of agriculture

	Bentgrass	Kentucky Bluegrass	Fine Fescue	Tall Fescue	Orchard Grass	All Ryegrass
Sample of 147 farms						
Number of farms	51	40	63	33	42	97
Total acreage[1]	8, 283	4, 637	6, 940	3, 739	5, 394	34, 531
Average acreage per farm	162	116	110	113	128	356
1969 Census of Agriculture						
Number of farmes	212	125	250[2]	131	163	647
Total acreage	21, 200	19, 500	26, 000	12, 000	14, 000	162, 600
Average acreage per farm	100	156	104	92	86	252
Number of sample farms x census average acreage per farm	5, 100	6, 240	6, 550	3, 040	3, 610	24, 420

[1] Includes seedling acreage not harvested, estimated to total 3, 700 acres or ten percent of perennial grass acreage.

[2] Estimated total fine fescue growers after eliminating duplication of growers raising both chewings and red fescue varieties as reported in census.

(6) The sample farms reported a greater frequency of multiple grass seed enterprises than the general population. The initial population reduction from 2400 to 1800 by eliminating duplications suggests that less than one-third have two or more grass seed types. Yet the 147 sample farms reported 355 seed enterprises, or 2.4 per farm. Therefore, the sample was apparently not completely random since the sample farms have more seed enterprises and greater total seed acreage, than the general population average. The population estimate from number four above based on sample acreage understates the true population.

Combining the factors described above suggests that the 1969 Census of Agriculture provides the most reliable data for estimating the grass seed grower population. The Census reported some 1,600 growers including duplications. Assuming a 25 percent reduction through elimination of duplicates (see number 6 above) this suggests a population of 1,200 growers. Allowing an additional five percent who produce grass types and varieties other than the seven major types included in this study, the estimate becomes 1,260 growers. Therefore, it is hypothesized that the true Willamette Valley grass seed grower population lies in the range 1,260 $\pm$ 100, or between 1,160 and 1,360 growers.

Regional Characteristics

Initial review of the field schedules indicated that nearly three-fourths of the farms sampled produced two or more types of grass seed on the same farm. It also showed that many farms had outgrown the size class to which they were assigned in the initial sample stratification. This suggested stratification of survey data for analytical purposes by criteria different than that used in the sampling procedures. Seed production data by counties indicated that soil patterns and urban concentrations appear to markedly influence type of farm organization.

Consideration of urban and soil influences prompted separation of the Willamette Valley into five grass seed producing regions. Region 1 includes portions of Multnomah and Clackamas counties; Region 2 encompasses Linn, Benton, and Lane counties; Region 3 contains Marion County; Region 4 is Polk County; and Region 5 includes Washington and Yamhill counties. The general locations of these influences, and the resulting regions, are shown in Figure 10. Areas of urban influences are identified by noting locations of the Eugene, Salem, and Portland metropolitan areas on the map.

Region 1 - Clackamas and Multnomah Counties

Region 1 includes the hill area of Clackamas County and a small section of south central Multnomah County. The grass seed

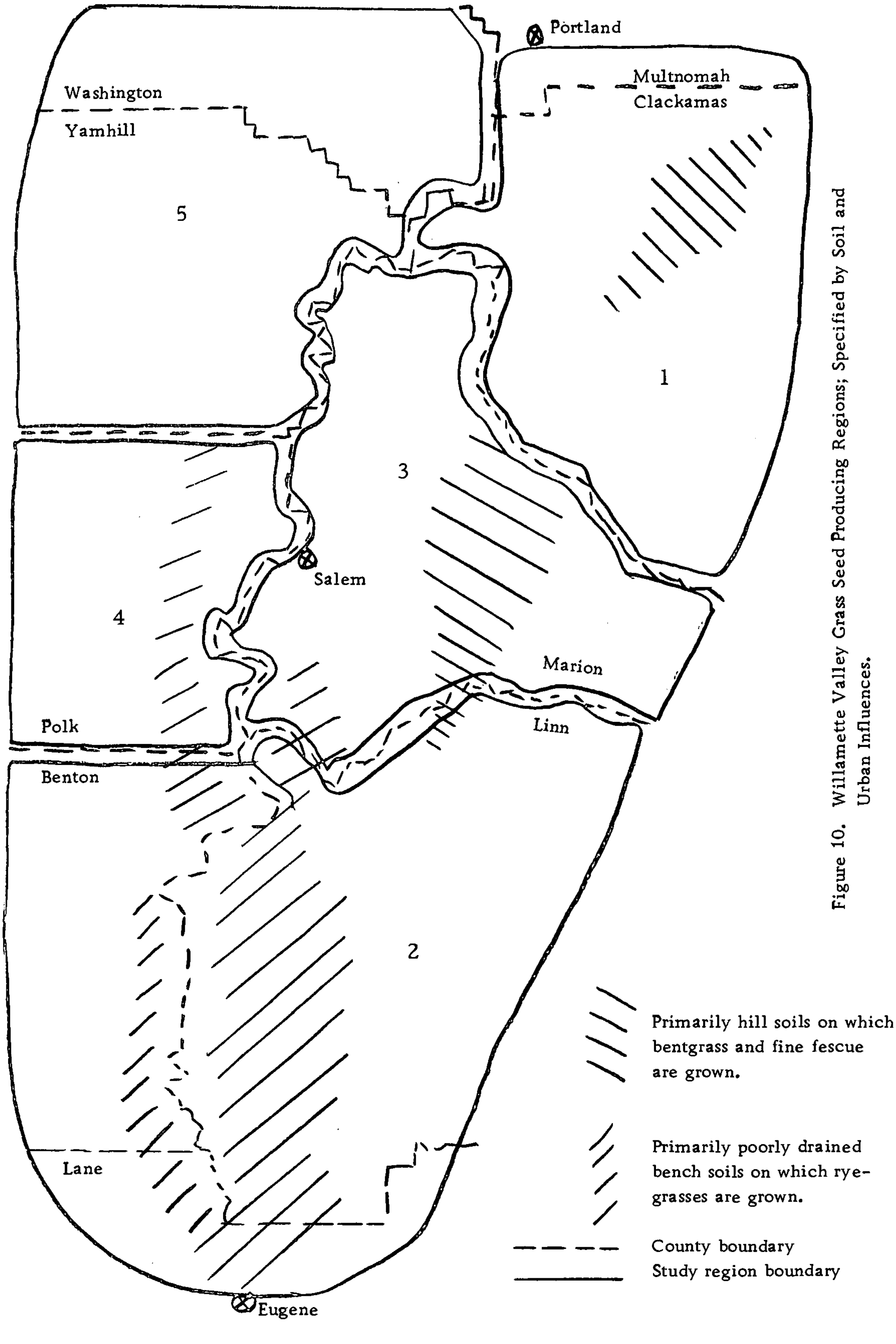


Figure 10. Willamette Valley Grass Seed Producing Regions; Specified by Soil and Urban Influences.

producing area, devoted almost exclusively to fine fescue production, is characterized by small acreages of farmland mixed with forest and urban districts. The area is located five to twenty miles from the Portland metropolitan area. Urbanization with its demand for homesites has resulted in increased land values with accordingly higher property taxes. These forces exert pressure for moving land into more intensive agricultural uses such as small fruits, vegetables, and nursery crops and eventually into home and industrial development sites.

Five farms were sampled from Region 1. All were located in hill areas five to twenty miles east of the Willamette River. Each of the five sample farms produced fine fescue as the primary grass seed crop.

Region 2 - Linn, Benton, and Lane Counties

Region 2 contains the upper Willamette Valley seed producing area. It accounts for three-fourths of all Willamette Valley grass seed acreage. Much of it consists of "Whiteland" soils on which ryegrasses are produced. Linn County produced 75 percent and Lane County produced ten percent of the U. S. ryegrass seed crop in recent years. Region 2 produces tall fescue, orchardgrass, and bluegrass on the higher, better-drained bench soils, and highland bentgrass in hill areas.

Sixty-seven farms were sampled in Region 2. Fifty-three farms reported annual ryegrass and 40 farms reported perennial ryegrass seed crop enterprises, grown mostly on "Whiteland" soils.

Region 3 - Marion County

Region 3 contains the mid-valley land area east of the Willamette River in Marion County. Marion is the leading Oregon county in value of agricultural crop production. Most of the intensive high-valued fruits and vegetable crops are located on well-drained river bottom soils.

The primary grass seed area extends along the east foothills of the valley. Highland bentgrass and fine fescue are grown almost exclusively on these well-drained hill soils. These two grass types occupy some 30,800 acres of cropland in Marion County and account for some 70 percent of the county's value from grass seed production. Some 4,200 acres of ryegrass are grown on poorly drained "Whiteland" bench soils. Small acreages of tall fescue, bluegrass, and other grass types not included in the study are found on various soil types in the county.

Forty-eight farm operations were sampled from Region 3. Highland bentgrass and/or fine fescue were the only seed crops reported on 32 hill farms. Only five farms failed to report either of these two crops and they were located in lowland areas near the Willamette or Clackamas Rivers and reported annual ryegrass production.

Region 4 - Polk County

Region 4 is located on the west bank of the Willamette River in Polk County. Geography is rolling and characterized by lowlands and low hills interspersed over much of the area. Drainage is better than on Region 2 lands, as indicated by predominance of small grain production which does not favor "Whiteland" soil conditions. Small grains, primarily wheat and barley, comprise over 45 percent of the total harvested cropland (Bureau of the Census, 1971). Only 11 percent of the cropland contained grass seed. Ryegrass accounted for 75 percent of the region's value of grass seed production and acreage (Middlemiss and Coppedge, 1970).

Fourteen farms were sampled from Region 4. Only one did not report production of small grains. Twelve of the sample farms reported annual ryegrass production.

Region 5 - Washington and Yamhill Counties

Region 5 is located on the western side of the lower Willamette Valley. The region's proximity to the Portland metropolitan area is noted by increasing urban and industrial use of the land area.

A wide range of topography and soils project a wide range of cropping patterns. Small grains play the dominant crop role. About 43 percent of the total harvested cropland is devoted to small grains, while 53 percent produces a wide variety of crops including fruits, nuts, and vegetables. Grass seed is produced on some 7,000 acres, or less than four percent of the cropland of Region 5.

Thirteen farms were sampled in Region 5. Seven reported annual ryegrass and six reported bentgrass seed production. Twelve of the thirteen farms reported legumes grown for seed.

CHAPTER 5

ECONOMIC CHARACTERISTICS OF FARMS

Chapter 5 contains two sections devoted to description and analysis of data collected from the sample farms. Part One presents descriptive physical and economic statistics from the 147 sample farms and Part Two is devoted to economic analysis of these data to determine the importance of variables which influence profitability of grass seed production. Analytical methodology will draw heavily upon theoretical considerations discussed in Chapter 4.

PART ONE - GENERAL CHARACTERISTICS OF THE SAMPLE FARMS

Presentation of general farm characteristics includes description of family characteristics, farm resources, farm income and expenses and resource returns on a total farm basis without regard to the role of separate enterprises such as grass seed. Role of separate enterprises is treated in a later section.

Farm Family Characteristics

Knowledge of farm family characteristics is important in discussing the role of grass seed production since it is both a user of a productive input, namely family labor, and a source of income for consumptive family living. It is particularly important in grass seed production since all of the sample farms were operated as family farms. Of the 147 farms 119 were organized as single proprietorships while 20 were organized as family partnerships and eight as family corporations.

FAMILY LABOR UTILIZATION

Family labor was divided into operator, wife, and children categories. Table 8 summarizes farm family labor on the 147 sample farms. The farm operator was employed full time on 93 percent of the farms sampled. This implies that nearly all farms sampled were operated as full time commercial farm operations. Only in Region 1 the farm was considered something less than a full time operation in two of the five sampled farms.

Very little off-farm work was reported. Of the 147 farms, only 15 reported that the operator utilized off-farm work to supplement family income. Only nine farm wives reported off-farm work. Farm family offspring were utilized to a limited extent with 76 farms reporting family members (other than wives) who worked at least part time on the farm. There were 114 children reported who worked on the 76 farms, with an average age of 16 years. This labor was utilized primarily during seed harvest months of July and August. Fifteen operators employed family offspring full time.

Table 8. Farm Family Labor Use on 147 Sample Farms Producing Grass Seed in the Willamette Valley, Oregon.

Labor Use	Region 1 Clackamas, Multnomah	Region 2 Linn, Benton, Lane	Region 3 Marion	Region 4 Polk	Region 5 Yamhill Washington	Sample Total
			(Number of Observations)			
Sample Size	5	67	48	14	13	147
Operator						
Full-time farm work	3	65	43	13	12	136
Part-time off-farm work	0	8	4	1	2	15
No family labor or hired labor assistance	3	5	4	1	1	14
Operator's Wife						
Full-time farm work	0	17	5	3	1	26
Part-time farm work	0	10	5	2	0	17
Off-farm work	1	0	4	3	1	9
Operator's Children						
Full-time farm work	0	9	5	0	1	15
Part-time farm work	0	22	17	6	8	61

FAMILY INCOME

Farm family income may be derived from two sources -- farm earnings and non-farm earnings. Table 9 summarizes average family earnings from both sources by region. Farm earnings are listed as net farm income, which represents the amount of current earnings which could be withdrawn from the farm business without reducing size of business. It represents residual return to operator's invested capital and to his labor and management skills for the 1969 production year. Off-farm earnings consist of labor earnings for operator and wife, and other off-farm income. Other off-farm earnings include interest on capital, stock dividends, government payments, and miscellaneous income.

Net farm income ranged from 84 to 88 percent of total family earnings in Regions 2, 3, 4, and 5. In those regions average off-farm earnings did not exceed $1,800 per farm. In Region 1 net farm income accounted for 18 percent of total earnings. For the 147 sample farms, total family earnings averaged $14,860 with 13 percent or $1,971 derived from off-farm sources.

OPERATOR AGE

The average age of farm operators interviewed was 46 years. The range was 24 to 82 years. Seventy-five operators were over 49 years of age. Average age by region was:

Table 9. Average Farm Family Earnings by Source and Region on 147 Willamette Valley Farms Producing Grass Seed, 1969.

Income Source	Region 1		Region 2		Region 3		Region 4		Region 5		Total Sample	
	Earnings	% of total earnings	Earnings	% of total earnings	Earnings	% of total earnings	Earnings	% of total earnings	Earnings	% of total earnings	Earnings	% of total earnings
Net Farm income[1]	669	18	19,800	88	4,522	84	8,510	85	17,578	88	12,889	87
Off-Farm earnings												
Operator job	--	--	918	4	351	7	143	1	2,208	11	742	5
Wife job	100	3	--	--	243	4	1,379	14	111	1	224	1
Other off-farm earnings[2]	2,903	79	1,780	8	285	5	5	--	15	--	1,005	7
Total Farm and non-farm earnings	3,672	100	22,498	100	5,401	100	10,037	100	20,012	100	14,860	100

[1] For a detailed analysis of farm income and expenses, see Table 14.

[2] Includes earnings from capital invested off the farm, Social Security payments, stock dividends, and miscellaneous.

Region	1	2	3	4	5
Average Operator Age	65	45	45	42	49

National trends for U. S. agriculture indicate a relationship between operator age and farm size. A size-age relationship also exists for grass seed producers as shown in Figure 11. Operators under age 50 predominate farm operations larger than 350 acres. Farm sizes reported by the 58 operators aged 50-64 years suggests a transitional characteristic of this age group. Although 25 farms were over 600 acres, nine were 350-600 acres and 24 were smaller than 350 acres in size. Farms with operators over 64 years were predominantly small with 12 of the 17 farms in this group under 250 acres in size.

Farm Resources

LAND

The 147 sample farms occupied 101,486 acres of land, as shown in Table 10. Of this total, 88,668 acres were cropland acres. The remaining 12,818 acres included timber, unimproved pasture and other non-crop land. Of the cropland acreage 63,823 acres were devoted to grass seed production. This statistic indicates that while grass seed may be the dominant enterprise on most farms sampled, other crop and livestock enterprises are also involved. Grass seed production predominated land use in Region 2 where 86 percent of

FIGURE 11. Farm Size Class and Operator Age Comparison for 147 Willamette Valley Farms Raising Grass Seed, 1969.

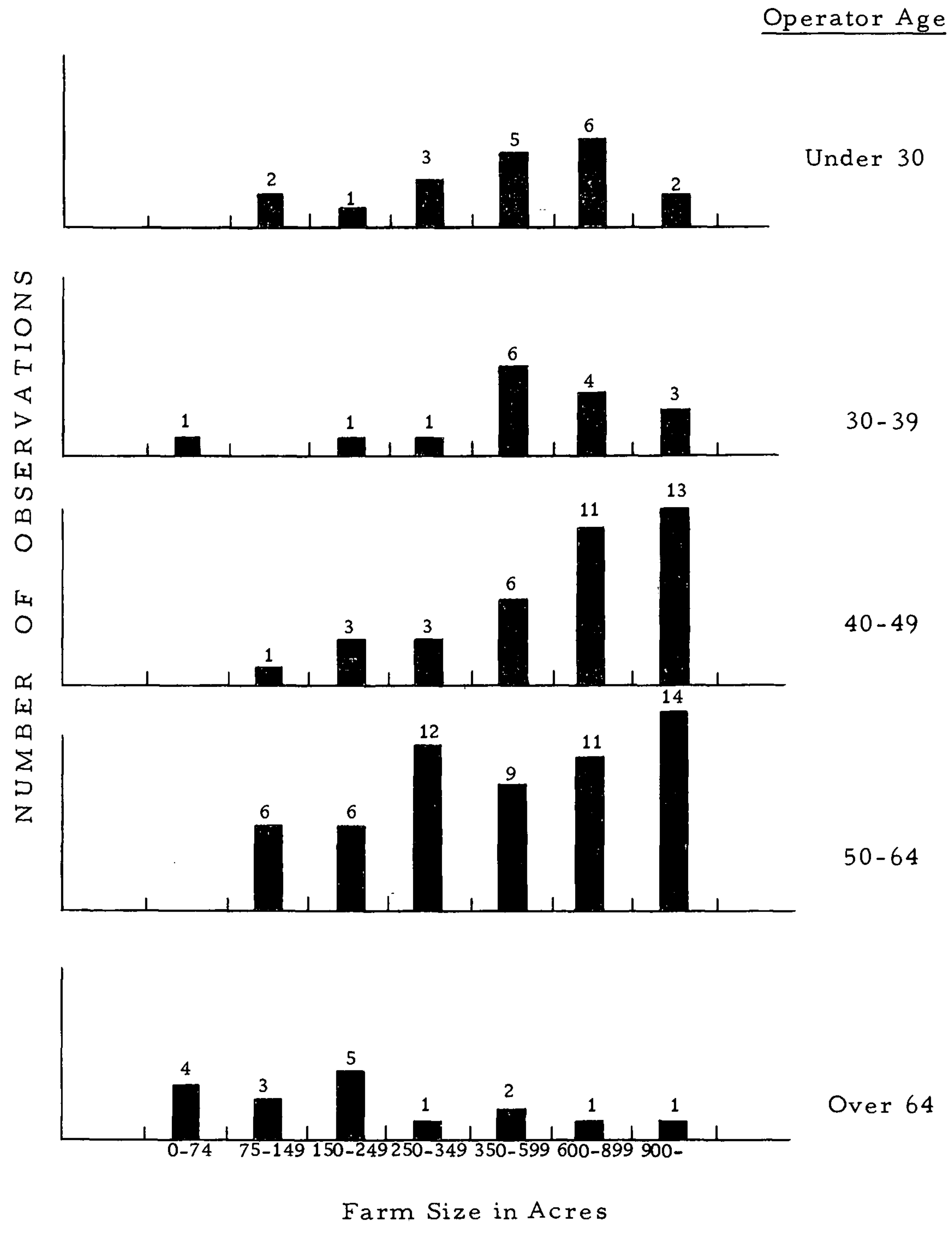


Table 10. Classification of Cropland, Reported by 147 Willamette Valley Farms Raising Grass Seed, 1969.

	Cropland Owned			Cropland Rented							
	Total Acres	Percent of total Cropland	Grass Seed Acres	Total Acres	Percent of total Cropland	Grass Seed Acres	Total Cropland Acreage	Total Grass-land Acreage	Total Farm Acreage Reported	Grass Seed Acreage as Percent of Cropland	Cropland as Percent of total Farm Acreage
Region 1 Clackamas, Multnomah	292	89	213	37	11	8	329	221	675	67	49
Region 2 Linn, Benton, Lane	25, 408	47	19, 010	28, 350	53	27, 263	53, 758	46, 273	58, 692	86	92
Region 3 Marion	11, 205	62	6, 333	6, 872	38	4, 463	18, 077	10, 796	23, 904	60	76
Region 4 Polk	4, 994	54	2, 153	4, 263	46	2, 510	9, 257	4, 663	10, 220	50	90
Region 5 Washington, Yamhill	2, 958	41	673	4, 289	59	1, 175	7, 247	1, 848	7, 995	26	91
Total Sample	44, 857	51	28, 392	43, 811	49	35, 441	88, 668	63, 801	101, 486	72	87

total reported cropland produced grass seed. Regions 1, 3, 4, and 5 reported 67, 60, 50, and 26 percent, respectively, of total cropland produced grass seed.

Approximately 51 percent of total cropland operated on the 147 sample farms was owned by the operators, with the remainder rented. In Region 1, 89 percent of total cropland acreage was owned by operators; in Region 2, 47 percent; in Region 3, 62 percent; in Region 4, 54 percent; and in Region 5, 41 percent of total cropland was operator-owned.

However, only 45 percent of grass seed acreage was operator-owned, with the lowest incidence of land ownership for grass seed production occurring in Regions 2, 4, and 5. In Region 1, 97 percent of grass seed acreage was operator-owned.

Grass seed type is a factor in land tenure. Sixty-three percent of fine fescue land and 59 percent of bluegrass land is operator-owned as shown by Table 11. Land producing annual ryegrass was only 38 percent operator-owned, and perennial ryegrass, 39 percent.

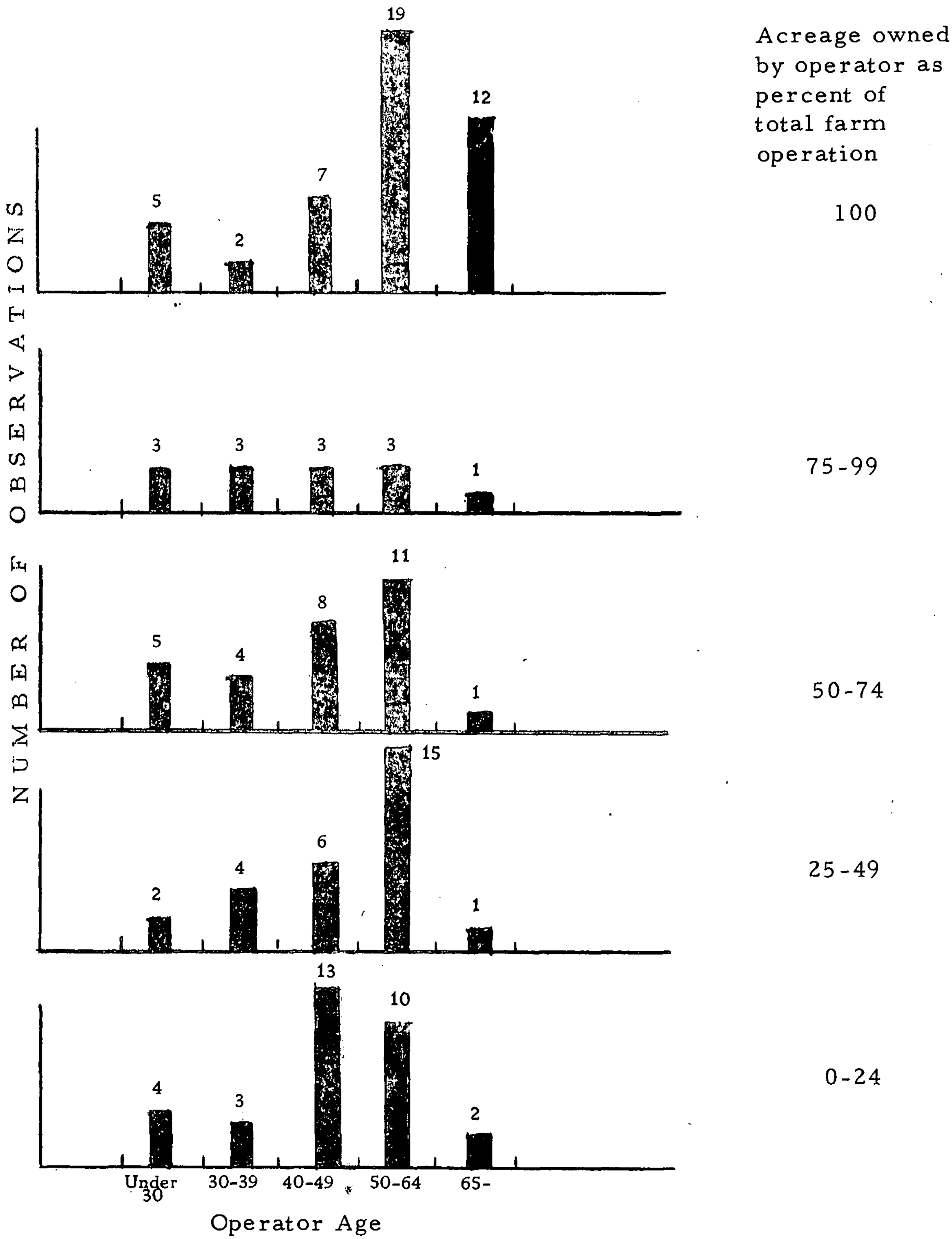
Operator age is also related to land tenure. Figure 12 shows that 70 percent of the operators over 65 years of age owned all land they farmed, 33 percent of the operators aged 50 to 65 years owned all of their acreage, and only 20 percent of operators under 40 years owned all of their acreage.

Table 11. Total Grass Seed Acreage by Land Tenure and Seed Type, 147 Willamette Valley Farms Raising Grass Seed, 1969[1]

	Land Owned		Land Rented		
	Acres	Percent of total grass acres	Acres	Percent of total grass acres	Total Grass Seed Acres
1. Bentgrass	3, 628	43.8	4, 655	56.2	8, 283
2. Bluegrass	2, 719	58.6	1,918	41.4	4, 637
3. Fine Fescue	4, 395	63.3	2, 545	36.7	6,940
4. Gall Fescue	1, 708	45.7	2, 031	54.3	3, 739
5. Orchardgrass	2, 627	48.7	2, 767	51.3	5, 394
6. Annual Ryegrass	9,952	37.6	16, 512	62.4	26, 464
7. Perennial Ryegrass	3, 121	38.7	4,946	61.3	8, 067
Total	28, 150	44.3	35, 396	55.7	63, 524

[1] A total of 277 acres of grass seed types other than the seven identified in the study was produced on the sample farms, of which 232 acres were owned and 45 acres were rented. These grass types included meadow foxtail, penncross bentgrass, and merion bluegrass. This accounts for differences in total acres between Tables 10 and 11.

FIGURE 12. Operator Tenure Position and Operator Age Comparison for 147 Willamette Valley Farms Raising Grass Seed, 1969.



Land rental is an alternative to land purchase as a means for farm size expansion. Of the 94 farms over 350 acres in size, 49 reported less than one-half of total land was owned as shown in Figure 13. By contrast 32 of 53 farms under 350 acres in size are wholly operator-owned.

LABOR

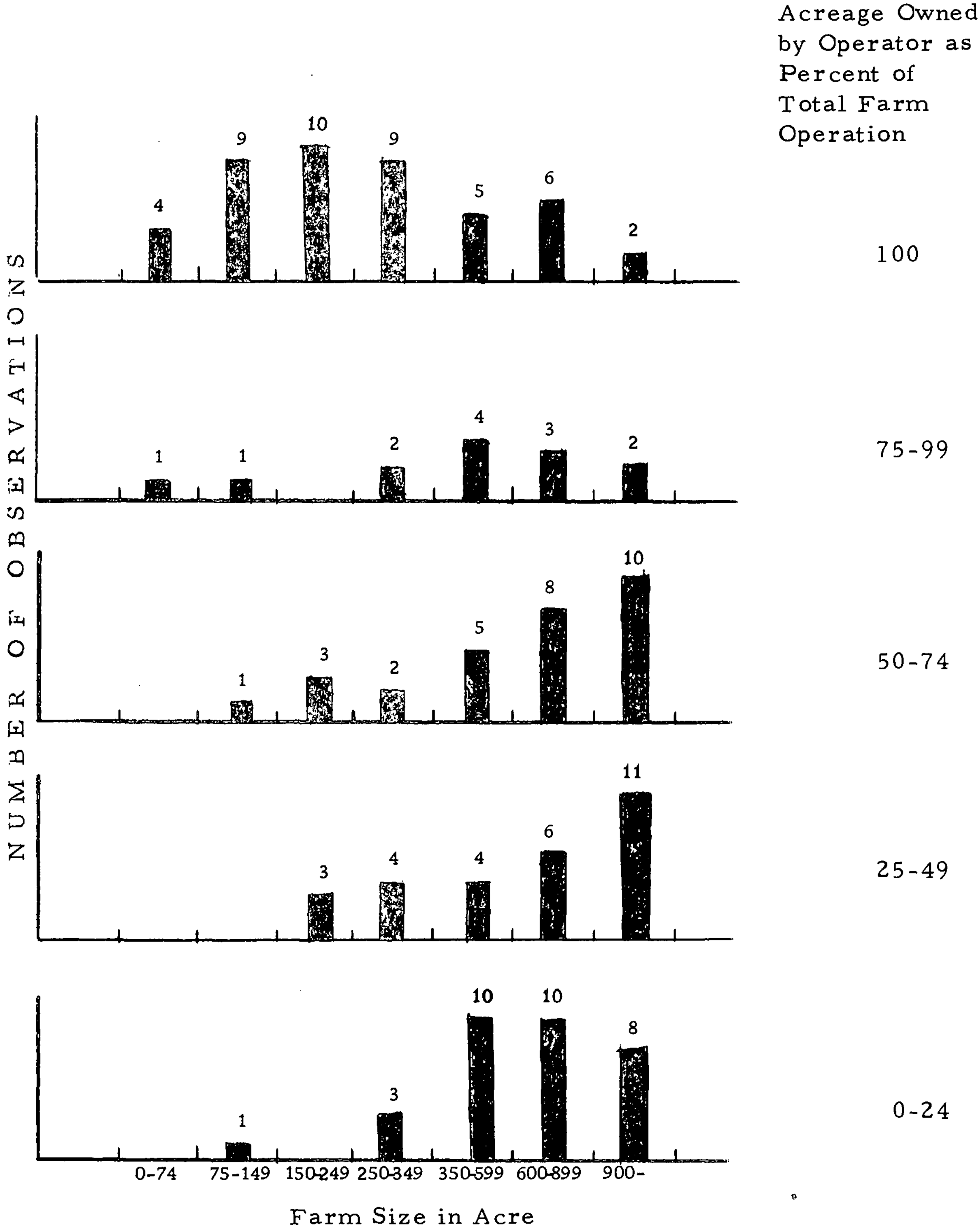
Review of total labor use produced the following results from the sample of 147 farms:

Man-months of Total Labor	Number of Farms
0 to 11	5
12 to 17	54
18 to 23	18
24 to 35	32
over 35	38

Seventy farms utilized 24 or more man-months of labor. Generally these were partnerships or individuals employing full-time hired men. Over half of this group, 38 in number, reported at least 36 man-months (equivalent of three full-time workers) of labor per year. Several farms reported row crop enterprises with heavy summer labor requirements. Seventy-seven farms utilized less than 24 man-months of labor per year. In most cases this available labor was constituted by the operator and part time family help, usually during harvest time.

However, labor composition and its level of use varied during the year. Operator labor was used more evenly and completely

FIGURE 13. Farm Size Class and Operator Tenure Position Comparison on 147 Willamette Valley Farm Raising Grass Seed, 1969.



throughout the year than other labor sources while the wife, children and hired labor fluctuated to meet seasonal requirements. The seed harvest period during July and August demanded the highest level of labor use in all areas.

Figure 14 provides a graphic presentation of average monthly labor use by source expressed in man-months of labor reported by the sample farms in each of the five regions. Labor is classified by operator, wife, children, and hired categories. Data presented indicates total farm labor use and does not indicate the portion allocated to grass seed production directly.

In Region 1, farm labor was provided by the operator with hired labor added for early spring, summer, and late fall field work. Approximately 11 man-months of labor per farm were employed annually on the farm with nearly three man-months provided by hired labor. About seven man-months per farm, or 64 percent, was devoted to grass seed production.

Region 2 labor use per farm averaged 31.7 man-months per year, or nearly three full time man-equivalents per farm. Operators accounted for 12.3 man-months while other family labor, operator wife and children, accounted for an additional 7.2 man-months per year. Total family labor provided over 60 percent of farm labor requirements. Children worked mostly during summer months, while labor of the operator's wife was evenly distributed throughout

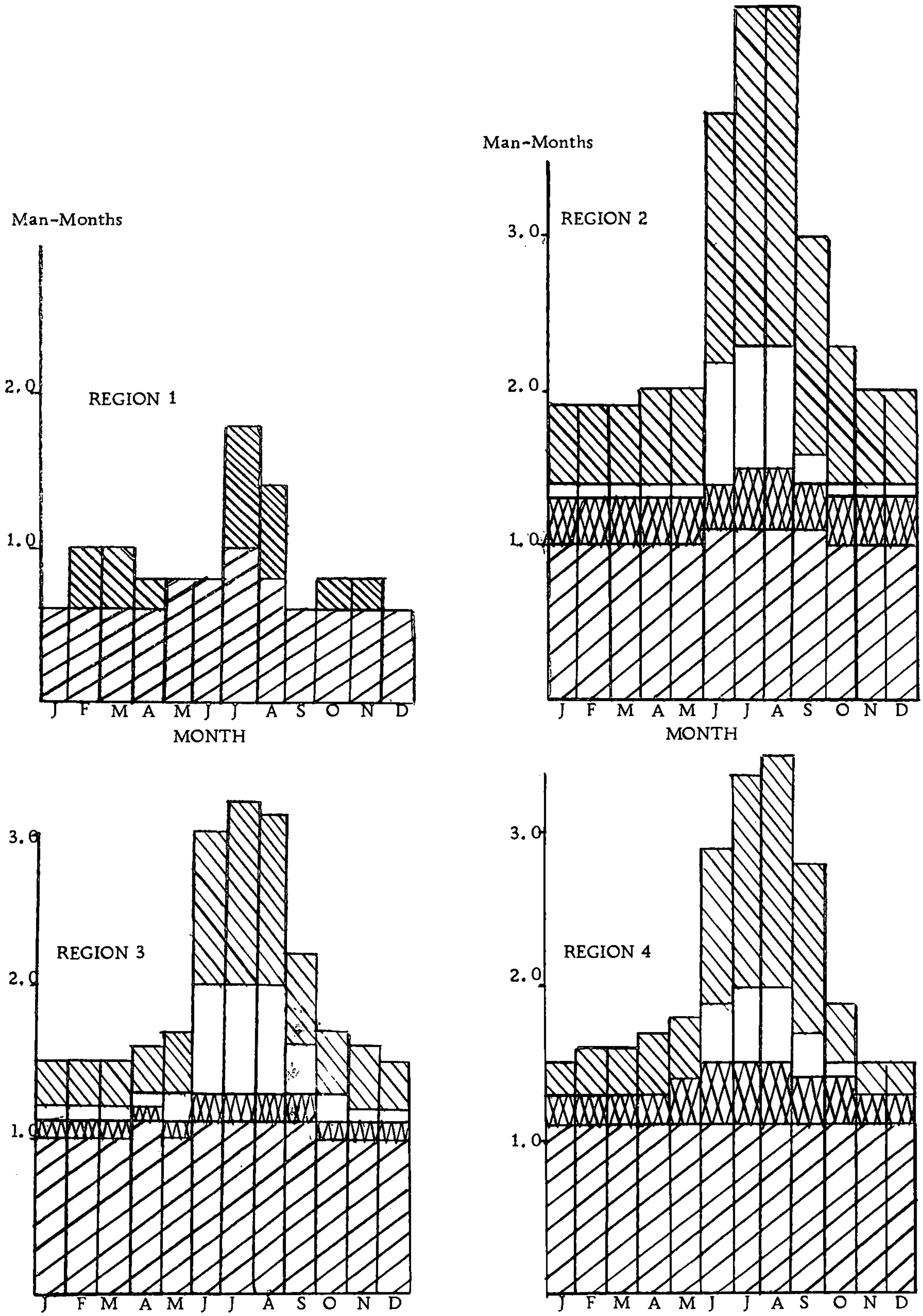


Figure 14. (Caption - see next page)

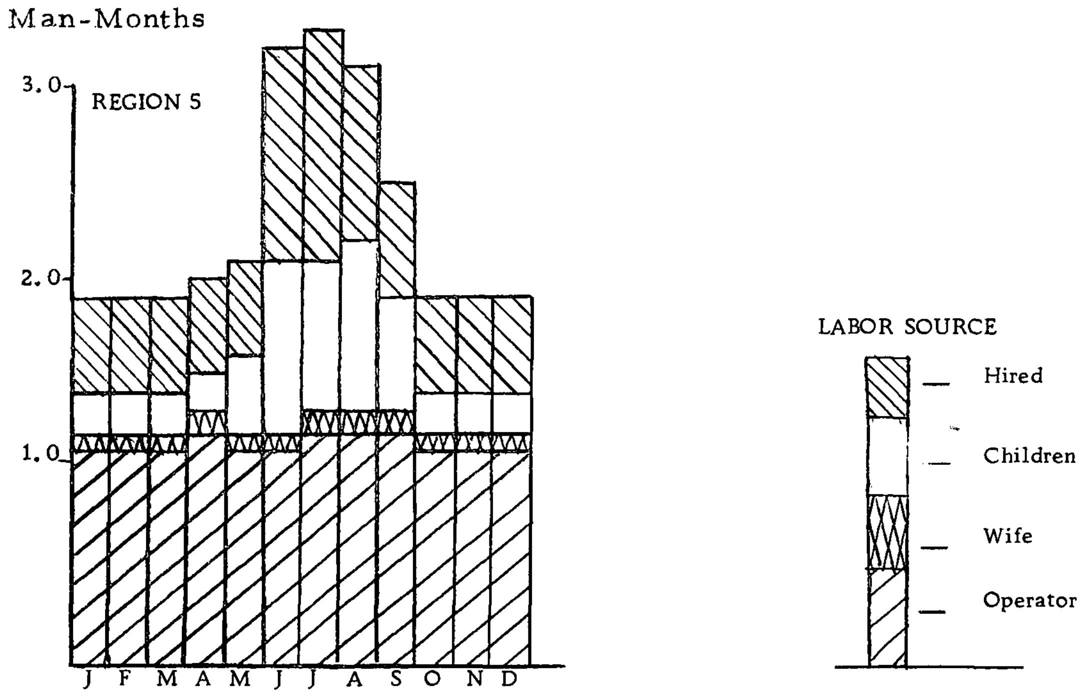


FIGURE 14 (Continued). Average Farm Labor Use in Man-Months per Month, by Labor Source, on 147 Willamette Valley Farms Producing Grass Seed, 1969.

the year and accounted for the majority of family labor exclusive of operators. Approximately one-half man-month per month was hired year-round. During the harvest months of June, July, and August an average of two men per month were hired on each farm. About 25 man-months per farm, or 80 percent of total labor, was allocated to grass seed enterprises on the sample farms.

Regions 3, 4, and 5 reported similar labor use characteristics. Average labor use per farm was slightly over two full time man-equivalents per year in each region. Operators accounted for 12.5 to 13.2 man-months while other family members added about five man-months per year. Family labor constituted 72 to 73 percent of total farm labor use in each region. In Regions 3 and 4, some 50 percent of total labor was devoted to grass seed enterprises, while only about 20 percent of total labor reported by Region 5 farms involved grass seed production.

CAPITAL INVESTMENT

Capital investment in farming includes value of land, buildings, machinery, and livestock. Average total capital investment on the sample farms is shown in Table 12 by region. Investment figures represent total assets owned by the farm operator rather than net worth since separation of operator equity and operator debt was not made in this study. Value of land and buildings rented is excluded.

Table 12. Average Capital Investment per Farm Operator, by Region, 147 Willamette Valley Farms Raising Grass Seed, 1969[1].

Item	Region 1	2	3	4	5	Average[2]
Acres owned	128	425	326	416	269	346
Value per Acre	$786	$386	$416	$443	$475	$438
Total Operator Investment:						
Land	106, 150	163, 918	135, 856	183, 970	128, 000	151, 548
Buildings	7, 153	18, 860	17, 636	21, 132	16, 690	18, 768
Machinery	4, 584	36, 125	21, 425	24, 663	21, 082	27, 898
Livestock	2, 326	2, 460	3, 276	2, 495	15, 321	3, 862
Total	120, 213	221, 363	178, 193	232, 260	181, 093	202, 076
Grass Seed Investment:[3]						
Land	33, 800	126, 700	58, 700	89, 700	33, 600	97, 700
Buildings	2, 577	13, 985	9, 025	4, 613	10, 425	10, 494
Machinery	2, 712	30, 685	14, 755	13, 162	4, 251	19, 716
Total	39, 084	171, 320	82, 500	107, 475	48, 276	127, 910
Percent of total investment for grass seed use	33	77	46	46	27	63

[1] Includes operator equity and operator debt but does not include value of resources rented by the operator such as land and machinery. Charges for use of rented resources are included in farm expenses shown on Table 15.

[2] Averages were calculated over all farms. Ten operators owned no land, 16 no buildings, seven no machinery, and 58 no livestock.

[3] Sample operators reported the acreage and value of land devoted to each farm enterprise, and specified the total value, and proportion devoted to grass seed enterprises, for buildings and machinery.

A charge for rented resources is included as a cash farm expense in the income and expense section. Average operator investment in total farm resources ranged from a low of $120,000 in Region 1 to a high of $232,000 in Region 4, with a sample average of slightly over $200,000 per farm.

Land constituted 71 to 88 percent of total asset value in each region. Average land value per farm ranged from $106,000 in Region 1 to $184,000 in Region 4. Region 1 land values were low due to small farm size, but were bolstered by urban influence on land values per acre, which were nearly double that of other regions.

Buildings represented six percent of total operator assets in Region 1, and nine to ten percent in all other regions. Region 1 operators reported average buildings value of some $7,000 per farm, while Regions 2, 3, 4, and 5 ranged from $16,000 to $21,000 per farm.

Machinery value averaged some $4,600 per farm or four percent of total assets in Region 1, and $36,000 or 16 percent of total assets in Region 2. In Regions 3, 4, and 5, average machine investment was $21,000 to $25,000 per farm, which constituted 11 to 12 percent of average total assets in these regions.

Livestock on most farms consisted of a few animals for home use only. Average value of livestock amounted to some $2,000 to $3,000 per farm in Regions 1, 2, 3, and 4. In Region 5 several extensive livestock enterprises raised average value per farm to over $15,000, or eight percent of total assets.

Average value of resources devoted to grass seed production (exclusive of rented resources) ranged from $39,000 in Region 1 to $171,000 per farm in Region 2, with an average of $128,000 per farm over all regions. The proportion of resources devoted to grass seed production was low in Region 1 and 5 partially because timber, pasture, and other non-crop land constituted over half the farm land in Region 1 (shown in Table 10) while livestock and crops other than grass seed were primary enterprise choices in Region 5.

Although averages were calculated over all farms sampled, it was noted that ten operators owned no land, 16 no buildings, seven no machinery, and 58 no livestock.

ENTERPRISES AND LAND USE

A statement made earlier in this chapter implied that while grass seed enterprises dominate land use on most farms sampled, other crop and livestock enterprises are involved. This section is intended to analyze enterprise relationships in more detail.

Frequency of specific farm enterprises reported by the sample farms in shown by regions in Table 13, while average grass seed acreages per farm by seed type are listed in Table 14. Region 1

Table 13. Number of Farms Reporting Specified Farm Enterprises by Region for 147 Willamette Valley Farms Producing Grass Seed, 1969.

Region	1	2	3	4	5	Total
Sample Farms	5	67	48	14	13	147
Grass Seeds						
Bentgrass	0	21	24	0	6	51
Bluegrass	0	20	6	1	3	40
Fine Fescue	5	11	37	6	4	63
Tall Fescue	1	30	2	0	0	33
Orchardgrass	0	32	6	3	1	42
Annual Ryegrass	0	53	5	12	7	77
Perennial Ryegrass	0	40	3	5	1	49
Other Grasses	0	3	3	0	0	6
Other Crops						
Wheat	0	23	19	6	8	56
Oats	0	13	12	7	5	37
Barley	1	10	6	6	7	30
Other Grains	0	3	8	6	7	24
Legumes	1	9	9	2	12	33
Hay	2	7	9	2	4	24
Row Crops	1	9	11	2	0	23
Orchards	0	0	7	2	2	11
Other Crops	1	10	8	3	1	21
Pasture	3	29	27	11	8	78
Timber	3	10	18	4	1	36
Summer Fallow	0	15	26	7	2	50
Livestock						
Cattle	1	35	24	5	9	74
Sheep	1	10	12	5	5	33
Hogs	0	3	2	2	1	8
Dairy	0	0	0	0	2	2
Horses	1	1	2	1	0	5
Other Livestock	0	2	1	0	0	3

Table 14. Average Grass Seed Acreage per Farm; by Region and Seed Type on 147 Willamette Valley Farms Producing Grass Seeds, 1969.

Region:	1	2	3	4	5	Total
County:	Clackamas Multnomah	Linn, Benton, Lane	Marion	Polk	Washington, Yamhill	Sample
Number of Farms	5	67	48	14	13	147
	Acres	Acres	Acres	Acres	Acres	Acres
Bentgrass	-	48	84	-	81	56
Bluegrass	-	61	9	1	8	32
Fine Fescue	43	14	103	41	19	47
Tall Fescue	1	54	2	-	-	25
Orchardgrass	-	72	6	17	2	37
Annual Ryegrass	-	333	11	231	30	180
Perennial Ryegrass	-	107	6	43	1	55
Other Grass	-	2	4	-	-	2
Total Grass Seed	44	691	225	333	142	434
Other Crops	22	112	152	328	415	169
Total Cropland	66	803	377	661	557	603
Pasture, Timber, and Other[1]	69	73	121	69	58	87
Total Farm Acreage	135	876	498	730	615	690
Grass Seed Acreage as percent of total farm acreage	33	79	45	46	23	63
Grass Seed Acreage as percent of total cropland acreage	67	86	60	50	26	72

[1]Other land includes primarily farmstead and roads.

farms averaged 135 acres in size, with less than 50 percent listed as cropland. Pasture and timber enterprises occupy the non-crop land. Grass seed enterprises occupy 67 percent of total cropland in Region 1. Fine fescue is grown to the virtual exclusion of all other seed types (see Table 14).

Region 2 farms average 876 acres in size. Grass seed production accounts for 79 percent of total land use and 86 percent of cropland use. Ryegrasses constitute 64 percent of grass seed acreage, with production centered on "Whiteland" soil areas. Hill land and better drained bench soils in Region 2 accounted for production of bentgrass, bluegrass, tall fescue, and orchardgrass. The major valley acreage of bluegrass, tall fescue, and orchardgrass centers in Region 2.

Region 3, Marion County, is noted for its diversity of crop production. Table 14 indicates the frequency of varied enterprises even on the 48 sampled grass seed farms, with grains, hay, row crops, pasture, timber, and summerfallow reported by many operators. Grass seed occupied 60 percent of cropland acreage on the farms sampled. Highland bentgrass and fine fescue production accounted for 83 percent of the grass seed acreage and occurred primarily on well-drained hill soils of the area. Only minor acreages of each of the other five grass seed types are noted. The high incidence of summerfallow (26 to 48 farms) illustrates the difficulty of controlling weed grasses while preparing hill soils for establishment of grass seed crops.

Region 4 farms average 730 acres in size, with small grains and grass seeds sharing the predominant role in land use. Annual ryegrass dominates as the principal grass seed type, accounting for 82 percent of total grass seed acreage. Some production of fine fescue and orchardgrass occurs on rolling hills and better quality bottomland.

Crop production in Region 5 centers on small grains, fruits, nut crops, vegetables, and nursury enterprises. Grass seed production plays a minor role in crop choices, accounting for 26 percent of total cropland acreage reported by sample farms. Bentgrass and fine fescue were major grass seed types grown on well-drained hill soils, while annual ryegrass was grown on poorly-drained bottomland.

Although Table 13 indicates a high frequency of livestock enterprises on the sample farms, it was noted that in most cases only very few animals were involved, usually for home consumption. Capital investment in livestock shown in Table 12 points this out. The contribution to farm income provided by livestock is included below, indicating relatively low economic importance of livestock as enterprise choices on the sample farms with exception of Region 5.

Farm Income and Expenses

A summary of average gross farm income, expenses, and net farm income per farm by region is presented in Table 15. Gross farm income is separated into value of all grass seed produced including landlord shares, value of other crop production, value of livestock production, and value of other farm income including custom work and government payments. Gross farm income averaged $65,000 per farm, ranging from $8,100 in Region 1 to $93,000 in Region 2. Grass seed enterprises provided 78 percent of total sales in Region 2, 61 percent in Region 3, 56 percent in Region 1, 49 percent in Region 4, and 28 percent in Region 5. Other crops constituted 34 percent of gross income in Region 4 and 42 percent in Region 5, while livestock provided an additional 28 percent in Region 5.

Farm expenses were divided into seven expense categories -- cash operating expenses, land rent divided into cash and crop-share categories, livestock expense, overhead, miscellaneous operating expenses, and depreciation on machinery and buildings. Operating expenses include hired labor, seeds, chemicals, fuel, supplies, storage, and machine hire. Land rent includes cash rent and an estimated value of crop share distributed to landlords. Since

Table 15. Average Farm Income and Expenses per Farm by Source and Region, 147 Farms Producing Grass Seed, Willamette Valley, 1969.

Region:	1	2	3	4	5	Total Sample
Gross Farm Income -						
Grass Seed	4, 504	72, 528	22, 772	27, 479	15, 070	44, 596
Other Crops	1, 724	15, 776	9, 877	19, 006	22, 788	14, 300
Livestock	1, 298	1, 588	2, 644	5, 315	15, 448	3, 504
Other	577	3, 102	2, 226	4, 715	1, 308	2, 725
Total Gross Farm Income	8, 103	92, 994	37, 519	56, 515	54, 614	65, 125
Farm Expenses -						
Cash Operating	4, 946	41, 650	19, 064	22, 087	18, 778	29, 141
Cash land rent	44	7, 600	2, 164	5, 298	4, 415	5, 067
Crop-share rent[1]	0	4, 184	1, 442	1, 758	1, 370	2, 667
Livestock	352	447	1, 211	2, 350	2, 883	1, 090
Overhead	1, 454	9, 106	5, 326	8, 873	5, 953	7, 310
Miscellaneous	73	4, 130	893	3, 633	176	2, 538
Depreciation	565	6, 077	2, 897	4, 006	3, 461	4, 423
Total Farm Expenses	7, 434	73, 194	32, 997	48, 005	37, 036	52, 236
Net Farm Income[2]	669	19, 800	4, 522	8, 510	17, 578	12, 889

[1] Net crop share rent per acre received by landlords was assumed equal to average cash rent per acre reported in the area.

[2] Net farm income is the return to labor, management and capital resources owned by the farm operator. This sum can be removed from the farm operation without affecting its current capital level.

complete crop-share data was not collected, net crop share per acre received by landlords was assumed equal to average cash rent per acre reported in each area.

Livestock expense includes feed, breeding fees, and veterinary services. Overhead expenses include interest on operating capital borrowed, taxes, insurance, utilities, dues, licenses, and farm travel expenses. Miscellaneous expense includes those items which sample operators chose to lump together under this heading.

Magnitude of livestock inventory adjustments during the year were not calculated. For individual farm observations this can lead to erroneous net farm income computations. However, in this study the averaging of incomes over the sample farms was assumed to compensate for individual farm errors, since results are reported on an aggregate basis.

Average net farm income per farm ranged from $669 in Region 1 to $19,800 in Region 2. For the entire sample of 147 farms, net farm income averaged nearly $13,000 per farm for the 1969 production year.

Resource Returns

Net farm income reported in Table 15 represents earnings to operator equity capital and labor and management skills. Calculation of residual return to these resources is necessary in determining

Table 16. Estimated Average Residual Returns to Operator Capital, Labor, and Management Resources per Farm, by Region, 147 Farms Producing Grass Seed, Willamette Valley, 1969.

Item	Region: 1	2	3	4	5	Average
Average Operator Returns, or Net Farm Income	669	19, 800	4, 522	8, 510	17, 578	12, 889
Operator equity capital[1]						
Land and buildings	113, 303	163, 559	146, 660	181, 004	136, 533	156, 316
Machinery and Livestock	6, 910	30, 185	21, 713	16, 620	32, 840	25, 635
Operating capital	6, 869	38, 839	20, 223	12, 489	24, 569	27, 901
Total	127, 082	232, 583	188, 596	210, 113	193, 942	204, 852
Interest on operator equity[2]	7, 797	14, 840	11, 837	12, 960	12, 334	13, 266
Return to labor and management[3]	-7, 128	4, 960	-7, 315	-4, 450	5, 244	- 377
Number of full-time operators[4]	.68	1. 05	1. 05	1. 17	1. 10	1. 05
Charge for operator labor[5]	5, 130	7, 890	7, 860	8, 750	8, 270	7, 900
Return to capital[6]	-4, 463	11, 910	-3, 338	-240	9, 308	4, 989
Percent return to capital	0	5. 1	0	0	4. 8	2. 4

[1] Estimated from incomplete interest payment data reported by the sampled farm operators. Some overstating of operator equity is suspected thereby underestimating returns to capital.

[2] An estimated charge of what the capital could earn if invested off the farm with six percent used for long-term, seven percent for intermediate and 7.5 percent for operating capital.

[3] Residual resource claimant to labor and management, after subtracting interest on operator equity from net farm income as reported on Table 15.

[4] Operator who works 25 ten-hour days per month for 12 months.

[5] Operator labor charged at $2.50 per hour resulting in a $7, 500 per year charge for a full-time operator equivalent, representing an estimated earning potential off the farm in gainful employment.

[6] Residual resource claimant to capital, after subtracting the charge for operator labor and management from net farm income as reported on Table 15.

profitability of farm resource use. Table 16 shows the calculated resource returns to capital and operator labor and management skills. Calculation of residual returns to these two sets of resources is somewhat arbitrary, depending upon the level of charges for operator labor and management skills and capital invested deemed reasonable, by individual operators. In computing residual returns, this study used local market values of labor and capital as an opportunity cost or alternative use choice. Operator labor was assigned a value of $2.50 per hour or $7,500 per year for a full-time operator equivalent, while operator capital was assigned 6.0 percent for long-term, 7.0 percent for intermediate, and 7.5 percent for operating capital.

In Regions 1, 3, and 4, net farm income was not adequate to cover the charge for operator labor and still provide a positive residual return to operator equity capital. In Regions 2 and 3 net farm income was high enough to cover the charge for operator labor and provide a positive residual return to capital. In Region 2, residual return to capital (after assigning the return to operator labor) averaged 5.1 percent while in Region 5 it averaged 4.8 percent.

CHAPTER 5 - PART TWO

ANALYSIS OF FACTORS AFFECTING SAMPLE FARM PROFITABILITIES

Farm profitability is determined in part by the types of enterprise combinations selected and their influence in the use of resources. This suggests that initial analysis be conducted on a whole-farm basis prior to determining influences of individual enterprises, particularly grass seed types. To do so also avoids the troublesome issue of allocating overhead or fixed costs to individual enterprises, since any allocation of overhead costs is at best arbitrary.

Whole-Farm Influences

FARM TYPE

Farmers from whom data were collected operated several farm types. Some produced grass seed exclusively, but for most, grass seed production formed an integral but not necessarily dominant portion of the total farm operation.

Relative to grass seed production, the sample farms were divided into three categories for purposes of analyzing farm type differences: Type 1, seed farms, with at least 80 percent of gross farm sales derived from grass seed enterprises; Type 2, mixed, with at least 40 percent but less than 80 percent of gross farm sales derived from grass seed; and Type 3, other farms, with less than 40 percent of farm sales provided by grass seed.

Grouped according to these farm type definitions, there were 72 Type 1, 42 Type 2, and 33 Type 3 farms. Average net farm incomes for each type were $15,455, $9,738, and $11,401 per farm, respectively. This data is summarized in Table 17.

One exceptional Region 2 farm markedly affected average net farm income statistics. The farm was large and reported unusually high returns which raised Region 2 Type 1 average net income from $12,286 to $20,781 per farm. Omitting this farm, regional average returns for Type 1 (primarily grass seed) farms are $12,286, $15,591, and $5,902 per farm for Regions 2, 3 and 4, respectively.

Type 2 farms averaged $9,738 net income per farm, ranging from a low of $184 in Region 1 to a high of $21,682 in Region 2. Type 3 farms derived less than 40 percent of gross income from grass seed; enterprises other than grass seed have a strong influence upon the level of average returns ($11,301) for this group of farms. In Region 4 grain production contributed to the high returns of $17,134 per farm, while for Region 5 livestock enterprises and many crop enterprises other than grass seed added to the average net income of $15,425 per farm.

Table 17. Average Net Farm Income, by Farm Type and Region; 147 Willamette Valley Farms Raising Grass Seed, 1969.

	Region 1 Clackamas, Multnomah		Region 2 Linn, Benton Lane		Region 3 Marion		Region 4 Polk		Region 5 Washington Yamhill		Total Sample	
	No.	N. F. I.	No.	N. F. I.	No.	N. F. I.	No.	N. F. I.	No.	N. F. I.	No.	N. F. I.
TYPE 1												
80 percent grass seed	1	*[1]	47 (46)	$20, 781 ($12, 286)[2]	19	$5, 591	5	$5, 902	0	-	72 (71)	$15, 455 ($9, 909)[2]
TYPE 2												
40 percent; 80 percent grass seed	3	$184	12	21, 682	17	1, 289	5	4, 220	5	$21, 022	42	9, 738
TYPE 3												
40 percent	1	*[1]	8	11, 214	12	7, 409	4	17, 134	8	15, 425	33	11, 301
ALL FARMS	5	669	67	19, 800	48	4, 522	14	8, 510	13	17, 578	147	12, 889

*[1] Results omitted to prevent divulging information pertaining to individual farms.

[2] Aggregate results omitting a single farm reporting unusually large acreage and net income.

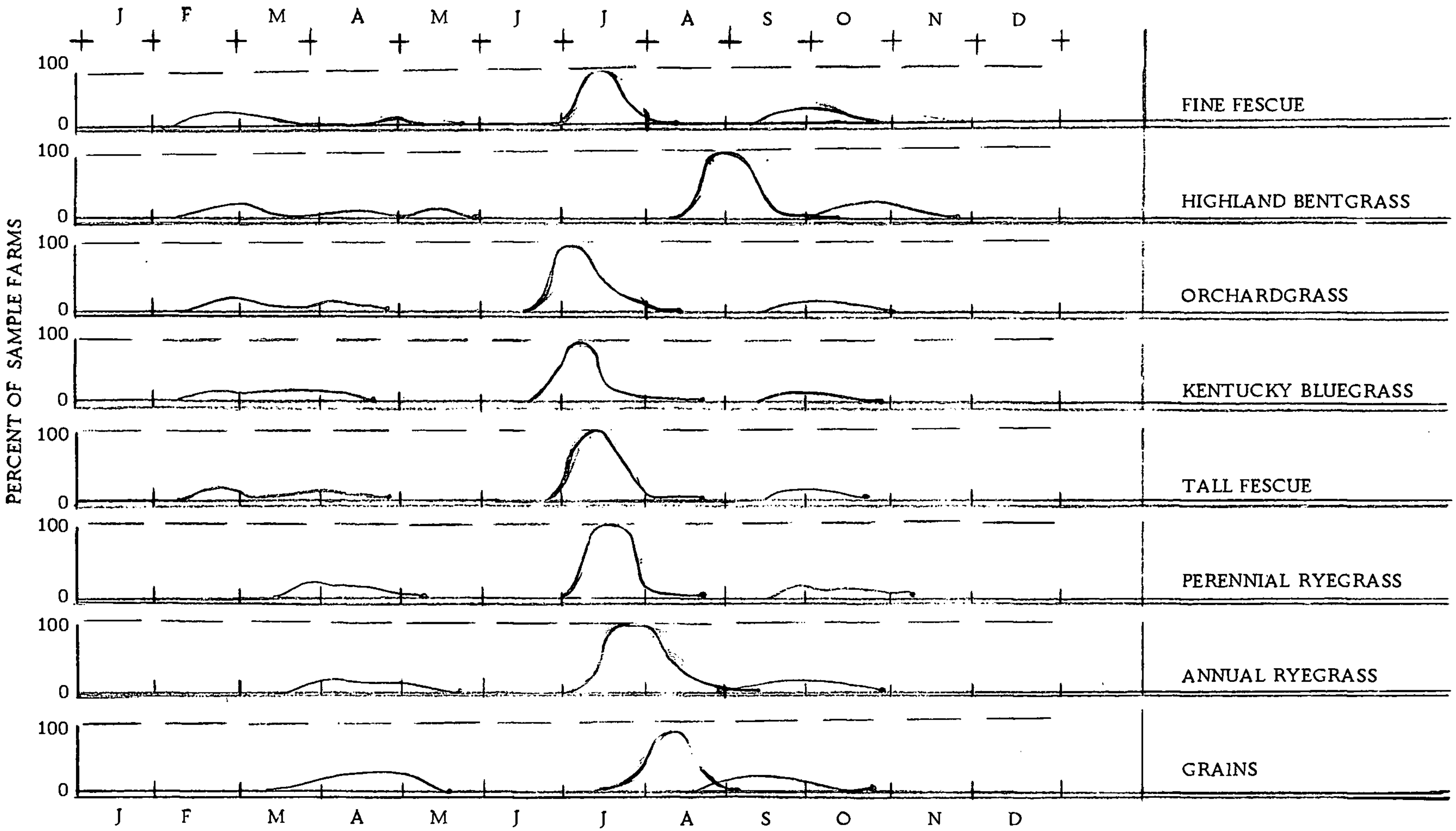
ROLE OF GRASS SEED IN ENTERPRISE COMBINATIONS

Large variations in resource use were observed on the sample farms. Resource requirements for grass seed production, like most field crops, are highly seasonal with peak periods and slack periods. The most critical are labor and machine requirements for harvesting, seed handling, and field burning. Secondary peaks occur during spring and fall applications of fertilizers and chemicals and during stand establishment. The winter months between fall and spring chemical applications involve little or no resource use. General labor and machine use requirements by month for each of the seven grass seed types and small grains are shown in Figure 15.

Complementarity

Most grass seed growers raise two or more seed types not only as a hedge against price and yield uncertainties for individual crops, but also to achieve more efficient use of fixed resources, especially family labor, machinery and storage facilities. Complementarity in resource use exists between many grass seed types in the timing of field operations. Timing of primary resource requirements is illustrated by seed type in Figure 15. In Marion County, for example, highland bentgrass and fine fescue are both grown on many farms. Although necessary field operations are essentially identical for both crops, fine fescue develops and matures about six weeks earlier than bentgrass, permitting most field operations for

FIGURE 15. Timing of Labor and Machine Use Requirement by Seed Type, Reported by 147 Sample Willamette Valley Farms Raising Grass Seed, 1969.



Spring Chemical Application includes fertilizer, herbicide, and spot spray. Harvest includes swathing, combining, and seed hauling. Fall Chemical Application includes fertilizer, if any, and herbicide, if any, and planting of annual ryegrass and grains.

fine fescue to be performed several weeks prior to respective operations for bentgrass.

Seed harvest is the cultural practice which requires the highest level of machine and labor use. Its occurrence ranges from July 5-20 for fine fescue to August 20-September 10 for bentgrass. Thus an operator can utilize labor and machinery for a longer period of time if he produces both crops than is possible if he produces only one. In Region 2 many farms produce orchardgrass, Kentucky Bluegrass, tall fescue, and ryegrass to achieve similar advantages. Harvest for these crops generally ranges from June 22 to August 15, with harvest of each successive seed type beginning some five days later. The resulting advantages are lower machinery and labor requirements for a given farm (lower fixed costs) or possible addition of more farmland which can be operated with the same fixed labor and equipment.

In Polk County complementarity often occurs with grains and annual ryegrass on the same farm. Although the two crop types sometimes compete for land and/or capital, they are complementary in the use of fixed labor and machine resources particularly during planting and harvest since these operations generally occur for annual ryegrass two to three weeks earlier than for grains.

<u>Vertical Diversification</u>

Vertical diversification exists on some 30 percent of the sample farms in the form of seed cleaning operations, as shown in Table 18. The seed cleaning function is performed after harvest during fall and winter. Essentially all operators who own cleaning facilities provide custom cleaning services for neighboring farmers. This practice effectively lowers the operators' average fixed cost of cleaning their own seed and utilizes labor during the months when no field work is required.

Some cleaning plant operators also provide seed marketing services for farmers whose seed they clean. Most farm cleaner operators do not assess an extra fee for this service. The usual practice is to reimburse the seed producer the selling price of the clean seed less the cleaning charge.

WHOLE-FARM COSTS

Whole-farm cost data was used to derive average fixed, average variable, and average total costs per acre for the entire sample and for each farm type.

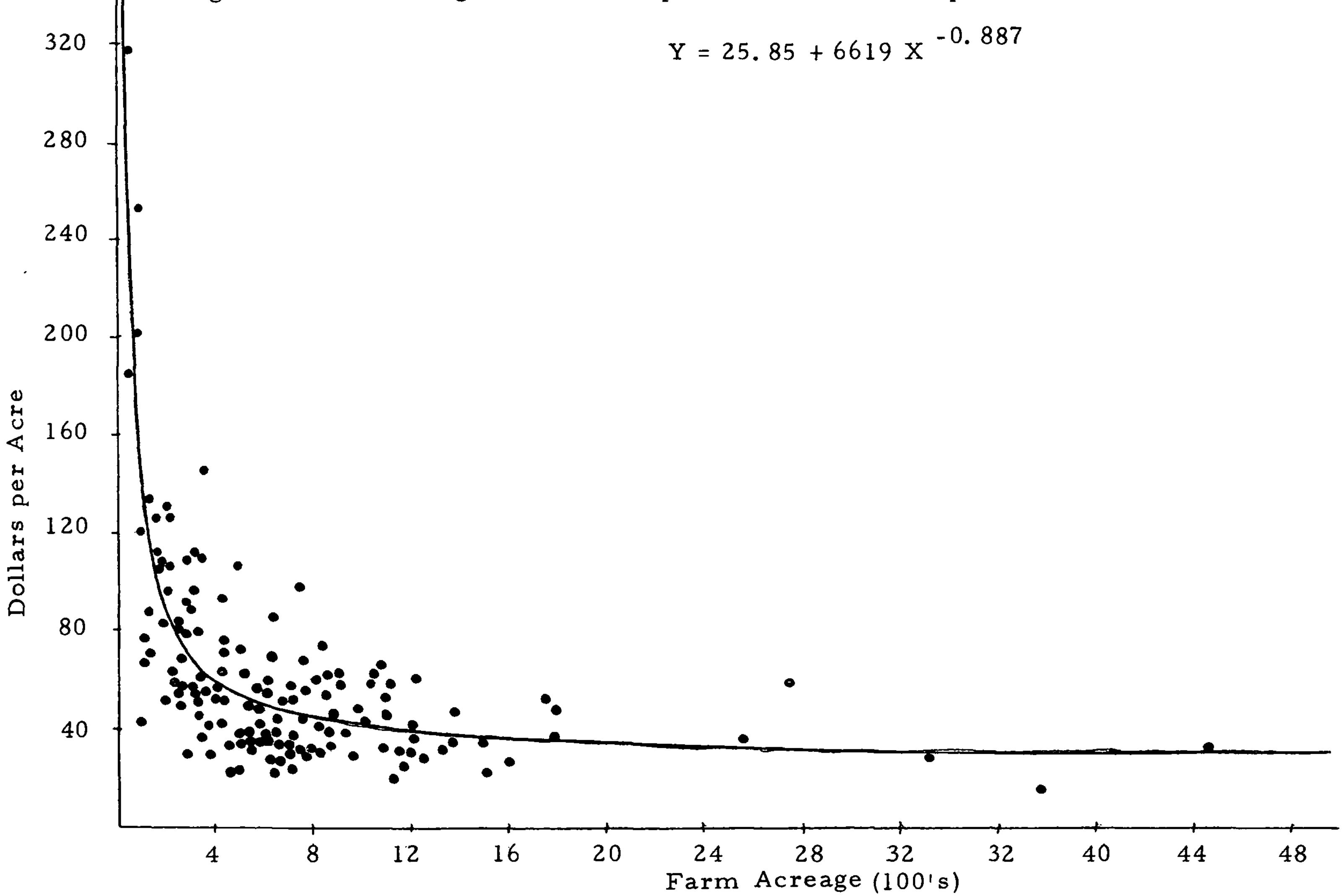
<u>Average Fixed Costs</u>

Average fixed costs per acre were plotted for each of the 147 sample farms, and curves fitted to the data for the sample and for each farm type. The mathematical model used, $Y = b_1 + b_2 x^{b_3}$,

Table 18. Seed Cleaning Facilities, Reported by 147 Sample Farms, Willamette Valley, 1969.

	Region 1 Clackamas Multnomah	Region 2 Linn, Benton Lane	Region 3 Marion	Region 4 Polk	Region 5 Yamhill Washington	Total Sample
Sample Farms	5	67	48	14	13	147
Seed Cleaners Reported	1	16	20	4	3	44
Percent of Sample Farms reporting Seed Cleaners	20	24	42	29	23	30

Figure 16-a. Average Fixed costs per acre - Total sample.



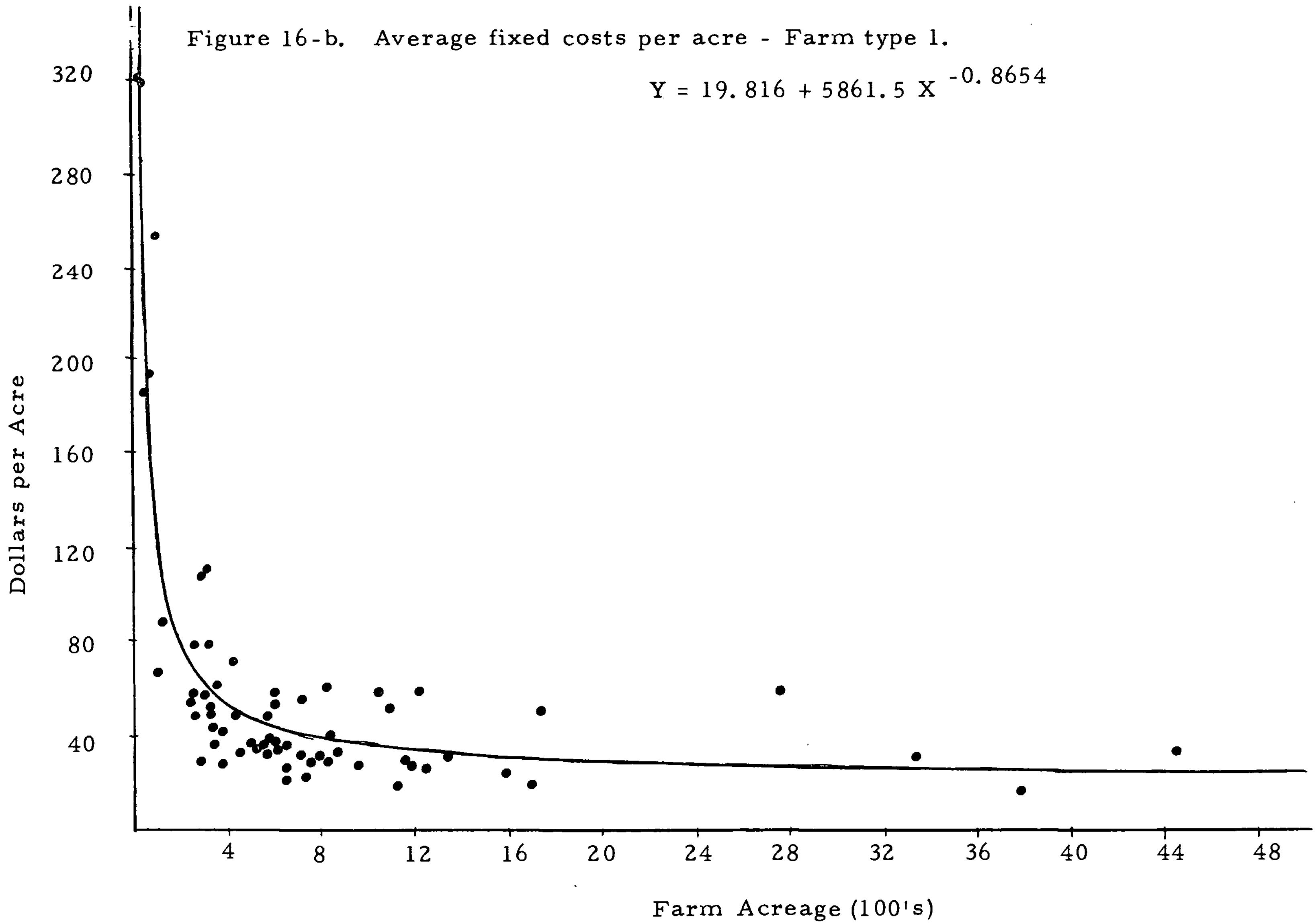


Figure 16-b. Average fixed costs per acre - Farm type 1.
Y = 19.816 + 5861.5 X -0.8654
320
280
240
200
160
120
80
40
Dollars per Acre
4
8
12
16
20
24
28
32
36
40
44
48
Farm Acreage (100's)

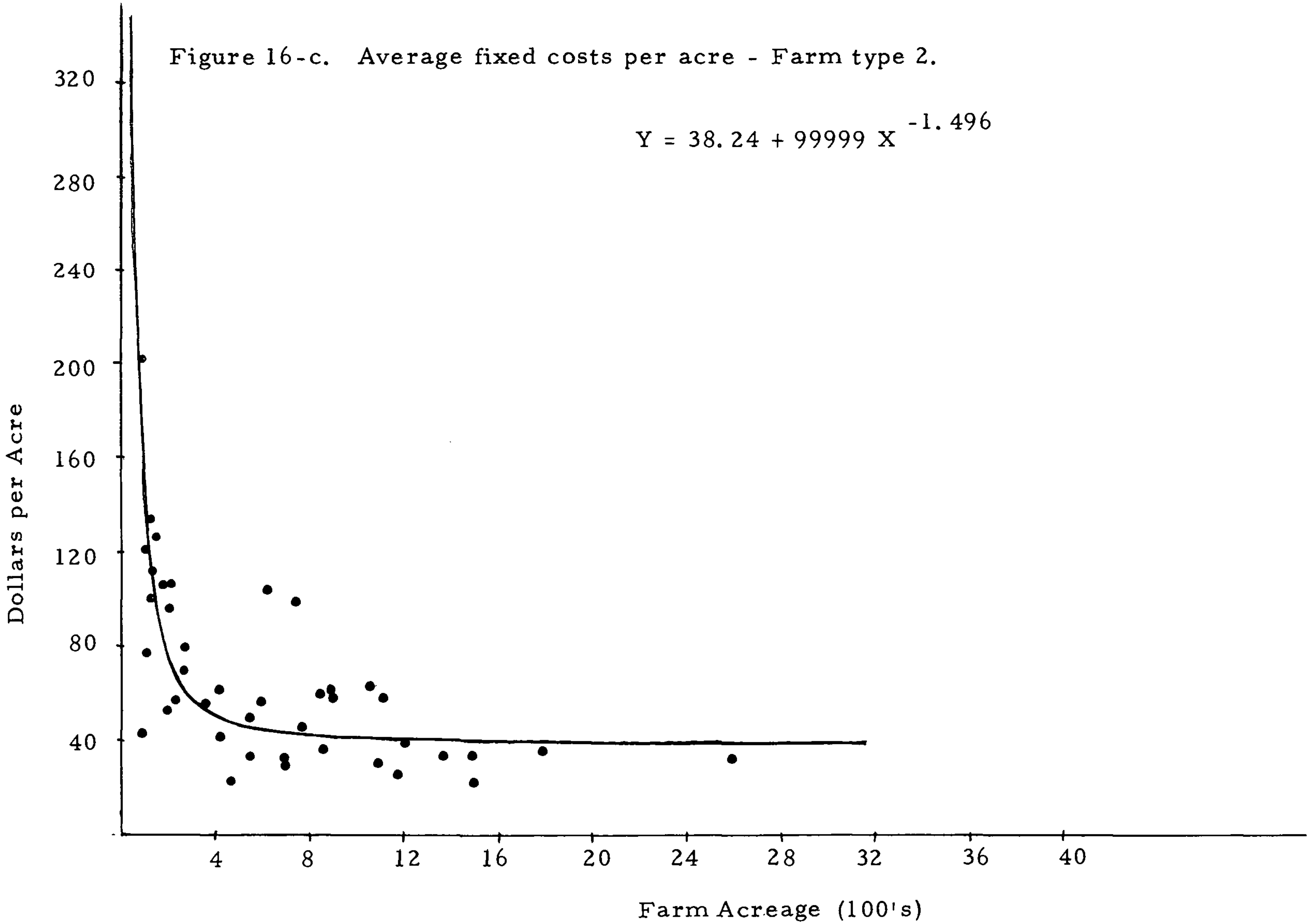


Figure 16-c. Average fixed costs per acre - Farm type 2.

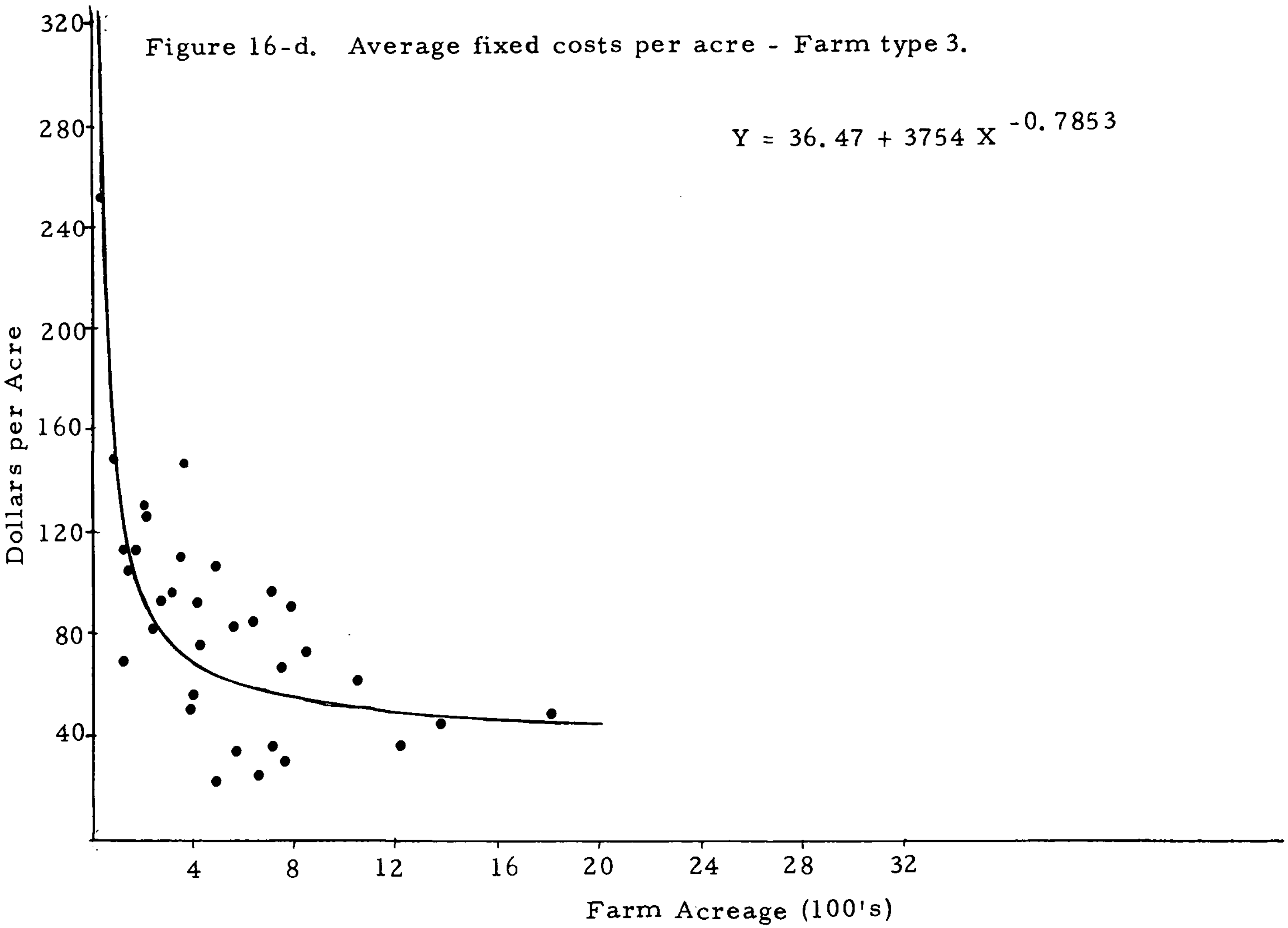


Figure 16-d. Average fixed costs per acre - Farm type 3.

was selected as a decreasing curvilinear function with convenient curve-fitting properties.

Fixed costs used in deriving curves in Figures 16.-a, b, c, d include depreciation on buildings and machinery, interest, taxes, insurance, overhead items such as utilities and licenses, and an opportunity cost charge on operator labor and real estate capital.[9/] Return to management is not included.

Average fixed costs for all farm types were similar with Type 1 farms some $12 per acre lower than Types 2 and 3. Type 2 and 3 farms included several more intensive crop choices indicating land of higher value than that customarily used for grass seed production and additional machinery components associated with more intensive cropping.

Average Variable Costs

Average variable costs per acre generally ranged from $5 to $100 for all farm sizes. A wide distribution of variable cost occurred for each farm type, as illustrated in Figures 17.- a, b, c. . Average variable costs per acre for each farm type were $40 on Types 1 and 2 and $85 on Type 3 farms. Three Type 3 farms reporting primarily intensive row crops and specialty crops had average variable costs above $200 per acre.

[9/] Operator charges of $7, 500 per man-equivalent and seven per-cent interest on investment in real estate were used.

Figure 17-a. Average variable costs per acre - Farm Type 1.

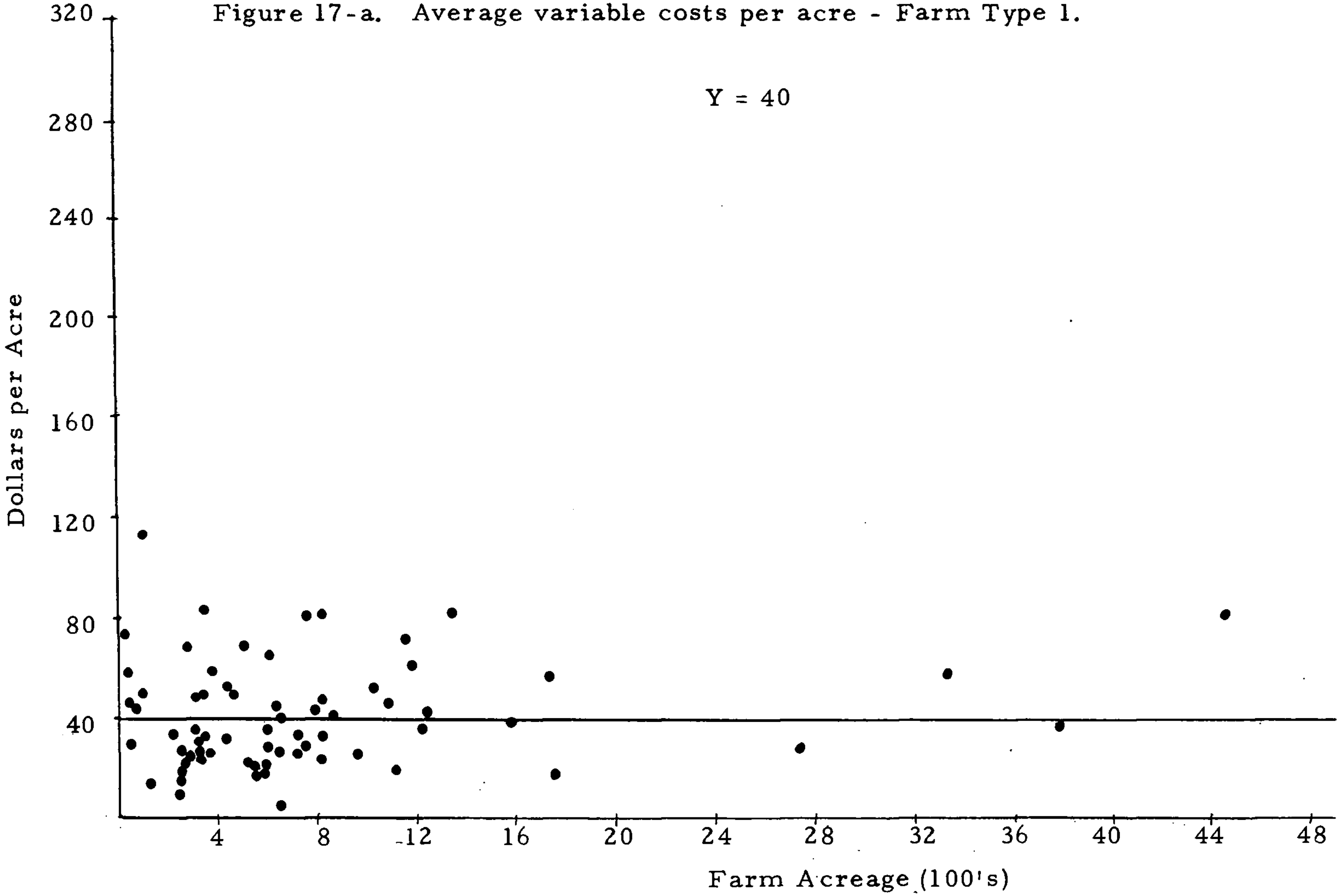


Figure 17-b. Average variable costs per acre - Farm type 2.

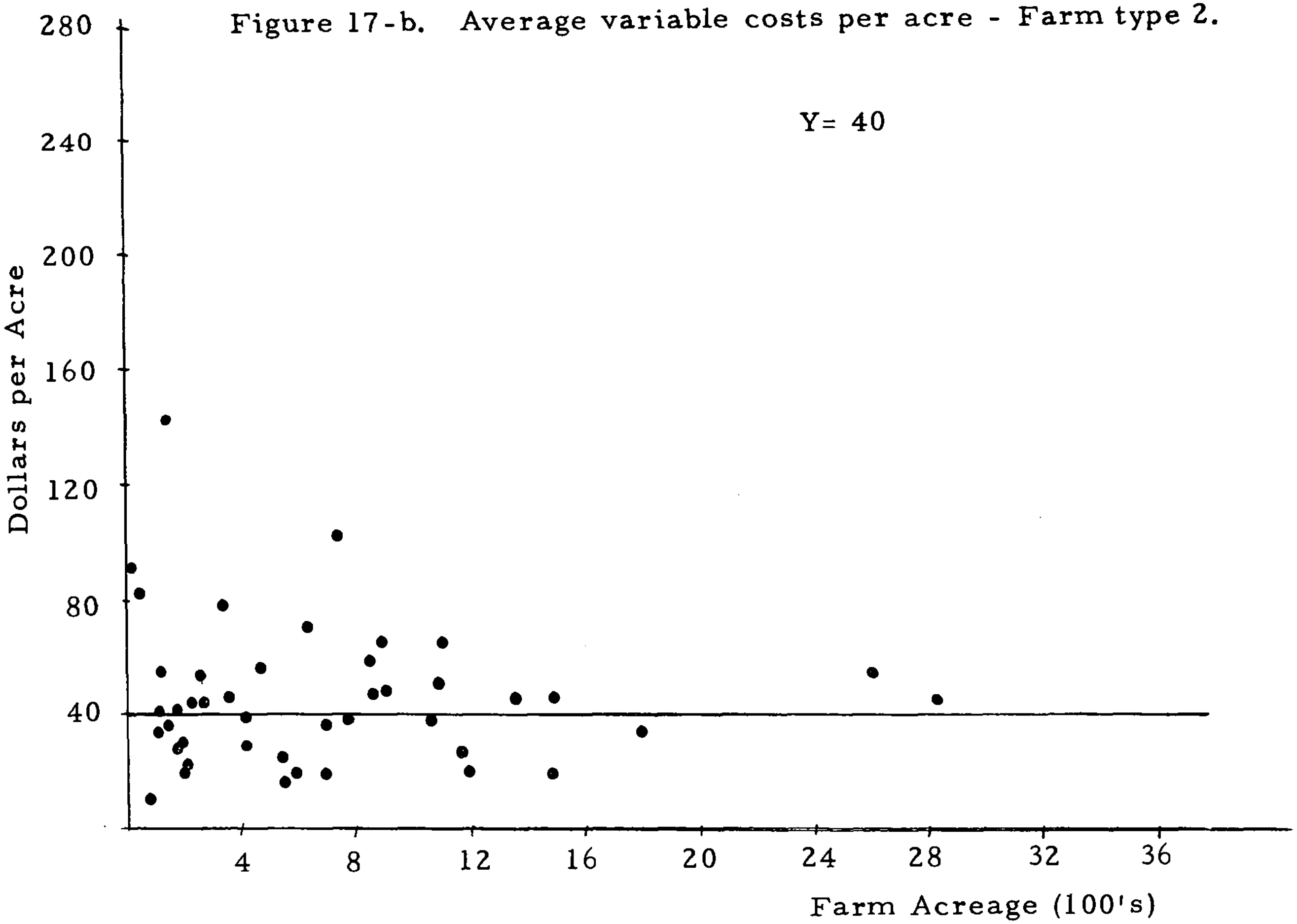
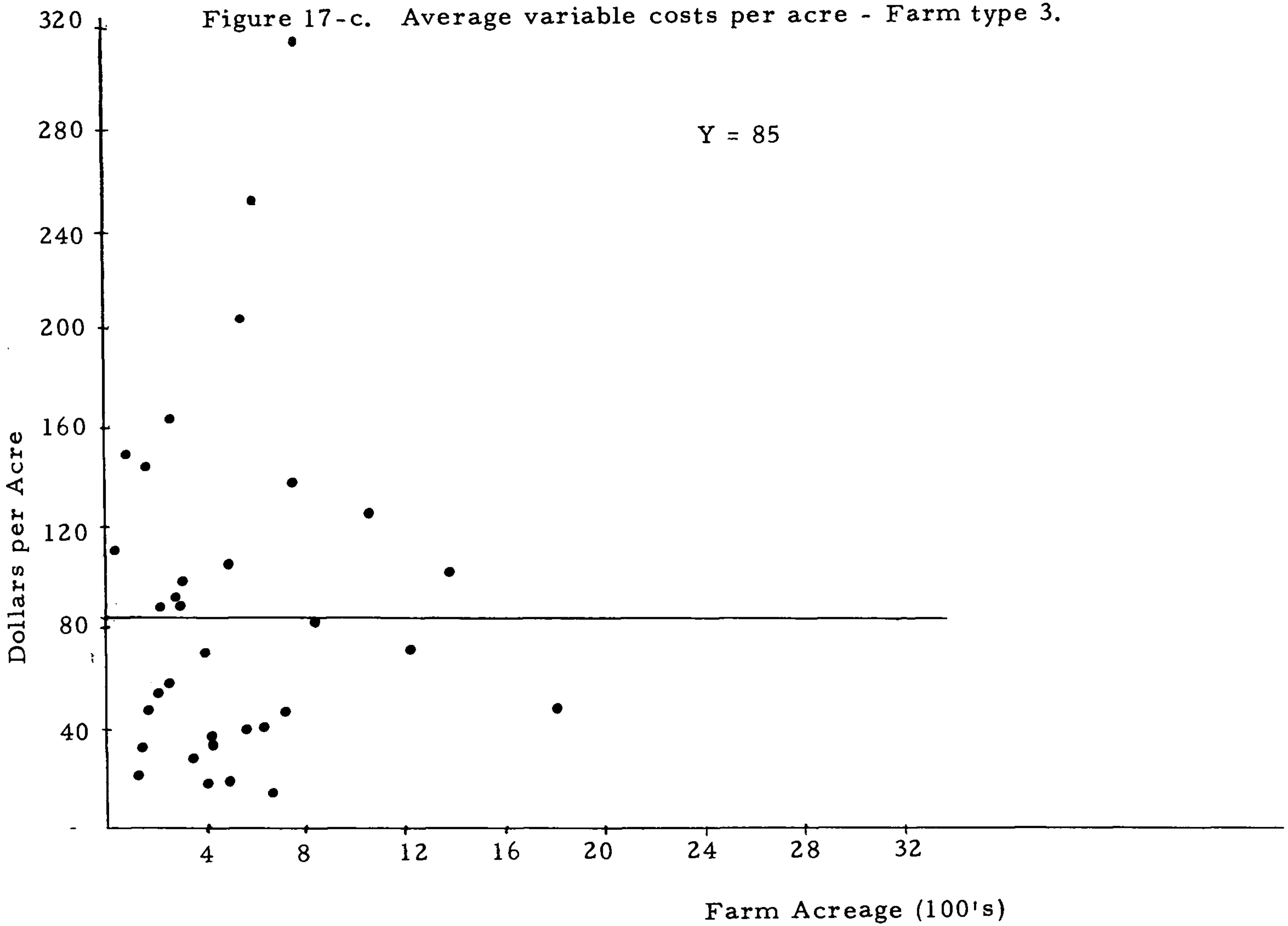


Figure 17-c. Average variable costs per acre - Farm type 3.



Low variable costs occurred in all categories. Average variable costs less than $15 per acre were reported by four Type 1, two Type 2, and two Type 3 farms.

Variability of Cost Composition

Data from the sample farms indicate a wide range exists among farms in the proportion of total costs due to fixed and variable components. This comparative analysis is illustrated in Figures 18 - a, b, c, d. Fixed costs as a percentage of total costs were calculated for each farm and plotted according to farm type and size categories. Farms under 300 acres generally had much higher proportions of fixed costs in their total cost structure than did farms in larger size categories. This trend occurred among all three farm type categories.

At the extremes, one small farm of 80 acres reported fixed costs were 95 percent of total costs. This operator was earning very poor (negative) returns to labor and capital, although variable costs were being covered by returns. A large farm, nearly 800 acres in size, reported the lowest proportion of fixed costs at 22 percent of total costs. This operator's variable costs were high due to intensive row crop enterprises which placed this farm in Type 3.

Several Type 1 (grass seed) farms over 1,000 acres reported fixed costs of 28 to 30 percent of total costs. Contributing to these low fixed costs was a high percentage of rented land with land rent included in the variable cost component.

FIGURE 18-a. Fixed Costs as percentage of Total Costs; by Farm Size; 143 Willamette Valley Farms Raising Grass Seed, 1969.

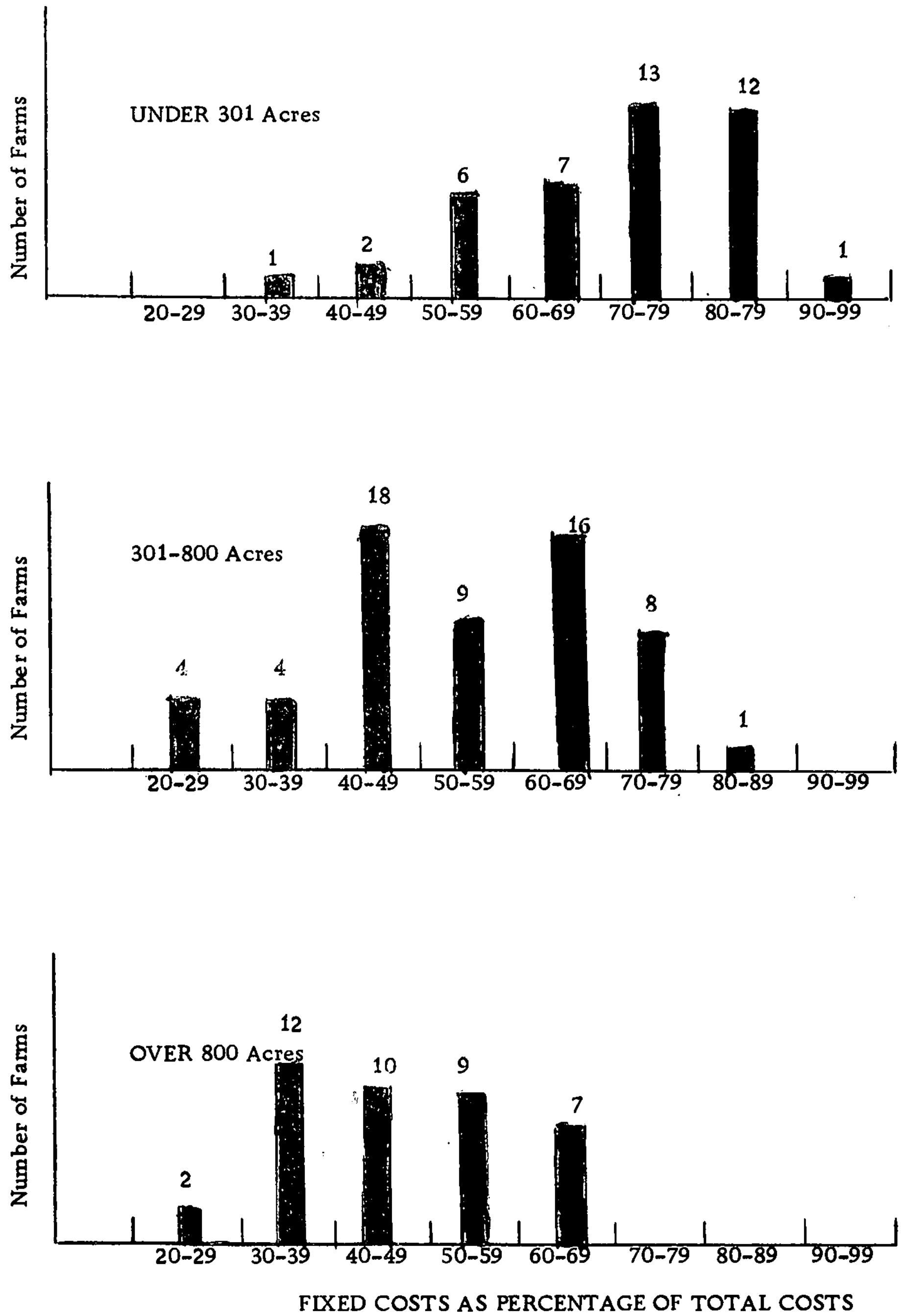


FIGURE 18-b. Fixed Costs as Percentage of Total Costs; Category One Farms (Grass seed $\geq$ 80 percent of total farm sales)

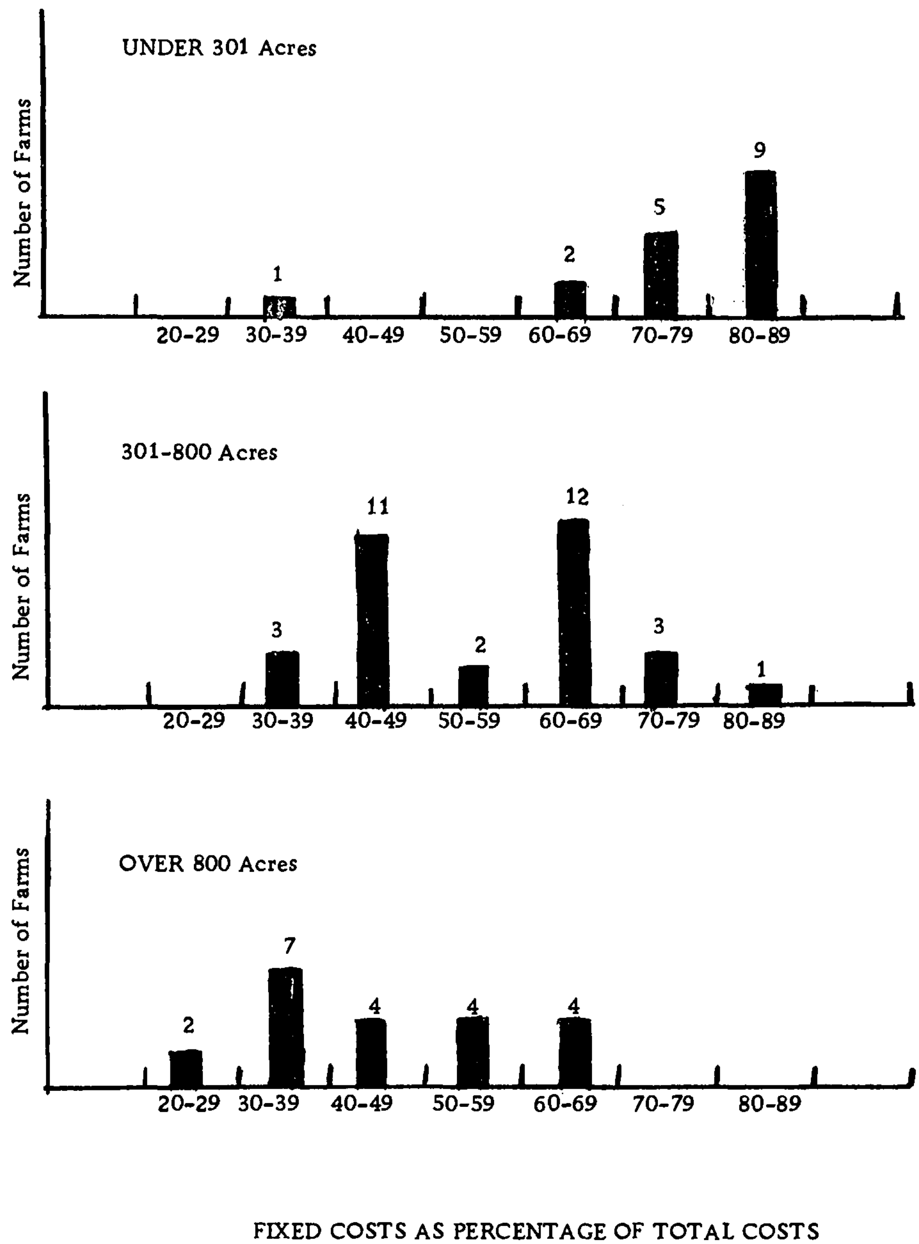


FIGURE 18-c. Fixed Costs as Percentage of Total Costs; Category Two Farms (Grass Seed Providing ≥40 percent, <80 percent of total farm sales)

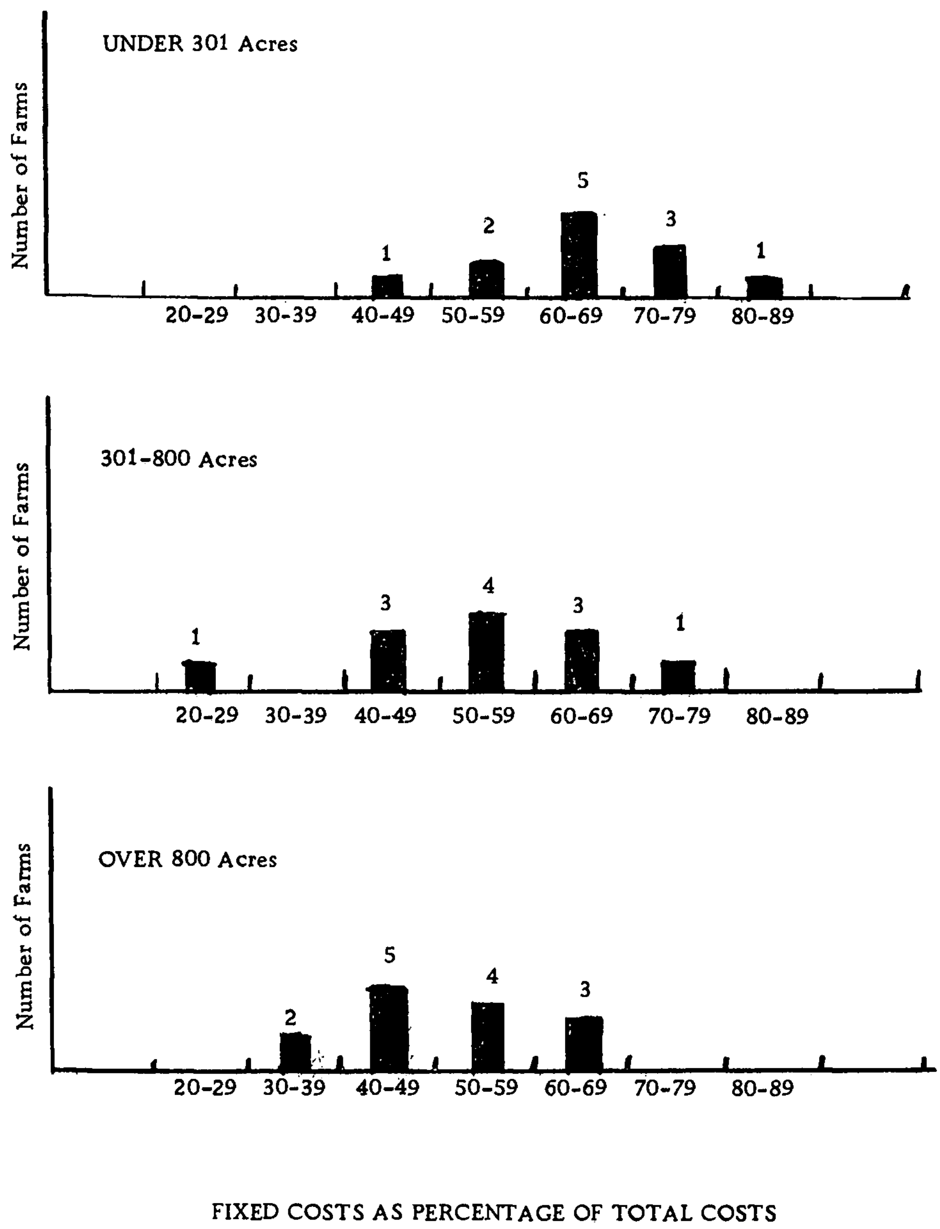
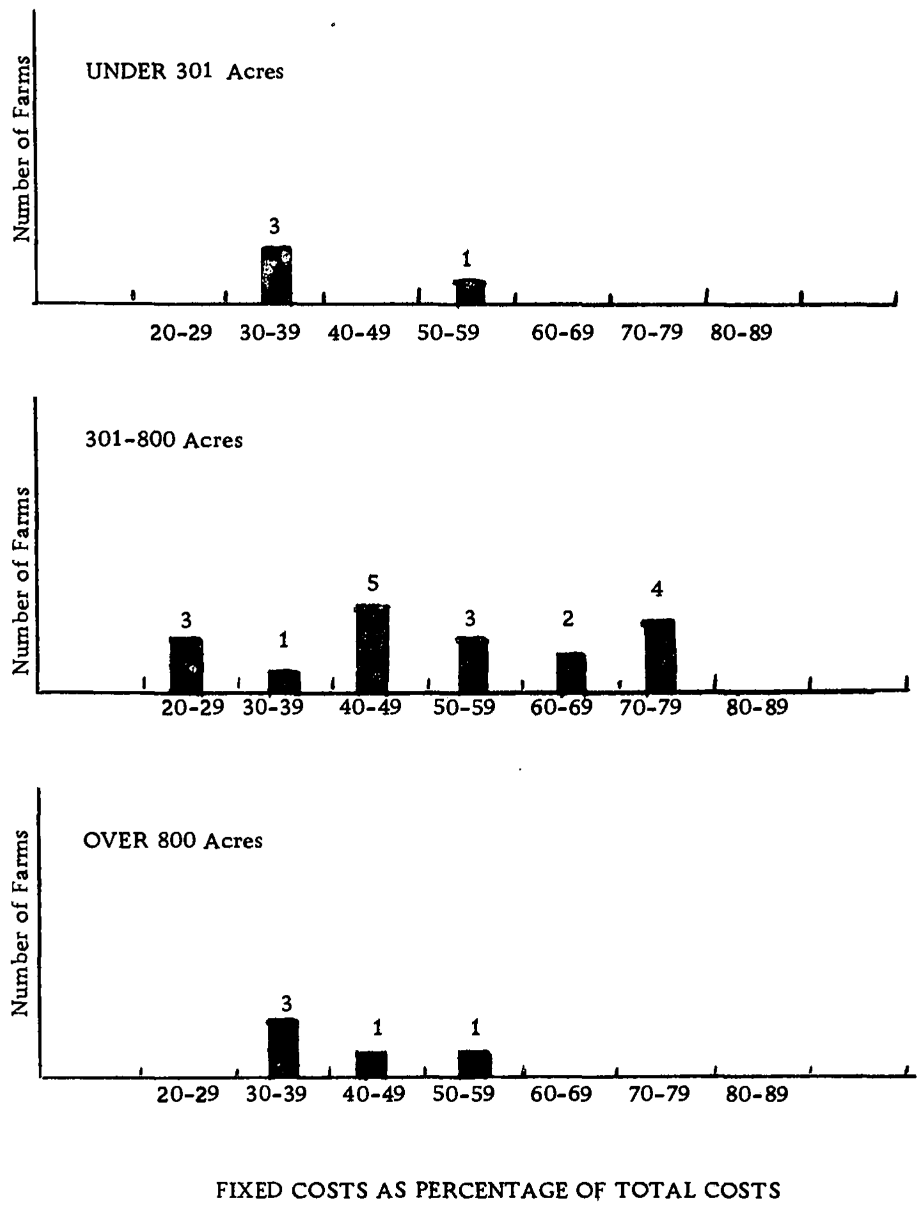


FIGURE 18-d. Category Three Farms
(Grass seed < 40 percent of total farm sales)



Average Total Costs and Farm Size Economies

Average total costs per acre were derived by simple summation of the average fixed and the average variable costs and shown in Figures 19 - a, b, c, d. Average variable costs per acre from Figure 17 showed no apparent relationship to farm size, since similar production practices are employed by farmers on each acre regardless of farm size. Consequently, the decline in the average total costs curve as farm size increases is due primarily to the average fixed cost component. Spreading of fixed costs over larger acreages produced significant size economies.

It is evident that shapes of ATC curves correspond to those of AFC curves, which decrease until farm size reaches about 600 acres and are essentially horizontal above 1,000 acres. Examination of the data plots revealed no tendency toward increasing average total costs at large farm size. Therefore, the decreasing curvilinear function $Y = b_1 + b_2 x^{b_3}$ was used to fit average total costs due to its convenient curve-fitting properties.

Average total costs for each farm type were also plotted. A curve was fitted for Type 1 ATC which appeared to be lower than total sample ATC. Curves were not fitted to Type 2 and 3 data due to its wide dispersion. Examination of the plots indicates Type 2 and 3 farms have higher average total costs than Type 1 farms. Figures 16 and 17 indicate both fixed and variable components contribute to the

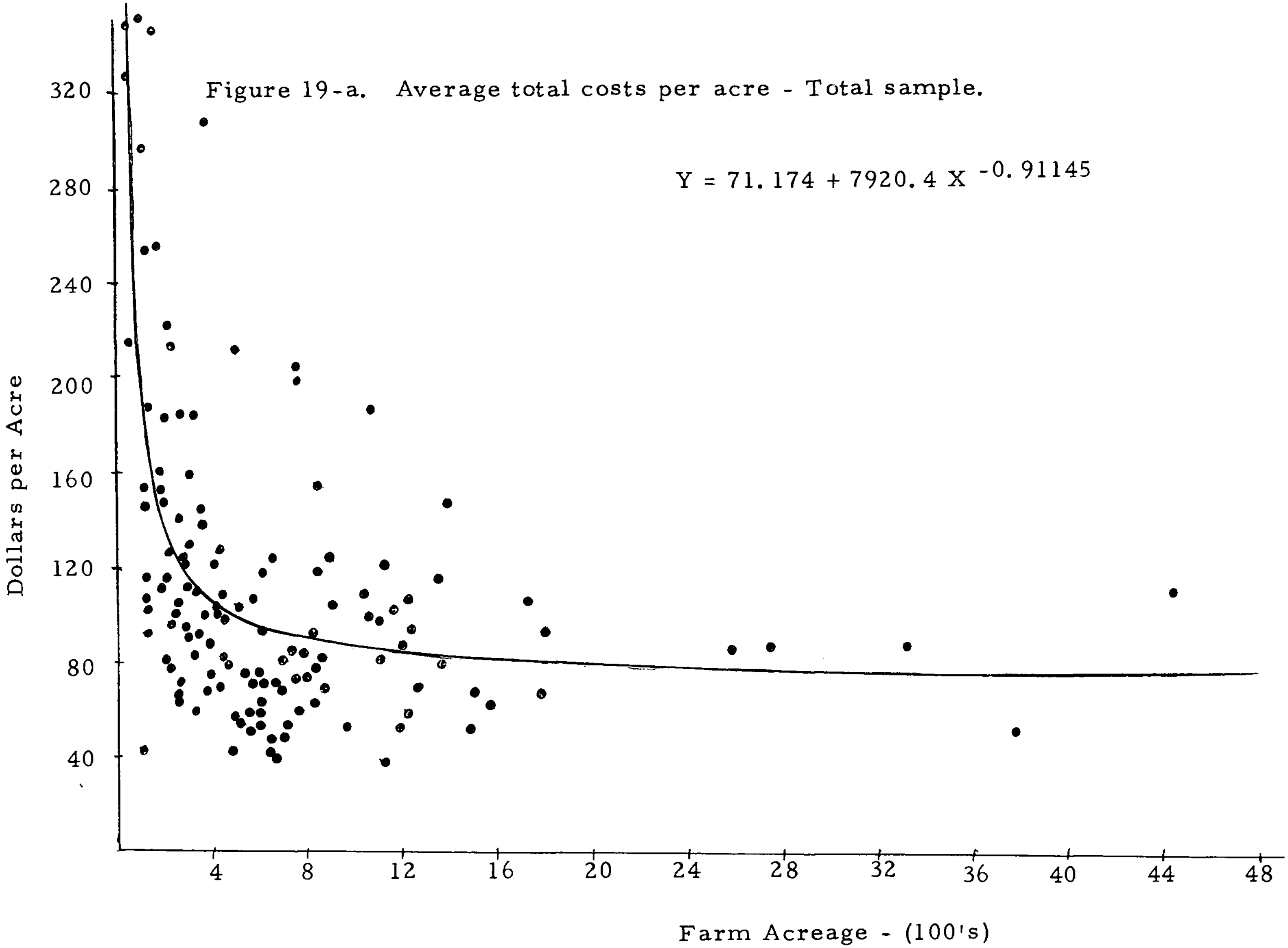


Figure 19-a. Average total costs per acre - Total sample.

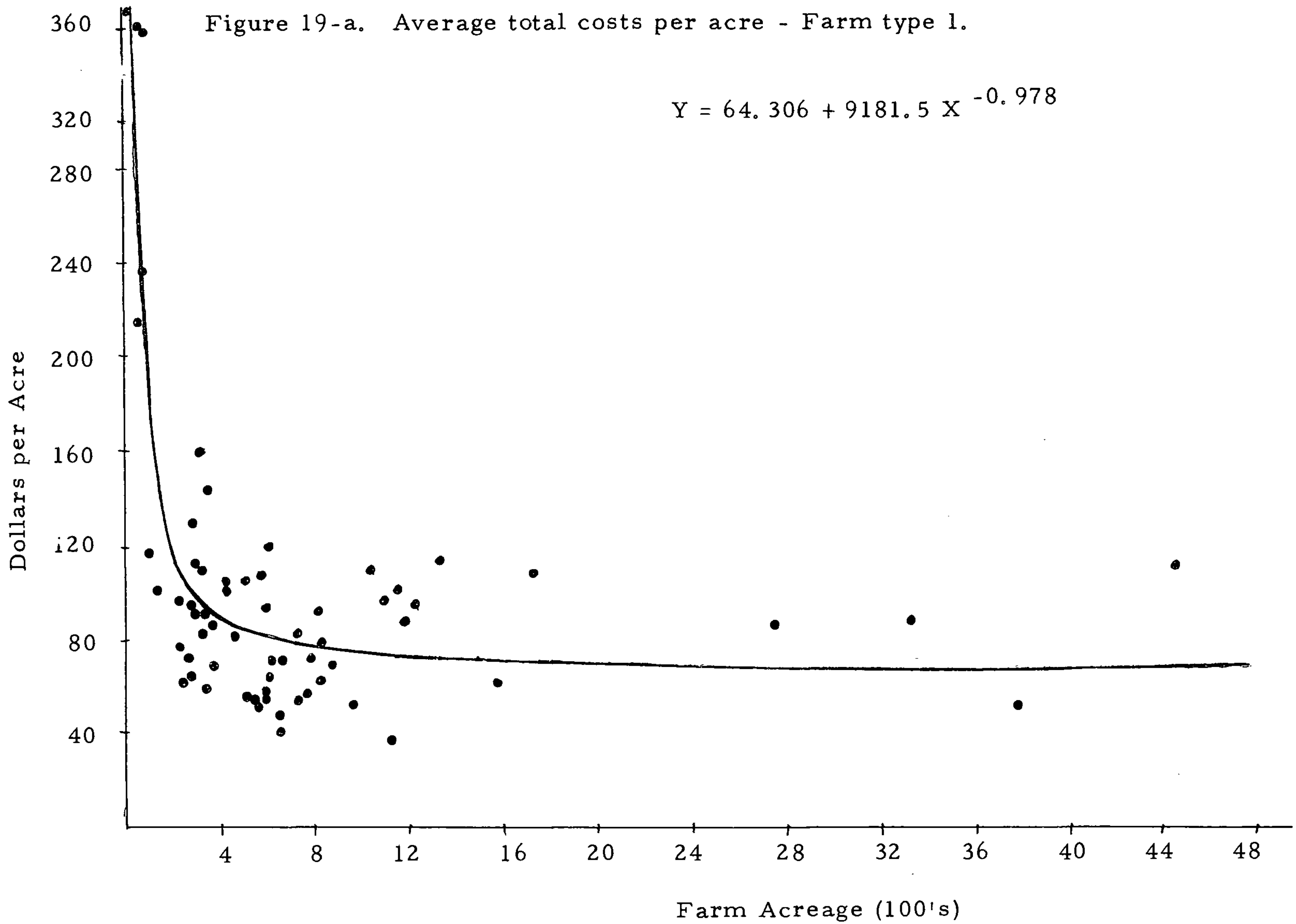


Figure 19-a. Average total costs per acre - Farm type 1.

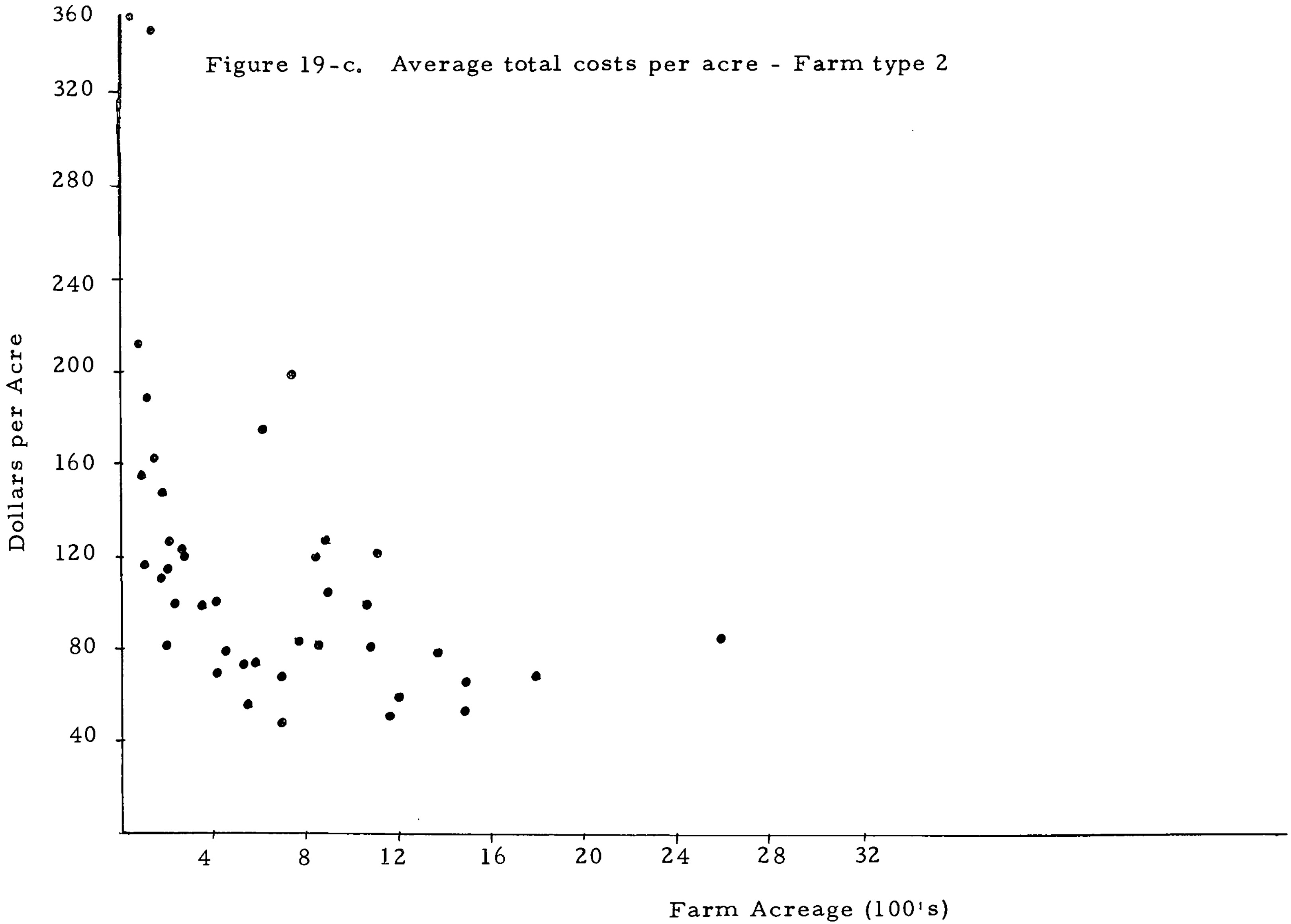
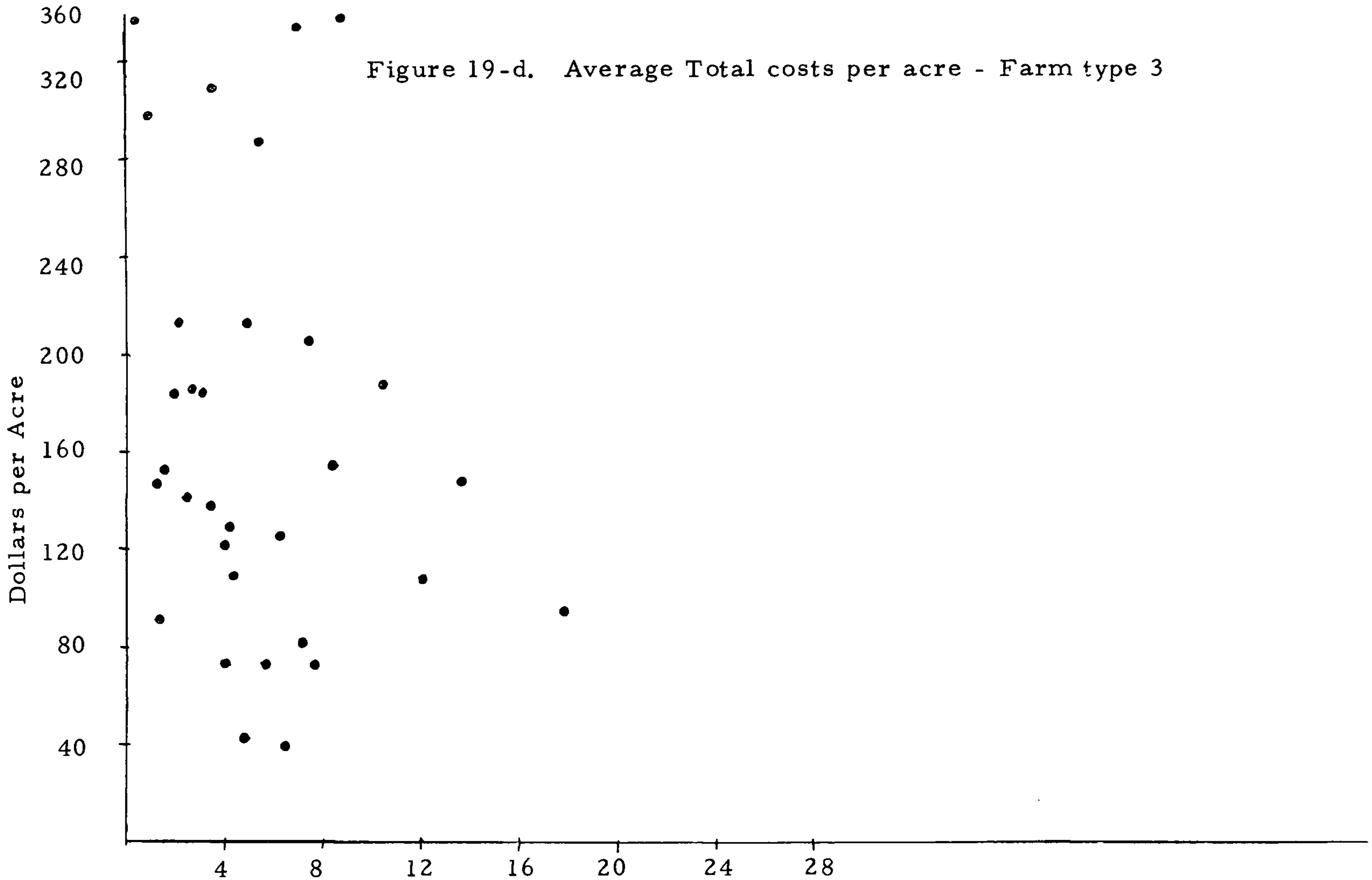


Figure 19-c. Average total costs per acre - Farm type 2

Figure 19-d. Average Total costs per acre - Farm type 3



differential. Type 1 farms are primarily limited to grass seed production, which requires a single machinery component and relatively few inputs per acre as an extensive crop alternative. Type 2 and 3 farms with major enterprises other than grass seed may require additional machinery components, adding to fixed costs, and more intensive input usage which raises variable costs.

Grass Seed Type Influences

Analyses of production costs, returns, and profitability of the seven major grass seed types are included in this section. Variations among seed types and within seed types are discussed.

GROSS RETURNS

Year-to-year variations in gross income among grass seed types were identified by analyzing Willamette Valley yield and price data over the last decade. Due to large year-to-year fluctuations in both seed yields and prices, single year data collected from sample farms was not used since it would not have accurately reflected average gross returns.

Table 19 summarizes the gross returns data. Average gross returns per acre range from $66.35 for annual ryegrass to $172.94 for orchardgrass. Standard deviation of average returns indicates the magnitude of fluctuation in returns for each seed type. Kentucky bluegrass, with the second highest gross return per acre, had the

Table 19. Yield, Price, and Gross Returns per Acre, by Seed Type. Willamette Valley, 1960-69.

	Highland Bentgrass	Kentucky Bluegrass	Fine Fescue	Tall Fescue	Orchard-grass	Annual Ryegrass	Perennial Ryegrass
Average yield, pounds per acre	250	565	390	720	730	1,290	910
Standard deviation	32.2	98.5	71.6	66.7	122.8	137.7	127.9
Coefficient of variation	.129	.174	.183	.093	.168	.107	.141
Average farm price per pound	.299	.279	.250	.128	.237	.051	.079
Standard deviation	.068	.045	.092	.035	.036	.014	.022
Coefficient of variation	.228	.161	.368	.274	.152	.275	.278
Average gross return per acre	74.82	157.82	97.65	92.37	172.94	66.35	71.66
Standard deviation	14.38	41.42	37.86	23.74	28.71	22.22	14.55
Coefficient of variation	.192	.262	.388	.257	.166	.335	.203

NOTE: Data derived from unpublished statistics compiled by county extension agents in Willamette Valley.

highest variability, with a standard deviation of $41.42. By contrast, bentgrass and perennial ryegrass, with two of the three lowest gross returns, had by far the lowest standard deviations of $14.38 and $14.55 per acre, respectively.

Coefficient of variation provides an indication of relative uncertainty or riskiness, by relating standard deviation to average. Fine fescue generated the highest coefficient of variation of gross returns due to high price fluctuation relative to average price. Bentgrass and tall fescue generated low coefficients of variation, indicating relatively sure gross income levels.

PRODUCTION COSTS

Detailed production cost data was collected for each seed type grown on most of the sample farms[10] for both establishment periods and annual production of established crops. A description of individual field operations performed on each seed enterprise during the production year included machine, labor, and material requirements. Standard hourly rates were assigned for machine use and labor (Stevens and Fehr, 1964). Machine costs include a standardized overhead component and all operating costs associated with machine use except labor which was recorded separately, and approximate total costs of machine ownership and operation.(See Appendix C).

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[10] A number of growers producing several seed types reported cost data for their primary seed type only.

Operating cost data includes all operating expenses directly associated with yearly crop production. Production costs include operating costs plus an imputed land rent, amortized establishment costs, and general farm overhead. The land charge included is the average cash rent per acre paid on land producing the particular seed type. Establishment costs include all cultural operations performed from removal of previous crop until first crop of new stand is ready for harvest. Comparison of establishment costs amortized over the average stand life of each seed type is shown in Table 20. Fine fescue growers reported high establishment costs due to longer establishment periods. Extensive cultivation occurs generally for two summers to control perennial weed grasses, in addition to several herbicide applications either preceding planting or during the first growing season. Perennial ryegrass establishment costs were low due to shorter establishment periods and fewer herbicide applications.

Annual ryegrass establishment costs include additional tillage operations practiced at three to five-year intervals to control weeds. Plowing and tillage is accomplished after harvest and field burning, then seeding is completed the same year, thus a crop year is not lost. In all other production years grassland seeding, with little or no tillage, is practiced.

Table 20. Establishment Costs per Acre, by Seed Type, Average of Sample Farms Raising Each Seed Type.

Seed Type	Life Cycle	Average Establishment costs per acre[2]	Amortized establishment costs[1]
Bentgrass	14	60.80	7.16
Bluegrass	11	64.60	8.83
Fine Fescue	10	78.20	11.37
Tall Fescue	17	46.60	4.95
Orchardgrass	11	43.00	5.88
Annual Ryegrass[3]	4	8.76	2.98
Perennial Ryegrass	10	30.00	4.37

[1] Total establishment cost amortized at 7.5 percent interest rate over life of stand.

[2] Establishment costs include all fixed and variable components of operating costs described on p. 116-117.

[3] Annual ryegrass establishment costs include only those additional tillage operations practiced at three- to five-year intervals to control weeds.

A general overhead charge of five percent of production costs was included. An examination of several farms raising a single grass seed enterprise and estimates by OSU Farm Management specialists suggested this rate.

Average production costs per acre by seed type are summarized in Table 21. Production costs per acre were quite similar for most seed types, ranging from $64 to $94 per acre. Kentucky bluegrass represents the high cost side due primarily to relatively heavy fertilizer and chemical applications and higher harvest costs compared to other seed types. Perennial ryegrass production costs were lowest of the seven grass seed types due to generally lower costs of nearly all operations.

VARIABILITY OF OPERATING COSTS WITHIN SEED TYPES

Table 22 summarizes the range of operating costs per acre for each seed type. All statistics are averages of four farms with either highest or lowest costs for the seed type. Primary elements of cost variations are large differentials in chemical applications of both fertilizers and herbicides.

Groups of high-cost farms reported costs roughly double the cost level of low-cost groups for highland bentgrass, Kentucky Bluegrass, and fine fescue. High-cost groups raising tall fescue, orchard grass, annual ryegrass, and perennial ryegrass reported average costs per acre roughly triple those of respective low-cost groups.

Table 21. Average Production Costs Per Acre, by Seed Type, for Sample Farms Raising each seed type, 1969.

	Bentgrass	Kentucky Bluegrass	Fine Fescue	Tall Fescue	Orchardgrass	Annual Ryegrass	Perennial Ryegrass
Operation							
Plow	--	--	--	--	--	1.97	--
Chisel plow	--	--	--	--	--	.07	--
Disk	--	--	--	--	--	1.39	--
Cultivate	--	--	--	--	--	.44	--
Harrow	.02	.09	--	--	.02	1.91	--
Roll	--	--	--	--	--	.64	--
Seed	--	--	--	--	--	4.81	--
Overseed	.32	.53	--	--	--	--	--
Maintain Firebreak	.54	.22	.30	.26	.82	.49	.56
Fall Fertilizer	3.92	6.61	7.56	5.30	6.84	2.87	4.08
Fall Herbicide	4.25	7.50	4.54	5.75	5.86	.58	3.30
Spring Fertilizer	11.71	14.90	9.73	16.42	12.33	10.75	11.32
Spring Herbicide	2.09	5.72	1.75	1.54	2.22	1.09	1.05
Spot Spray	.69	.83	1.90	.89	.63	.05	.23
Haul Chemicals	.01	.02	.05	.02	--	.16	.01
Hand Weeding	--	--	.78	.15	.34	--	--
Windrow	2.70	2.38	2.13	2.08	2.54	2.26	2.01
Combine	11.50	13.83	10.43	7.91	9.10	7.85	7.47
Haul Seed	1.28	1.17	1.16	.94	1.16	1.25	1.16
Seed Cleaning	5.77	6.66	10.88	6.91	9.38	10.05	6.76
Insurance	.02	.16	.01	--	.01	.01	--
Field Burning	.69	.94	1.08	.72	.89	.60	.60
Management	.39	.81	.29	.43	.84	.52	--
TOTAL OPERATING COSTS	45.90	62.37	52.59	49.32	52.98	49.76	38.55
Amortized Established Costs[1]	7.16	8.83	11.37	4.95	5.88	2.98	4.37
Production Costs	53.06	71.20	63.97	54.27	58.86	52.74	42.92
General Overhead (5 percent)	2.65	3.56	3.20	2.71	2.94	2.64	2.15
Average Land Rental	17.52	19.44	15.04	18.45	19.95	17.11	19.04
TOTAL PRODUCING COSTS PER ACRE	73.23	94.20	82.21	75.43	81.75	72.49	64.11
Number of Sample Farms	35	22	42	20	24	44	30

[1] Operating costs incurred during establishment period were amortized over life of stand, at 7.5 percent rate of interest.

Table 22. Operating Cost Variability; Per Acre Costs by Seed Type. Averages of four high-cost farms and four low-cost farms for each seed type, 1969.

Operation	Highland Bentgrass		Kentucky Bluegrass		Fine Fescue		Tall Fescue		Orchard-grass		Annual Ryegrass		Perennial Ryegrass	
	high cost farms	low cost farms	high cost farms	low cost farms	high cost farms	low cost farms	high cost farms	low cost farms	high cost farms	low cost farms	high cost farms	low cost farms	high cost farms	low cost farms
Plow	--	--	--	--	--	--	--	--	--	--	3.27	--	--	--
Chisel Plow	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Disk	--	--	--	--	--	--	--	--	--	--	1.12	.58	--	--
Cultivate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Harrow	.13	--	--	--	--	--	.13	--	.13	--	4.81	--	--	--
Roll	--	--	--	--	--	--	--	--	--	--	2.63	.31	--	--
Seed	--	--	--	--	--	--	--	--	--	--	10.86	1.35	--	--
Overseed	2.75	--	1.25	--	--	--	--	--	--	--	--	--	--	--
Maintain Fire-break	3.13	.14	.34	.07	--	.23	.14	.02	.27	.46	.14	.07	2.99	--
Fall Fertilizer	11.33	1.71	9.42	2.06	14.15	--	5.41	3.03	14.76	1.18	1.02	1.18	10.32	1.18
Fall Herbicide	7.15	1.97	11.72	4.08	5.16	2.89	9.60	4.12	12.57	3.40	--	--	7.75	3.27
Spring Fertilizer	15.04	8.46	16.99	10.07	12.24	9.17	22.68	9.58	16.95	9.58	17.74	7.38	17.97	6.07
Spring Herbicide	4.61	1.10	7.38	3.56	.65	1.42	2.34	.23	3.19	2.01	1.22	.45	1.43	--
Spot Spray	.63	--	1.31	1.27	3.99	--	2.87	--	1.00	--	.20	--	.20	--
Haul Chemicals	--	.05	--	--	.19	--	--	.07	--	--	--	--	--	--
Hand Weeding	--	--	--	--	.63	--	.69	--	.63	--	--	--	--	--
Windrow	2.26	1.28	3.12	1.94	1.28	2.37	2.64	.80	3.97	1.25	1.98	1.81	2.41	1.19
Combine	15.91	11.33	5.93	10.56	13.58	8.45	9.52	2.94	10.94	3.78	10.88	4.92	9.53	4.22
Haul Seed	1.47	2.13	1.58	1.72	.53	1.11	1.30	1.33	1.53	.95	1.01	1.08	.82	1.18
Seed Cleaning	9.07	6.90	8.93	5.00	21.13	11.26	14.57	2.15	18.13	7.00	18.96	8.00	16.22	2.10
Insurance	--	--	.75	--	.01	--	--	--	--	--	.14	--	--	--
Field Burning	.98	.34	.79	.85	1.17	.91	1.10	.90	1.35	.60	1.25	.75	.10	.43
Management	.31	.01	--	.06	.83	--	.63	.20	1.15	--	.94	.16	--	--
Total Operating Costs	74.77	35.42	84.51	41.24	75.54	37.81	73.62	25.37	86.57	30.21	78.17	28.04	69.74	19.64
Average Seed yield (pounds)	394	345	611	738	644	563	1000	700	912	912	1650	1128	850	850
Average stand life (years)	12	15	10	9	6	12	12	18	11	10	--	--	10	7

Perennial ryegrass costs were $69.74 and $19.64 per acre for the high-cost and low-cost groups, respectively, for the highest disparity. These wide ranges of operating costs are analyzed further by a breakdown of their variable cost components, shown in Table 23. The variable costs exclude the fixed machine cost and operator labor component included in operating costs.

Variability of average variable costs per acre both among seed types and within seed types are shown. Averages for all farms reporting respective seed types ranged from $25.86 on perennial ryegrass to $40.55 on Kentucky Bluegrass. Even greater variability existed within seed types, where group averages of four farms reporting highest costs per acre and four farms reporting lowest costs per acre were calculated for each seed type. Orchard grass groups, for example, ranged from $19.36 per acre (average of four low-cost farms) to $60.03 per acre (average of four high-cost farms).

Variable machine costs consisted of the variable cost component of total machine costs. Average machine costs ranged from $6.66 on perennial ryegrass to $10.44 on Kentucky Bluegrass. Within seed types, orchard grass machine costs (variable component) ranged from $3.68 per acre to $13.37 per acre, again comparing groups of four farms.

Variable labor costs represented hired labor other than paid family labor. As a relatively small component of total variable costs,

Table 23. Variability of Average Variable Costs Per Acre[1], by Seed Type; 147 Willamette Valley Farms, 1969.

	Average-All Farms				Average-4 high-cost farms				Average-4 low-cost farms			
	Machine	Labor	Materials	Total	Machine	Labor	Materials	Total	Machine	Labor	Materials	Total
Highland Bentgrass	8.41	1.35	18.12	27.88	11.38	2.26	35.01	48.65	7.44	1.03	11.72	20.19
Kentucky Bluegrass	10.44	2.06	28.05	40.55	13.48	4.76	38.89	57.13	7.00	1.53	17.64	26.17
Fine Fescue	9.89	.78	20.05	30.72	15.08	.85	29.29	45.22	8.66	.48	11.36	22.50
Tall Fescue	7.06	2.01	27.08	36.15	11.96	2.86	36.15	50.97	2.93	1.49	14.14	18.56
Orchard Grass	8.55	2.17	24.39	35.11	13.37	4.29	42.32	60.03	3.68	1.52	14.16	19.36
Annual Ryegrass	10.24	1.66	15.82	27.72	15.70	2.40	26.99	45.09	6.76	.70	7.68	15.14
Perennial Ryegrass	6.66	1.45	17.75	25.86	11.39	1.62	36.61	49.62	3.44	.93	8.40	12.76

[1]Excludes fixed component included in operating costs of Table 21 and Table 22.

average labor costs per acre ranged from $.78 on fine fescue to $2.17 on orchard grass. It was observed that about ten percent of total fine fescue labor was hired, while almost 40 percent of total orchard grass labor was hired.

Material costs included primarily fertilizer and herbicides. Average material costs per acre ranged from $15.82 on annual ryegrass to $28.05 on Kentucky Bluegrass. Wide ranges occurred on orchard grass with $14.16 for the low-cost group of four farms and $42.32 for the high-cost group, and on perennial ryegrass with group averages of $8.40 and $36.61.

SEED YIELD AND STAND LIFE

Seed yield and stand life data reported in Table 22 were compiled to analyze the effects of input intensity on returns through seed yield and stand life. Although fertilizer application constituted a primary element of cost variations within seed types, yield data show that yields do not vary significantly. Tall fescue and annual ryegrass seed yields showed significant relationships to cost levels, while little if any yield variations appear for the remaining seed types. Kentucky bluegrass yield was lower on the four high-cost farms than on the four low-cost farms.

Stand life can also be affected by input intensity, according to farmers interviewed. Table 22 statistics show no positive effect of input intensity on stand life; however, Highland bentgrass, fine fescue, and tall fescue stand lives correlate inversely to costs, with low-cost operators reporting longer stand lives.

Seed yields per acre for each farm by region were plotted against variable costs per pound of seed to illustrate variations in operating costs per pound caused by input intensity and possible regional differences in soil characteristics, as shown in Figures 20-a to 20-g. Wide ranges of seed yields and costs per pound existed for all seed types. Discernable relationships between yield and average unit cost existed on Kentucky Bluegrass, fine fescue, and orchardgrass indicating that higher yields tended to decrease average unit costs for these crops. No recognizable trend existed between yield and average unit cost for highland bentgrass, tall fescue, annual ryegrass, or perennial ryegrass.

Average variable costs per pound ranged from 1.8 cents to 16.6 cents on highland bentgrass, 1.4 to 14.5 cents on Kentucky bluegrass, 2.1 to 12.0 cents on fine fescue, 1.5 to 5.4 cents on tall fescue, 1.6 to 9.6 cents on orchard grass, 0.9 to 4.8 cents on annual ryegrass, and 0.6 to 7.8 cents on perennial ryegrass.

Few regional trends were evident, indicating the reliability of operators' grass seed enterprise choices as a measure of soil characteristics, i.e., soil producing Highland Bentgrass in Benton County is similar to soils producing that crop in Marion County, for

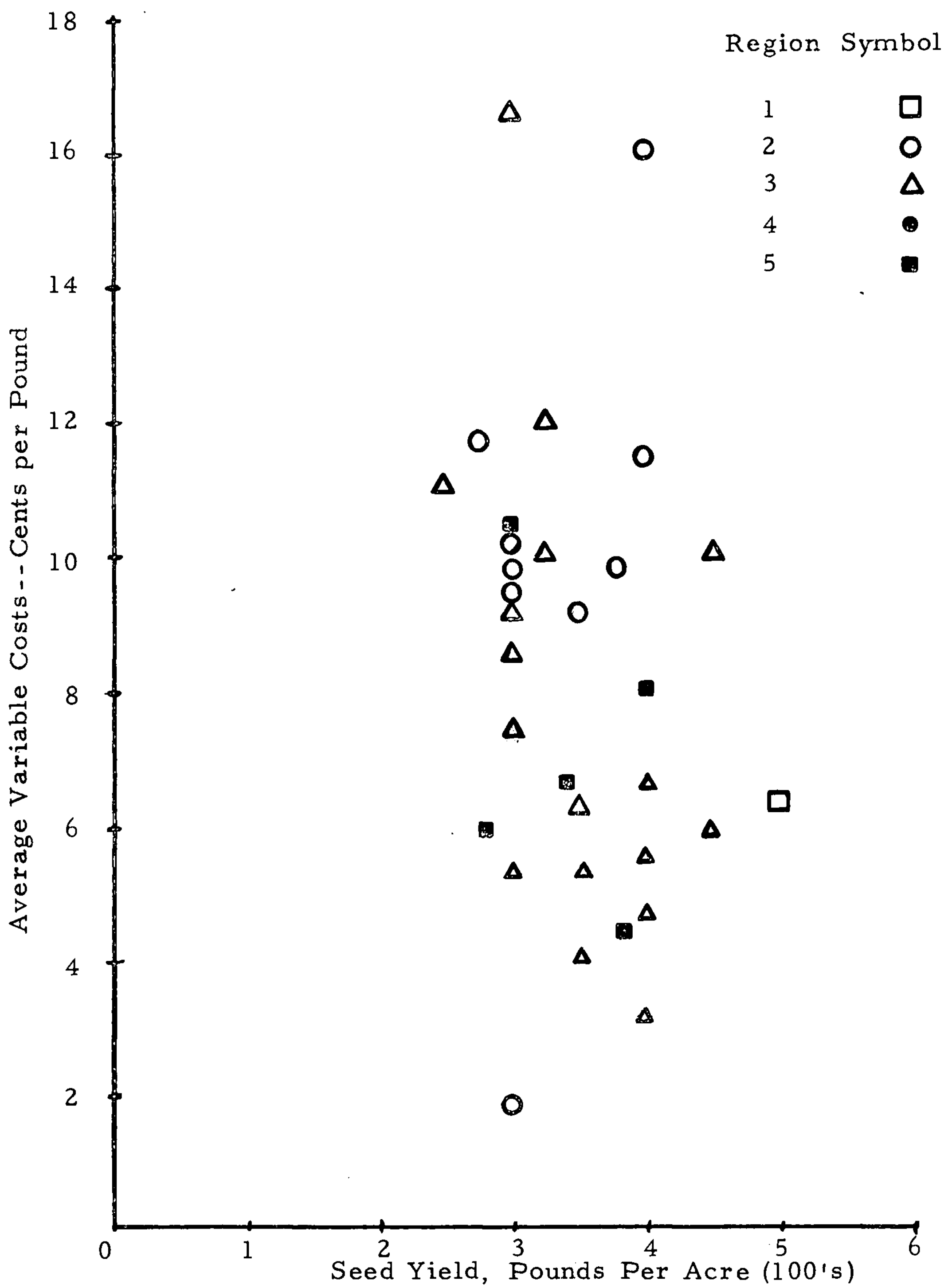

Figure 20. Variable Costs per Pound, by Seed Type, Reported by Sample Willamette Valley Farms Raising Grass Seed.

A. Bentgrass

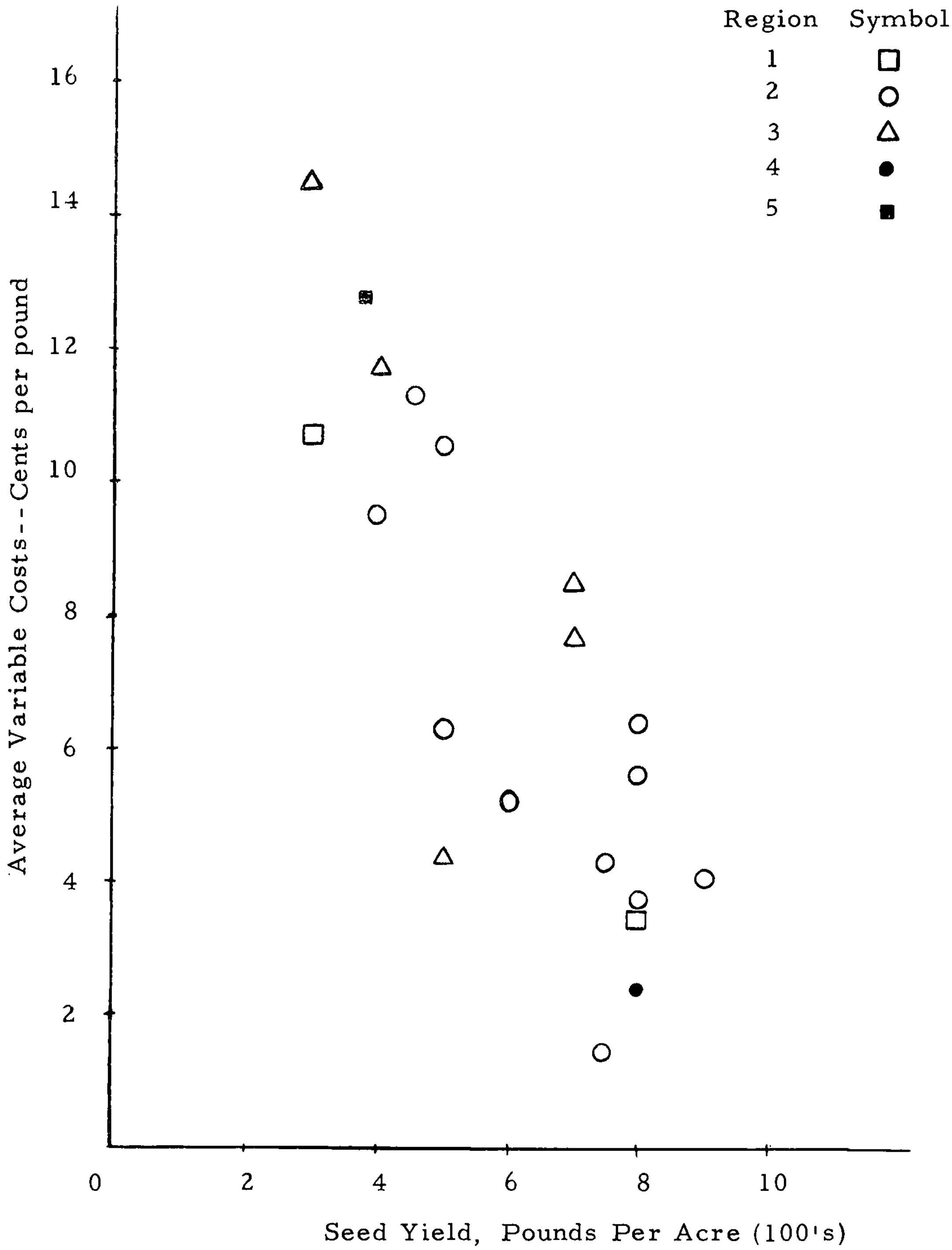

Figure 20-b. Bluegrass

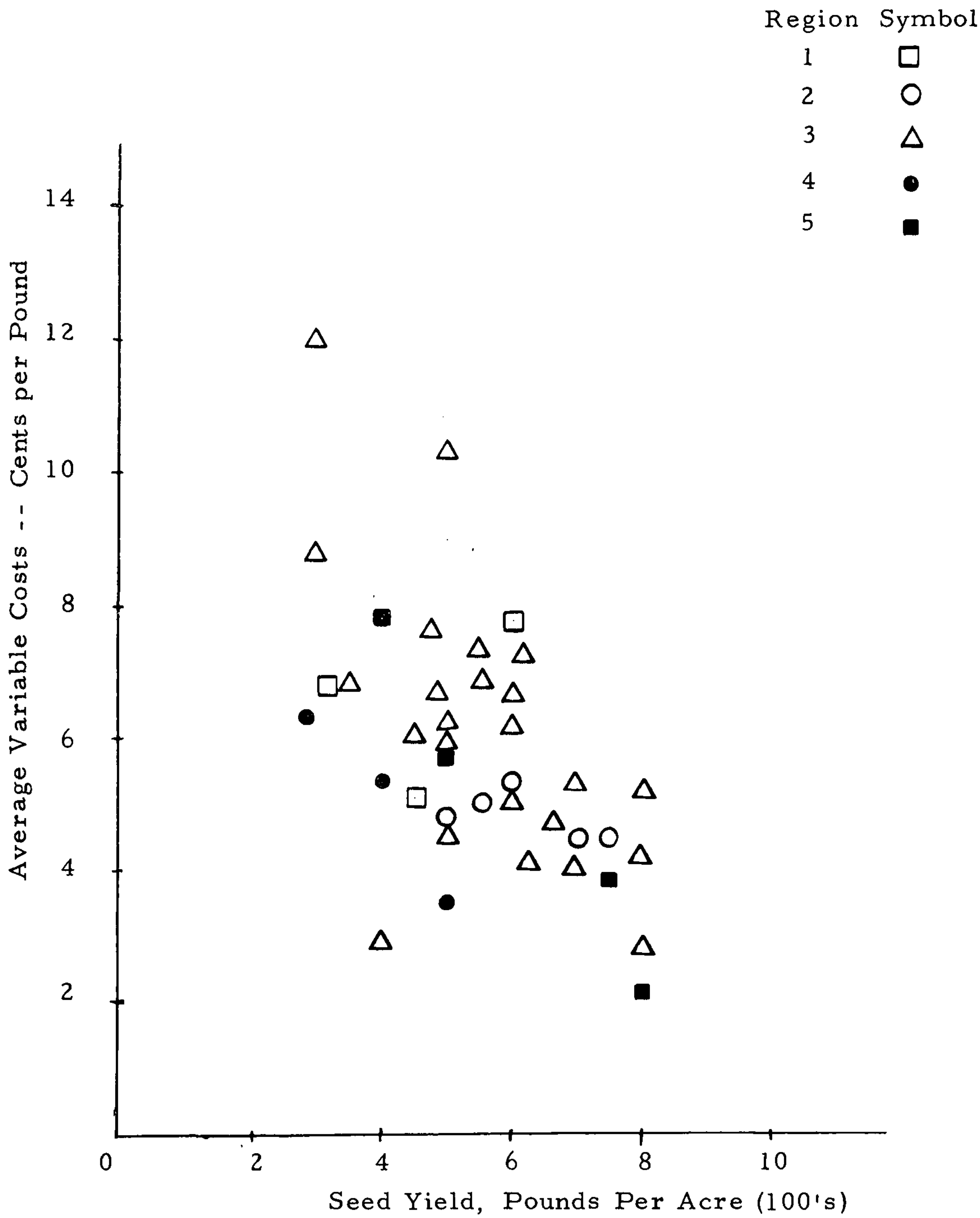

Figure 20-C. Fine Fescue

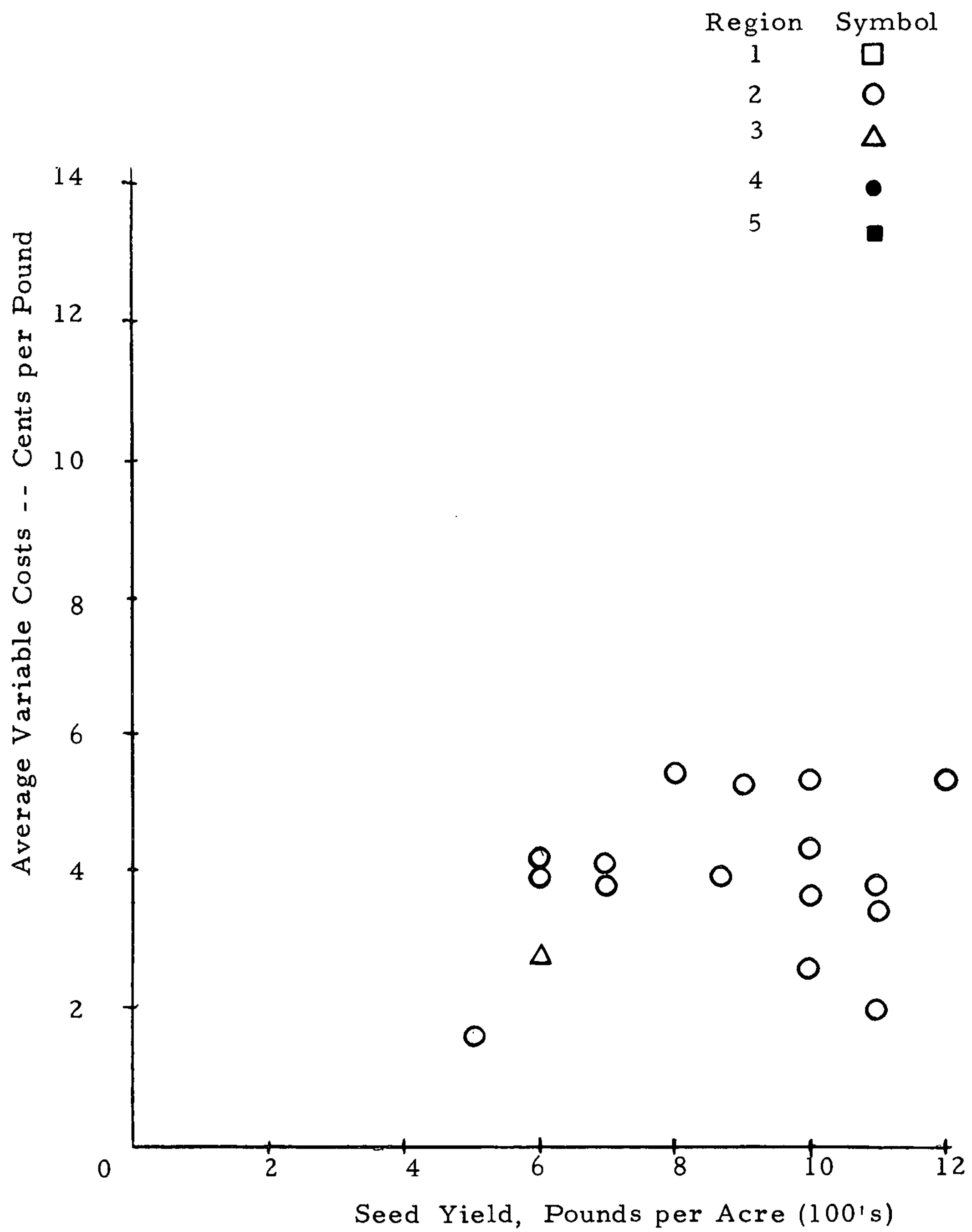

Figure 20-d. Tall Fescue

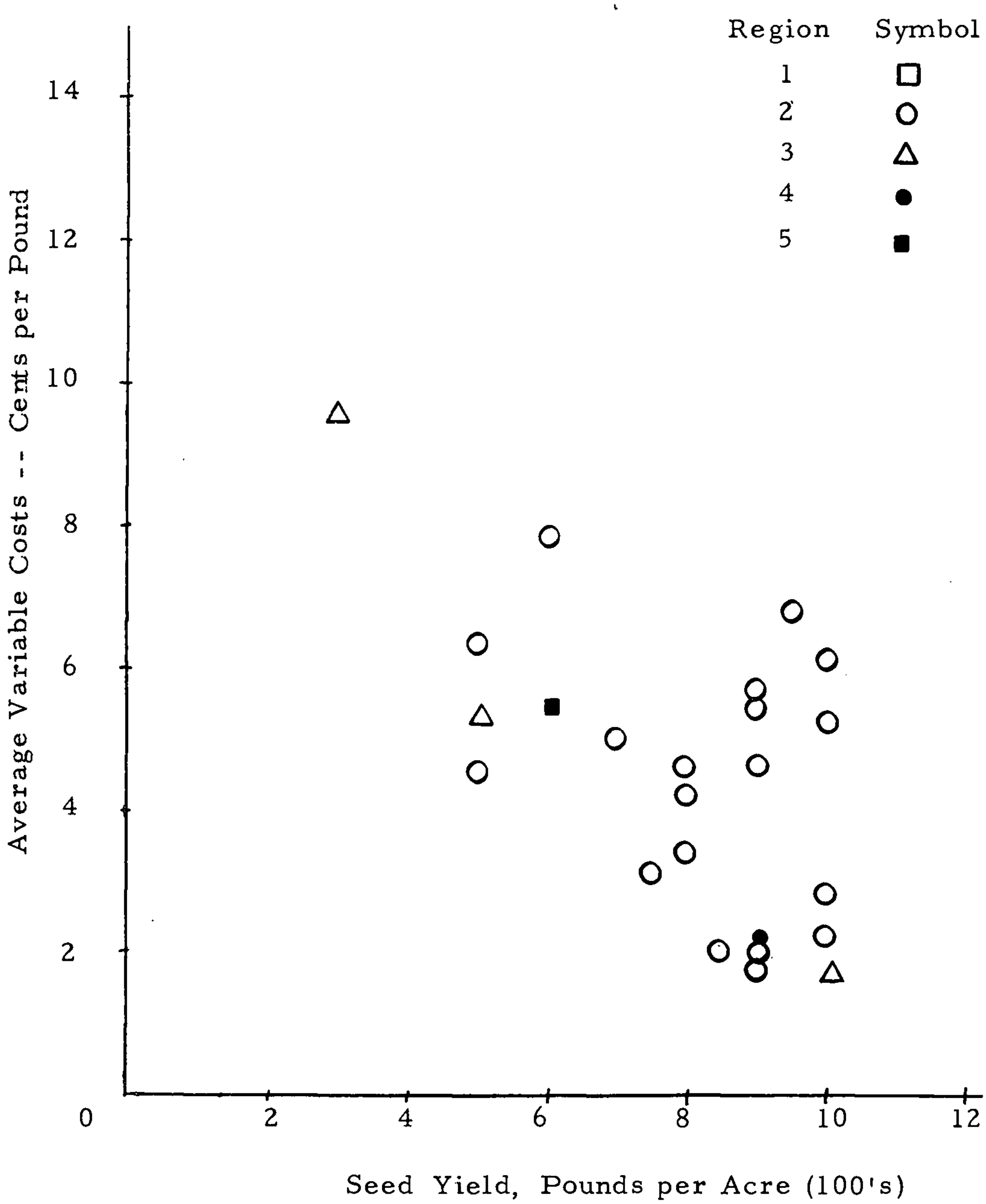

Figure 20-e. Orchardgrass

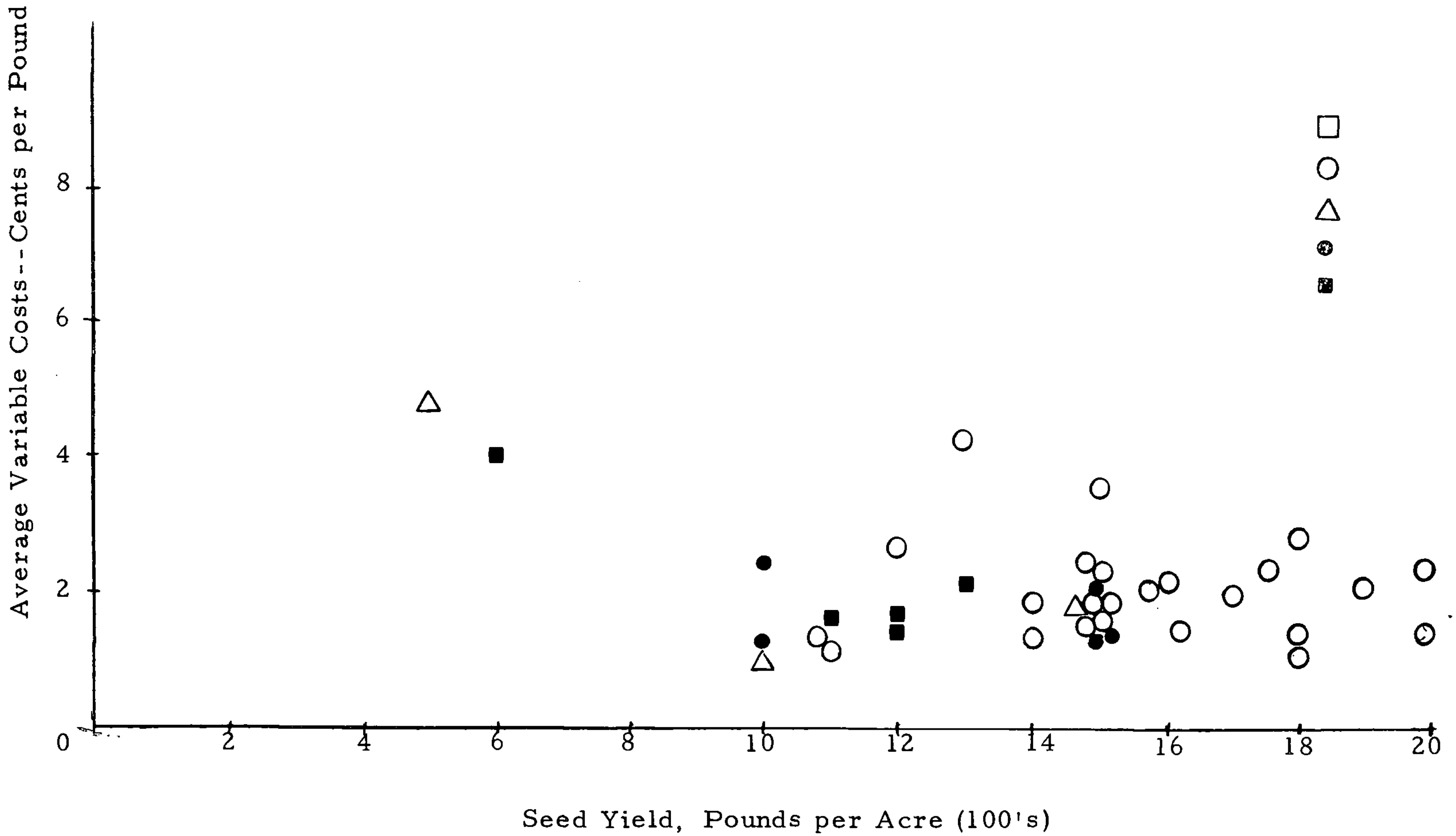

Figure 20-f. Annual Ryegrass

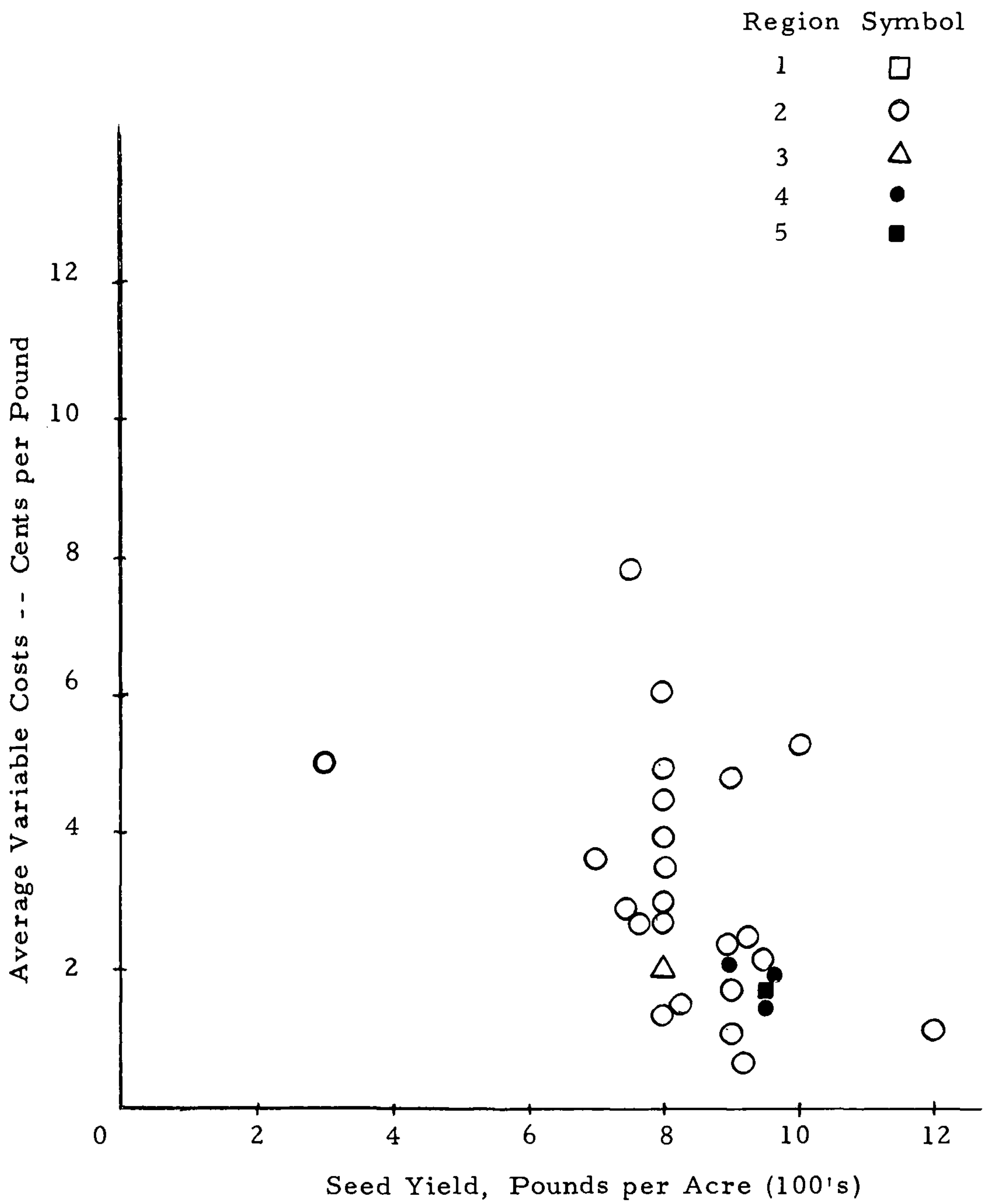

Figure 20-g. Perennial Ryegrass

example. Slight trends appeared for ryegrasses, with Regions 3, 4, and 5 reporting generally lower yields of annual ryegrass than Region 2, the predominant area. For perennial ryegrass, Regions 4 and 5 showed slightly higher yields and lower costs than the average in Region 2, although few observations outside Region 2 are noted.

RETURNS OVER PRODUCTION COSTS

Cost data from Table 21 and returns from Table 19 are combined with stand life data. It was found that stand establishment periods and stand life cycles varied among grass seed types, which affected average annual returns over the complete cycle. This analysis, including average annual net returns over production costs per acre, is shown in Table 24.

Data indicates that grass seed type is a significant factor affecting net returns. Average annual net returns over production costs per acre over the stand life cycle[11/] ranged from negative $6.14 on annual ryegrass to $91.19 on orchard grass. These data include estimated fixed costs for operator labor, land, and machinery on grass enterprises. The results of Tables 21 and 24 should be used only to compare profitability of various grass seed types, rather than to portray absolute profit levels of grass seed enterprises. Other

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[11/] It is assumed that price and yield data used to derive average gross returns in Table 19 are representative of the entire stand life cycle, since crop data for a given year includes both new stands and old stands.

Table 24. Average Annual Net Return Over Production Costs, per Acre, Over Stand Life Cycle, by Seed Type, Willamette Valley Sample Farms, 1969.

	Highland Bentgrass	Kentucky Bluegrass	Fine Fescue	Tall Fescue	Orchard-grass	Annual Ryegrass	Perennial Ryegrass
Average gross returns per acre ($)	74.82	157.82	97.65	92.37	172.94	66.35	71.66
Average total costs per acre ($)	73.23	94.20	82.21	75.43	81.75	72.49	64.11
Net returns over total costs per acre per producing year ($)	1.59	63.62	15.44	16.91	91.19	-6.14	7.55
Average stand life[1] (yrs.)	13.0	9.8	9.3	15.8	10.3	-2/	9.7
Establishment time[1] (yrs.)	1.9	2.0	2.1	1.8	1.9	-2/	1.6
Total stand life cycle[1] (yrs.)	13.9	10.8	10.4	16.6	11.2	---	10.3
Number of full crops per cycle	12.5	9.3	8.8	15.3	9.8	---	9.2
Average number full crops per year	0.90	0.86	0.85	0.92	0.88	---	0.89
Average annual net returns above production costs over stand life cycle ($)	1.43	54.75	12.87	15.56	80.25	-6.14	6.72

1/ Average stand life is the period from planting of new crop extending to last crop harvest. Establishment time begins when last old stand crop is harvested and extends to first harvest of new stand. Total stand life cycle extends from last crop harvest of previous stand to last crop harvest of present stand.

2/ For annual ryegrass, time required to produce crop is unaffected by planting method, i.e., grasslanding or soil tillage and drilling.

fixed cost components, as discussed in an earlier section, should be taken into account on an individual farm basis when determining absolute profit levels.

The Management Component

Variations in costs and returns occur not only among grass seed types, but also within groups of farms raising one type of seed. Such differences are caused partly by variables discussed in earlier sections of this chapter: farm type, farm size, and regional location. Some variations within grass seed types still remain but the causal elements are difficult to define as well as measure. It is suspected that some of the elements peculiar to individual farm situations which have not been accounted for in this study but which contribute to remaining cost and returns variations include farm differences in operator utility and risk preference functions, labor and capital restrictions, opportunity cost of resources, and singular physical characteristics of individual farms. All of these factors can affect input level intensity, costs, production, and profits.

Risk aversion and limited capital may cause an operator to invest lower levels of inputs per acre, while limited labor or machinery might cause an operator to intensify input usage rather than renting additional land. Demands of a farmer's wife and family for more leisure time or more consumptive income can affect capital inflow into the farm operation. In other words, variables exist which have not been discussed in this study but must be recognized as determinants of profitability and are, for simplicity and convenience, included here as undefined and unmeasured management components.

CHAPTER VI

SUMMARY, INTERPRETATIONS, AND IMPLICATIONS OF A BURNING BAN

Summary

This section presents a summary of analytical results, beginning with specific seed type cost and profitability differences and concluding with selected regional farm characteristics and additional observations.

COST INFLUENCES

Large cost variations were observed, primarily due to differences in operator input intensity and composition of farm costs. The importance of operating costs, production costs, and whole-farm costs were identified.

Operating Costs

Operating costs were divided into variable and fixed components. The variable or out-of-pocket cost component included hired labor, materials (seed, fertilizer and chemicals) and cash machine costs (fuel, oil, lubricants). The fixed component included an imputed overhead charge for machine use and value of operator labor. For each seed type, average operating costs per acre were calculated over all sample farms raising it, and for groups of four farms with high costs and four farms with low costs. These averages are included in Table 25. Variable operating costs ranged, in general, from about $20 to $50 per acre for each seed type. Within each seed type, low operating costs were one-third to one-half the high-cost averages, generally reflecting large differences in resource use intensity.

Wide variations in materials input, primarily fertilizers and herbicides, constituted much of the variability. Comparison of variable operating costs, resulting yields and total revenue revealed that in some cases high costs of seed, fertilizers, and chemical input usage appeared only to reduce profitability because yields were not necessarily increased. It was observed that Highland bentgrass, fine and tall fescue, and annual ryegrass production showed higher yields, while bluegrass showed significantly lower yields when input usage was intensified.[12]

Production Costs

Average production costs included operating costs plus amortized establishment costs, average land rental charge, and general overhead (five percent of operating plus establishment costs) allo-

[12]It is doubtful that yield differences between high and low-cost operators in Highland bentgrass production would be significantly different if subjected to statistical analysis.

igh-cost and four low-cost farms, and sample averages, 1969.

	Tall Fescue			Orchard Grass			Annual Ryegrass			Perennial Ryegrass		
gh	Low	Ave.	High	Low	Ave.	High	Low	Ave.	High	Low	Ave.	High
.08	2.93	7.06	11.96	3.68	8.55	13.37	6.76	10.24	15.70	3.44	6.66	11.39
.85	1.49	2.01	2.86	1.52	2.17	4.29	.70	1.66	2.40	.93	1.45	1.62
.29	14.14	27.08	36.15	14.16	24.39	42.32	7.68	15.82	26.99	8.40	17.75	36.61
.22	18.56	36.15	50.97	19.36	35.11	60.03	15.14	27.72	45.09	12.77	25.86	49.62
61	4.38	9.83	17.97	8.58	12.81	20.09	10.14	15.37	23.47	5.15	9.49	15.90
71	2.43	3.34	4.68	2.27	5.06	6.45	2.76	6.67	9.61	1.72	3.20	4.22
.54	25.37	49.32	73.62	30.21	52.98	86.57	28.04	49.76	78.17	19.64	38.55	69.74
65	3.72	4.95	6.33	4.18	5.88	9.01		2.98		3.10	4.37	6.42
.11	1.45	2.71	4.00	1.74	2.94	4.78	1.40	2.64	3.91	1.15	2.15	3.80
04	18.45	18.45	18.45	19.95	19.95	19.95	17.11	17.11	17.11	19.04	19.04	19.04
.34	48.99	75.43	102.40	56.08	81.75	120.31	46.55	72.49	99.19	42.93	64.11	99.00
	700	846	1000	912	816	912	1128	1427	1650	850	851	850
0	.128	.128	.128	.237	.237	.237	.051	.051	.051	.079	.079	.079
00	89.60	108.20	128.00	216.00	193.20	216.00	57.50	72.70	84.20	67.10	67.20	67.10
.66	40.61	32.77	25.60	159.92	111.45	95.69	10.95	.21	-14.99	24.17	3.09	-31.90

Average seed yields for 1967, 68, 69 reported by sample operations.

Table 19 10-year average prices used because 1967-69 prices reflected low carryover supplies due to poor 1968 crop.

Fixed component of machine costs imputed as 60 percent of total machine costs listed in Appendix C.

Operator labor imputed as $2.50 per hour.

cable to grass seed production. Production costs per acre also are shown in Table 25. Production cost variations, both within and among seed types, is caused primarily by operating cost components discussed above. Additional variation due to operator labor may reflect substitution of operator for hired labor or more intensive labor use. Variation in land rental charge was small, ranging from $17-22 per acre. Overhead cost variation is likely misleading due to the imputed nature of this component. Establishment costs provided most of the variation not included in operating costs, ranging from about $3 to $25 per acre for various groups. Gross returns for each group of farms also were calculated to compare revenue with cost. Typical seed yields for 1967, 1968, and 1969 for sample operators in each grass type group, and average industry prices over the decade 1960-1969 were used to generate the gross revenue calculations. Average 1968-70 industry prices were not used because of the market influence of small carryovers of seed supply following poor harvest conditions in 1968 resulting in abnormally high industry prices in those years. Comparison of production costs to total revenue indicates the high-cost producers of annual and perennial ryegrass were not covering production costs while high-cost bentgrass and <u>average</u> ryegrass producers were earning less than $6 per acre returns over production costs. Comparatively high returns above production costs ($49-160 per acre) were earned by all groups producing orchardgrass and Kentucky bluegrass, while producers of bentgrass and fine and tall fescue earned from $5 to $80 per acre above production costs.

Whole-Farm Costs

Operating and production costs described above included several imputed fixed cost elements which were identified for sole use by grass enterprises in order to compare costs and profitability levels of various grass seed types. Due to the difficulty of allocating fixed or overhead farm costs of a more generalized nature to specific enterprises, farm costs and profitability were also analyzed on a whole-farm basis. Several farm organization types were identified which recognized varying roles of grass seed enterprises relative to the total farm operation and their impact upon whole farm fixed costs, competitiveness, and complementarity of resource use and farm size economies.

Three farm type organizations were defined according to relative share of gross income produced by grass seed enterprises: (1) Type 1 farms derived at least 80 percent of gross farm sales from grass seed, (2) Type 2 farms derived 40 to 80 percent from grass seed, and (3) Type 3 farms derived less than 40 percent of gross sales from grass seed enterprises. Type 3 farms reported the highest variability of costs and returns due to wide variations in

Table 26. Comparison of Average Total Cost Levels and Range of Fixed and Variable Cost Components for 66 Type 1 Farms, 1969.

ATC Range	Number of Farms	Fixed Costs As Percentage of Total Costs	Range of Fixed Costs as Percentage of Total Costs
Below $67/Ac.	17	50	30-89
$67-107/Ac.	32	53	30-86
Above $107/Ac.	17	44	28-87

major farm enterprises other than grass seeds. Those Type 3 farms reporting row crop and livestock enterprises contributed significantly to the high revenue variability.

Particularly in the case of Type 1 farms, size economies appeared to be a significant factor affecting farm profitability, due to their capability of spreading fixed costs over large acreages. Whole-farm cost data were available for 66 Type 1 farms. These data revealed that one-fourth (17 farms) reported average total costs above $107 per acre, another one-fourth (17 farms) reported ATC below $67 per acre and the remaining one-half (32 farms) reported ATC ranging between $67 and $107 per acre. Observation of the fixed and variable cost levels revealed that some substitution of fixed for variable costs occurred when inter-farm comparisons were made (Table 26). For the 17 low-cost Type 1 farms, fixed costs averaged 50 percent of total costs. More significantly individual sample farm observations revealed that fixed costs varied from 30 percent to 89 percent of total costs within the group. For the 17 high-cost Type 1 farms, fixed costs averaged 44 percent of total costs, ranging from 28 to 87 percent. For the remaining intermediate Type 1 farms, fixed costs averaged 53 percent of total costs and ranged from 30 to 86 percent. One can conclude from these observations that fixed cost composition alone is not the sole criteria in specifying production cost levels. The absolute magnitude of dollar levels of fixed and variable cost components is also fundamental. While the low-cost farms averaged 897 acres and the high-cost group averaged 960 acres in size, economies of size were indicated by the fact that farms under 100 acres in size reported total costs averaging $307 per acre, with fixed costs comprising 78 percent of total costs for this group of five farms. Size economies continued to be significant for farms up to 300 acres, as shown in Figure 19-b.

These data indicate that farms over 300 acres experience significant size economies due primarily to spreading of fixed operator labor and machine costs over larger acreages. For larger farms, fixed and variable cost proportions depended largely on operator tenure position since rented land costs were considered variable while owned land costs were considered fixed. Some operators also substitute fixed depreciation charges on new machinery for variable repair costs on old machinery in the short run.

Farm Types 2 and 3 reported major farm enterprises other than grass seed which caused wide variability of both fixed and variable cost components as shown in the scatter diagrams of Figures 16-c, d and 17-b, c. Specification of cost curves was not attempted due to the wide cost diversity of these farm types. Average fixed costs per acre ranged from $22 to $406 for Type 2 farms, and from $23 to $250 for Type 3 farms. Average total costs per acre ranged from $44 to $487 for Type 2 farms, and from $40 to $361 for Type 3 farms.

Farms raising two or more seed types representing three-fourths or 110 of the sample farms appear to enjoy cost advantages resulting from complementarity in resource use. Major grass seeds develop and mature at varying times during the growing season, enabling a farm operator to perform cultural operations on several seed types at staggered time periods with a minimum of duplicated investment in fixed machine and labor resources. This condition is particularly pronounced during the summer harvest period.

Seed cleaning operations on nearly 30 percent of the sample farms provided a means of reducing average costs primarily by utilizing fixed labor resources during winter months for those operators who chose to incorporate seed cleaning into their operational framework.

Most seed cleaning operators provided custom cleaning services for neighboring farms as well as some seed marketing services.

REGIONAL CHARACTERISTICS

The Willamette Valley study area was divided into five regions to identify possible influences of soil, topography, and urban pressure on farm organization. They are: (1) Clackamas and Multnomah counties; (2) Linn, Benton, and Lane counties; (3) Marion county; (4) Polk county; and (5) Washington and Yamhill counties. Selected average regional characteristics are shown in Table 27.

Region 1, near the Portland metropolitan area, reported small farms, high land values due to urban influence, and the lowest returns of the five regions. Income generated was not sufficient to provide positive returns to both operator labor and capital. Farms averaged 135 acres in size and are affected by rough topography which is not conducive to economies of size through farm enlargement. Several factors contributed to low returns in Region 1. Three of the five sample operators had reached retirement age and received supplemental retirement income. The remaining operators also reported off-farm sources of income which represented a substantial portion of total family earnings. Living in an area of urban pressures on land use, these operators appear to be accepting capital appreciation on their real estate in lieu of larger net farm incomes in the short run.

Table 27. Summary of Selected Regional Characteristics, 147 Sample Willamette Valley Farms Producing Grass Seed, 1969.

	Region 1 Clackamas Multnomah	Region 2 Linn, Benton, Lane	Region 3 Marion	Region 4 Polk	Region 5 Washington Yamhill
Average Farm Acreage	135	876	498	730	615
Average Land Value per Acre	786	386	416	443	475
Average Land Rental Per Acre	---	15-18	16-18	18-20	20
Average Operator Return[1]	669	19, 800	4, 522	8, 510	17, 578
Operator Equity Capital per Farm[2]	127, 082	232, 583	188, 596	210, 113	193, 942
Percent of Capital Resources Devoted to Grass Seed	33	77	46	46	27
Residual Return to Operator Capital[2]	---	5.1%	---	---	4.8%
Primary Enterprises Choices[3]	fine fescue pasture timber	annual ryegrass perennial ryegrass orchardgrass tall fescue bluegrass	fine fescue bentgrass diverse enterprises	grains annual ryegrass	bentgrass diverse crops livestock
Relative Contribution of grass seed enterprises[4] to gross farm income	56%	78%	61%	49%	28%

[1] Average Operator Returns from Table 15

[2] Operator Equity Capital from Table 16

[3] Enterprise data from Table 13

[4] Calculated from Gross Income data from Table 15

Region 2, containing the upper Willamette Valley counties of Linn, Benton, and Lane, included two-thirds of total grass seed acreage sampled, 67 of 147 farms sampled, and the majority of annual ryegrass, perennial ryegrass, tall fescue, Kentucky bluegrass, and orchardgrass sampled. The area contains large acreages of poorly-drained soils suitable for extensive ryegrass cropping. Farm size averaged 876 acres per farm indicating ample opportunity for achieving size economies. Operators devoted over three-fourths of their resources (according to value) exclusively to seed production. Income data supports the claim that grass seeds, particularly the ryegrasses, contribute substantially to the area's economic prosperity. One-third of the farms reported grass seed as the only source of farm income, while three-fourths relied on grass seed for at least 70 percent of farm sales. The two most profitable seed types, Kentucky bluegrass and orchardgrass, are grown primarily in Region 2.

Operator returns averaged $19,800 per farm with residual returns to operator capital at 5.1 percent, the highest return level for all regions.

Region 3, Marion County, contained 48 sample farms, some 17 percent of total sample grass seed acreage, and major proportions of Highland bentgrass and fine fescue seed crops. Sample farms averaged 498 acres in size. Operators reported generally low returns of $4,522 per farm, resulting in no residual return to operator capital. One-half of the 48 sample farms derived over 70 percent of gross farm income from grass seed. The remaining 24 sample farms, while deriving substantial income from grass enterprises, also relied upon a multitude of other enterprises to generate farm income, a situation reflecting the wide range of enterprise choices generally available to Marion county farmers.

Operators in Region 4, Polk County, reported grain crops and annual ryegrass as major enterprise choices. Farms averaged 730 acres in size, and some 46 percent of assets were devoted to grass seed production. Although operator returns were higher than in Regions 1 and 3, no residual return to capital was earned.

Region 5, Washington and Yamhill Counties, reported many crop and livestock enterprises which dominated grass seed as enterprise choices and income generators. Resources devoted to grass seed constituted about 27 percent of total farm assets on the 13 sample farms, and about 26 percent of total cropland acreage. Operator returns averaged $17,578 per farm and provided a 4.8 percent residual return to operator equity capital.

ADDITIONAL OBSERVATIONS

Several relationships among various farm characteristics were identified in the data but not discussed previously which deserve mention here since they affect adjustment opportunities. The relationship of farm size, operator age, operator tenure position, and land value appreciation are discussed in this section. These factors indicate trends of the farm family life cycle and hence resource use. Data showed younger farmers generally operate medium-sized farms (350-899 acres) with a wide range of tenure positions. As operators reach middle age (40-64 years) farm size increases and proportion of rented land increases. At retirement age the farmer ceases farming rented land and concentrates on owned land, resulting in a smaller operation (under 600 acres). A possible explanation of such trends is that young farmers are often hampered by restricted capital and family labor conditions. Another factor is the consumption patterns of young families, whose members facing limited income may prefer emphasis upon short run consumption levels over long run goals of increased equity and farm growth. As the operator approaches middle age, say 45, his equity position appears to grow more favorable for expansion. More family labor is generally available which may also encourage expansion. Then at retirement age the desire for security and less responsibility, accumulation of owned land, decreased demand for consumptive income, possible lack of family labor, and estate planning for property transfers, appear as deterrents in the acquisition of more farm land by purchase or rental means.

Some 54 percent of all grass seed land reported by sample operators was rented. Cost data from these farms indicate that land rental is currently the cheaper method of farm size expansion. The fact that landlords earn a return to capital of some three percent of land value, after taxes, was pointed out. Possible capital gains due to urban influences may encourage landlords to continue renting to farm operators at low rates, while low farm incomes derived from grass seed discourage land buying as a method of expansion.

Tenure position varied widely among regions and seed types. Region 2 operators, reporting predominantly ryegrasses, rented 59 percent of all grass seed land farmed. Region 1 farms raised primarily fine fescues and reported only four percent rented land. The establishment costs of more intensive seed crops such as fine fescue and bluegrass involves higher initial cost outlays than that of annual and perennial ryegrasses. This may explain, in part, the historical reticence of ryegrass producers to shift to fine fescues and bentgrasses on whiteland soils even though they are culturally adapted and incur similar production costs.

Where low or negative residual returns to operator capital exist as with low average returns in Regions 1, 3, and 4, capital appreciation of land values may be viewed by these operators as a form of operator return. Nationwide, farmland values have increased at an average rate of nearly six percent annually in recent years

(USDA ERS, 1969). If farmers were to recognize and accept this increase in value as a substitute for return on investment, the opportunity cost on long-term capital charged in Chapter 5 could be ignored. Returns to operator resources exclusive of the imputed charge for operator investment in land were calculated by regions using the basic data of Table 16 with results presented in Table 28. Using this adjustment all study areas with exception of Region 1 show a positive residual return to operator labor and management ranging from a low of $1,500 per farm in Region 3 to a high of $15,000 per farm in Region 2. It must be recognized, however, that real estate appreciation, the critical assumption of Table 28, varies widely among geographic areas and is influenced not only by returns in agriculture but also by demands for land in non-agricultural uses. Future trends are problematical and beyond the scope of this study.

Interpretations

Analytical results of the sample farms indicate that some farm operations in 1969 were economically competitive while others were not. Specification of these groups and discussion of possible farm adjustments is included in this section. Wide variations in costs, for both individual seed types and whole farms, suggest that cost management and resource use adjustments may be necessary for some farms to remain commercially viable units of grass seed

Table 28. Average Returns to Operator Capital, Labor, and Management, Assuming That Capital Gains Constitute the Only Return to Investment in Land and Buildings, 147 Sample Willamette Valley Farms Raising Grass Seed, 1969.

Region	1	2	3	4	5	Sum
Net farm income[1]	669	19, 800	4, 522	8, 510	17, 578	12, 889
Assigned return to total operator capital[2]	999	5, 026	3, 037	2, 100	4, 142	3, 886
Residual return to labor and management	-330	14, 774	1, 485	6, 410	13, 436	9, 003
Assigned return[3] to operator labor	5, 130	7, 890	7, 860	8, 750	8, 270	7, 900
Residual return to operator management	-5, 460	6, 884	-6, 375	-2, 340	5, 166	1, 103

[1]Copied from Table 15.

[2]Copied from Table 16, excluding long term investment. It is assumed that capital gains (appreciation of farmland) provides satisfactory investment return on real estate.

[3]Copied from Table 16.

production. Possible adjustment areas include changes in enterprise organization, internal cost reduction, and farm enlargement.

ADJUSTMENTS WITHIN SEED TYPE

Wide ranges in operating costs exist within individual seed types. This is caused mainly by wide differences between sample farms in levels of fertilizer and herbicide application. This suggests that in many cases cost reduction alone in use of these inputs could improve income markedly. Cost of materials application on perennial ryegrass, for example, ranged from $8 to $36 per acre, with no apparent effect on seed yield. Such wide ranges suggest high cost operators raising each seed type could possibly benefit from increased managerial control of fertilizer and herbicide applications.

ENTERPRISE ADJUSTMENTS BETWEEN SEED TYPES

The comparability of average production costs for each seed type from $50 to $110 per acre across seed types reflects the use of somewhat similar production practices. However, wide ranges in production costs within seed types persisted between sample operators. High-cost farms within each seed type reported returns above production costs ranging from $95 on orchardgrass to -$31.90 per acre on perennial ryegrass. Low-cost farms reported average returns ranging from $160 on orchardgrass to $10.95 on annual ryegrass. These data suggest some merit in seed type substitution where soil condition, market opportunities, and managerial restraints permit, particularly for the better (lower cost) operators. It is extremely doubtful that it offers any cost panacea for the higher cost operators since their competitive position would probably not improve by simply shifting to different grass enterprises. For operators with low risk preference, continuation in production of perennial ryegrass or some shifting to Highland bentgrass or orchardgrass may be justified due to their low gross income variability. Soil conditions limit some seed type substitution, however. Kentucky bluegrass and orchardgrass, the two most profitable seed types do not tolerate the poor drainage conditions where ryegrasses are grown. A further limitation involves management skills. While the different seed types employ similar cultural practices they are not identical. This implies that greater managerial skills are required when more grass seed types are added to individual farm operations. Evidence of some grass seed type adjustments already exists. County Extension agent estimates indicate that a 5,000 acre increase in bentgrass plantings occurred in Linn, Benton, and Lane counties during the 1971 production year.

A final word of caution is necessary. Large-scale acreage shifts between grass seed types can be expected to adversely affect not only the absolute market price but also the relative prices between grass seed types, and hence significantly affect profitability of the crops experiencing increased production.

ADJUSTMENTS BETWEEN GRASS SEED AND OTHER ENTERPRISES

Possibilities for enterprise adjustments toward crops other than grass seed are limited, under current economic conditions, by soil characteristics, lack of market accessibility, and managerial constraints (Conklin and Bradshaw, 1971). Large-scale shifts to livestock production are also unlikely due to soil limitations and availability of livestock feed in the Willamette Valley.

FARM ORGANIZATION ADJUSTMENTS

The effects on profitability of variations in imputed fixed cost components within and among seed types can be misleading without considering whole-farm costs. Data analysis of farm size economies, whole-farm cost composition, and profitability levels suggest that 27 farms, or 18 percent of the sample, cannot remain economically competitive indefinitely since cash costs and depreciation were not covered by revenue. Ten of the 27 farms in this group were Type 1 farms averaging 1069 acres in size, indicating farm size economies alone do not guarantee profits either. If these operators fail to improve their cash positions in the short run through cost reductions or improved revenue levels, their only alternative may be to shift out of farming since they are earning no return to operator resources of labor, management, and capital. Possible short run adjustments include: (1) cash cost reductions by increased management of material applications and machine operation, or (2) increased revenue by shifting to alternate enterprises where feasible. As discussed above, such adjustments are limited in scope.

Eleven Type 2 farms and five Type 3 farms also earned no operator returns. Although the Type 2 farms in this group averaged 616 acres in size, five were under 150 acres and might benefit from size, economies through expansion to utilize more efficient technology, or complete shifting to more intensive land uses in the long run. Three of the five farms are located near metropolitan areas where urban use is probable. The remaining two farms will likely be combined with other units to form larger farm organizations in the long run.

The five Type 3 farms earning no operator returns ranged in size from 358 to 1054 acres, representing such a wide variety of major enterprises that generalizations for this group are impossible to make. However, since this group produced some 900 acres of grass seed in 1969, their adjustments may have considerable impact. For example, these five farm operators could conceivably increase their total seed production markedly or eliminate it completely in their search for profits.

None of the 27 farms identified as earning no operator returns can survive in the long run unless short run adjustments provide increased returns. Possible long run adjustments include (1) transfer of farmland to non-farm use or to present farm use by operators with greater managerial ability, or (2) reorganization by present operators to include more efficient use of existing resources resulting in per unit cost reductions and selection of more profitable enterprises. The remaining 120 sample farms appear to be more or less successrully competing at the present time. For these farms short run adjustments may not be critical under existing economic conditions.

REGIONAL ADJUSTMENTS

Examination of regional characteristics and possible farm adjustments suggests several implications for regional adjustments. These include: (1) Region 1 sample farms were characterized by small size, advanced operator age, low returns, and urban pressure on land use. It is likely that farmland in this area will convert to more intensive agricultural and/or non-agricultural uses when these operators retire. (2) Region 2 sample farms were characterized by large farms, specialization in grass seed production, and highest returns to operator resources of the five study regions. It is probable that any farm organizational adjustments in this area will involve further grass seed specialization and reduction in farm numbers as the more efficient operators replace those earning low or non-existent operator returns. (3) The heterogeneous nature of Region 3 farms indicates the difficulty of making meaningful generalizations concerning area-wide adjustments. Either increased specialization in grass seeds or shifting to other enterprises might occur. (4) Due to existing complementarity of grains and ryegrasses on Region 4 farms, further specialization either toward or away from grass seed is questionable. Soil characteristics also limit further specialization in either grass seeds or grains. (5) In Region 5 grass seed enterprises were somewhat complementary or supplementary in nature relative to other farm enterprises. On the average they provided but 28 percent of farm sales and involved relatively small acreages per farm. These operators might increase production of proprietary varieties and breeders' seed stock, both somewhat intensive in nature, requiring greater managerial capacity than the majority of seed enterprises but from which price advantages may be the major economic gain rather than internal efficiencies and economies of size.

Implications of a Burning Ban

Recent research at Oregon State University developed cost estimates for alternative practices to replace open field burning (Conklin and Bradshaw, 1971). Utilizing these estimates, this section projects possible short run changes in farm profitability of various grass seed types under a burning ban, and possible short run and long run adjustments in farm organization on farms producing grass seed.

Whole-farm costs and returns, both before and after a burning ban,[13] projected on the average by regions are shown in Table 29. Original costs and returns were calculated in Chapter 5. Additional costs associated with a burning ban vary among study regions for two reasons. First, average grass seed acreage per farm ranged from 44 acres in Region 1 to 691 acres in Region 2. Second, costs associated with specific seed types varied according to residue yield, and ranged from 17 dollars per acre on bentgrass and fine fescue to 22 dollars per acre on annual ryegrass. Therefore, a representative cost per acre was assigned for each region based on predominating seed types, ranging from 17 dollars per acre in Regions 1 and 3 to 21 dollars per acre in Region 4.

Resulting additions to whole-farm costs significantly affect net farm income, or total operator returns where grass crops are the dominant enterprises. Field sanitation costs of $13,820 per farm in Region 2 reduced net farm income from $19,800 to $6,470 per farm. Adjusted net farm income in other areas ranged from negative $35 in Region 1 to $14,970 in Region 5.

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[13] Assuming supply and average market price are not adjusted in the short run.

Table 29. Comparison of Average Net Farm Income per Farm, by Region, Before and After a Burning Ban.

Region	1	2	3	4	5
Original Net Farm Income	669	19,800	4,522	8,810	17,578
Field Sanitation Expense					
Average Grass Seed Acreage	44	691	225	333	142
Cost per Acre	17	20	17	21	19
Total Expense per Farm	748	13,820	3,825	6,993	2,698
Current Burning Expense	44	490	200	200	90
Net Additional Expense	704	13,330	3,625	6,793	2,608
Adjusted Net Farm Income	-35	6,470	897	1,717	14,970

Adjusted costs and returns per acre for each seed type are shown in Table 30. Original costs and returns were calculated in Chapter 5. Savings resulting from elimination of the current open burning practice range from \$0.69 per acre for bentgrass to \$1.08 per acre for fine fescue. Additional costs depend on residue volume as described above.

Adjusted returns per acre over production costs ranged from -\$27.54 on annual ryegrass to \$71.08 on orchardgrass. Orchardgrass and bluegrass provided the only positive return above production costs. By separating fixed costs and variable costs, it was found that all seed types yield a positive return above variable costs, but inclusion of the fixed cost component resulted in only bluegrass and orchardgrass providing a positive return above fixed costs and variable costs on the average.

Since averages mask adjustment pressures at the extreme, average operating costs for high-cost groups of four farms after a burning ban were compared with average gross returns. This comparison, shown on Table 31, reveals that high-cost annual ryegrass producers (ten percent of those raising it) would be unable to cover variable operating costs after a burning ban, while high-cost bentgrass and perennial ryegrass producers will earn under \$10 per acre above variable costs.

Table 30. Estimated Costs and Returns per Acre Before and After a Burning Ban, by Seed Type.

	Highland Bentgrass	Kentucky Bluegrass	Fine Fescue	Tall Fescue	Orchard-grass	Annual Ryegrass	Perennial Ryegrass
Average Gross Returns per Acre[1]	74.82	157.82	97.65	92.37	172.94	66.35	71.66
Average Total Production Costs per Acre[2]	73.23	94.20	82.21	75.43	81.75	72.49	64.11
Returns Over Production Costs per Acre	1.59	63.62	15.44	16.91	91.19	-6.14	7.55
Savings of Current Open Burning Costs[3]	.69	.94	1.08	.72	.89	.60	.60
Estimated Additional Costs[4] After Burning Ban							
Straw Removal	7.00	6.00	7.00	9.00	11.00	12.00	10.00
Field Sanitation	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Adjusted Returns Over Production Costs After Ban	-14.72	48.56	.48	-1.37	71.08	-27.54	-6.85
Original Variable Costs per Acre[5]	27.88	40.55	30.72	36.15	35.11	27.72	25.86
Original Returns Above Variable Costs	46.94	117.27	66.93	56.22	137.83	38.63	45.80
Adjusted Variable Costs per Acre including Field Sanitation	44.88	56.55	47.72	55.15	56.11	49.72	45.86
Adjusted Returns Over Variable Costs	29.94	101.27	49.93	37.22	116.83	16.63	25.80
Fixed Costs per Acre[6]	44.50	57.27	59.15	38.53	43.84	43.15	46.21

[1] Gross Returns from Table 19.

[2] Production Costs From Table 21.

[3] Current burning costs from Table 21.

[4] Estimated costs of alternative practices to replace open burning provided by Conklin and Bradshaw, 1971.

[5] Variable costs from Table 23.

[6] Fixed costs include total production costs from Table 21 minus variable production costs from Table 23.

Table 31. Comparison of Returns Above Variable Operating Costs Before and After a Burning Ban for High-Cost Farms, by Seed Types, 1969.

	Variable Operating Costs, four high-cost farms	Additional Costs After Burning Ban	Total Variable Costs After Ban	Average Gross Returns	Returns Above Variable Costs
Highland Bentgrass	48.65	16.31	64.96	74.82	9.86
Kentucky Bluegrass	57.13	15.06	72.19	157.82	85.63
Fine Fescue	45.22	14.92	60.14	97.65	37.51
Tall Fescue	50.97	18.28	69.25	92.37	23.12
Annual Ryegrass	45.09	21.40	66.49	66.35	-0.15
Perennial Ryegrass	49.62	19.40	69.02	71.66	2.64
Orchardgrass	60.03	20.11	80.14	172.94	92.80

These data suggest that immediate internal adjustments involving cost reduction through increased resources use efficiency would become necessary following a burning ban for the high-cost producers of bentgrass and the ryegrasses. Adjustments include control of (1) fertilizer and herbicide application, (2) machine costs (3) hired labor through increased supervision and more judicious resource use.

Various farm characteristics discussed earlier in this chapter suggest several possible farm organizational adjustments for individual farms. Such adjustments would likely be hastened by the advent of increased costs associated with a burning ban. Possible adjustments are summarized below.

(1) Adjustments within seed types will be necessary for farms having high operating costs. While 27 farms (18 percent of the sample) were identified as requiring short run adjustments to remain competitive under conditions permitting open field burning, an additional 29 operators, for a total of 56 (38 percent of the sample) will require short run adjustments under conditions of increased costs due to a burning ban. Again, adjustment alternatives involve greater efficiency of resource use and cost control on existing farms, including improved managerial control in coordination and supervision of production operations.

(2) Large-scale enterprise adjustments between seed types are unlikely to occur due to adverse effects of increased aggregate supply on price and profitability of specific seed types. Soil limitations also constrain the substitution of one grass seed type for another. Management limitations also suggest that where high internal costs exist on individual farms, shifting to other seed types will not achieve internal cost reductions.

(3) Farm organization adjustments beyond those identified in (1) above will likely occur over several years due to burning ban influences. For example: farms with high average fixed costs (due to small size and/or high operating intensities) might remain

economically competitive in the short run until the operators demand higher returns or existing machinery requires replacement. This group involves some 25 sample operators with fixed costs above $100 per acre, and includes some six percent of sample grass seed acreage. Adjustments toward larger size and/or resource shifts away from farming are probable.

(4) Cost and profitability data indicate that superior managers will be able to sustain increased costs associated with a burning ban and maintain acceptable operator return levels.

(5) Distinguishable regional adjustments appeared likely in three study areas. Sample farms in Region 1 (Clackamas County) were characterized by advanced operator age, small farm size, and low returns, are likely to sell farmland for urban use and to neighboring farmers. Increased costs associated with a burning ban will simply hasten this process. Region 2 farms, characterized by large size and specialization in grass seed production will likely extensify their operations as the primary means of adjusting to the open burning ban. Some reduction in farm numbers will result in Region 2 without necessarily a corresponding decrease in total grass seed production in the area. For Region 4 where grass seed production plays a greater complementary and supplementary role, increased production of proprietary grass seed varieties is expected. Variability of soil characteristics affecting enterprise choices and

resource combinations preclude the formation of generalizations regarding identifiable adjustments in Regions 3 and 4.

The Problem of Social Cost

This thesis partially provides the information necessary to evaluate the costs which would be imposed on the farmer by a field burning ban. Such government intervention sometimes occurs when the market system fails to recognize externalities such as air pollution. This section attempts to describe the framework of such a policy-making process, as well as the possible contribution of this thesis to that process.

EXTERNALITIES

Welfare economics states that an externality occurs when some consumption good or factor of production is not being paid its full marginal value product (positive or negative), due to the absence of a suitable market. Buchanan and Stubblebine (1962, p. 372) state the following definition,

> We define an external effect, An externality, to be present when, $u^A = U^A(x_1, x_2, \ldots, x_m, Y_1)$. This states that the utility of an individual, A, is dependent upon the activities, $(x_1, x_2, \ldots, x_m)$, that are exclusively under his own control or authority, but also upon another single activity, Y_1, which is, by definition, under the control of a second individual, B, who is presumed to be a member of the same social group.

Castle (1966, p. 2) notes that such a situation arises, "... because of technical interdependence of two decision units... ".

In the case of field burning, individual A would be a Willamette Valley citizen whose enjoyment of clean air is reduced by the field burning smoke, Y_1, while individual B is the farmer who burns his field.

The definition is carried one step farther by Baumol (1965, p. 25) when he points out,

> ... the second aspect of the externality--failure to pay or receive payment for a disservice or service which someone is providing to others. In sum, interdependence alone does not create an externality. An externality consists of the interdependence together with the lack of accompanying compensation.

There are several reasons for this lack of compensation. The user may not realize he receives benefits from the particular resource. The supplier may not be aware of his product's usefulness to some user, or it may be considered a "free good" by the user. If the awareness does exist, the parties may be unwilling or unable to enforce the necessary property rights, if such rights exist. In many cases they do not. As Headley states,

> If externalities are conceived as harm or benefits under existing property rights, then the internalizing of the effects will usually require some change in the system of property rights. External costs are the manifestation of the implied ownership right to use certain collective or common property resources without direct cost. External benefits represent the lack of an ownership right on the part of the benefit creator, to capture all the utility created by his actions. Thus, the internalizing of external effects requires changing the definition of ownership (1970, p. 3).

Consider the case of a honey producer whose bee hives are located adjacent to an apple orchard. The apple producer benefits from the bees' activities because the spread of pollen causes more apples to set. The honey producer fails to recognize and pay for that supposedly free resource. Such market failure is termed an "externality", or in this case an external economy for the apple producer.

Since apple production and honey production both increase as a result of the physical interaction, no real "harm" is inflicted as a result of the market failure (other than lost revenue). Of more serious concern are the externalities in which supply or production of one item is harmed by the actions or production of some firm, in which case an external diseconomy would occur.

The usual illustration of this case in recent years is the production of paper (through the reduction in water quality) decreasing a river's fish production. The problem is that the paper producer, who formerly considered water a free good (along with other people including economists) now finds that water is no longer a free good which can be polluted without someone incurring costs. For a market to operate and thereby remove the diseconomy, the paper producer must pay a charge (for using the water) which will reimburse those water users whose costs are increased by the pollution from paper production.

Several serious economic and social issues are involved in handling the problem described above, some of which have been ignored in the past, according to R. H. Coase (1960, p. 2),

> The traditional approach [advanced by Pigou] has tended to obscure the nature of the choice that has to be made. The question is commonly thought of as one in which A inflicts harm on B and what has to be decided is: how should we restrain A? But this is wrong. We are dealing with a problem of reciprocal nature. To avoid the harm to B would inflict harm on A. The real question that has to be decided is: should A be allowed to harm B or should B be allowed to harm A? The problem is to avoid the more serious harm.

Such is the current status of the field-burning controversy. Many Willamette Valley citizens favor complete abolition of open burning, with no consideration of the harm which such a ban might inflict on the affected farmers.

THE LOCAL PROBLEM

Air in the Willamette Valley is a natural resource. It is also publicly owned or common property. It is used each day by every resident of the valley. Yet users differ in their ability to keep air clean and in the air quality level demanded. Interdependencies unavoidably exist when we are all users and some users change the quality of the air during its use. Each user is depending on all others to keep the air clean. When some user produces pollution which decreases air quality, the other users suffer a decrease in utility derived from their air use.

The farmers of the Willamette Valley are using the atmosphere as a chimney to dispose of their smoke, while the citizens who use the air for other reasons desire clean air. These citizens may demand clean air at any cost, and be unwilling to accept any level of reimbursement for damages from the farmers.

Such a right (to demand clean air at any cost) is rather a moral issue, and if decreed would oppose Coase's philosophy of allowing market solution. Coase goes on to define a producer's rights in terms of common property resources,

> If factors of production are thought of as rights, it becomes easier to understand that the right to do something which has a harmful effect (such as the creation of smoke, noise, smells, etc.) is also a factor of production. Just as we may use a piece of land in such a way as to prevent someone else from crossing it, or parking his car, or building his house upon it, so we may use it in such a way as to deny him a view or quiet or unpolluted air. The cost of exercising a right (of using a factor of production) is always the loss which is suffered elsewhere in consequence of the exercise of that right--the inability to cross land, to park a car, to build a house, to have peace and quiet or to breathe clean air (Coase, 1960, p. 44).

It appears, then, that defining property rights with respect to the air resources is the most important phase of the policy-making process. It must be determined whether or not farmers have the right to pollute the air while burning their fields, or factories the right to spew effluent from chimneys, or homeowners the right to emit smoke from fireplace chimneys, etc., ad infinitum.

Once such rights are defined, studies such as this thesis can be useful in providing information necessary to evaluate costs and benefits of various practices. Again referring to R. H. Coase,

> It is all a question of weighing up the gains that would accrue from eliminating these harmful effects [public nuisances such as smoke, noise, and other pollution forms] against the gains that would accrue from allowing them to continue (1960, p. 26).

The results of this thesis, in addition to work currently in progress on the social costs of field burning, should provide the economic basis for decisions regarding the future of the practice.

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APPENDICES

APPENDIX A

THE FARM QUESTIONNAIRE

OREGON STATE UNIVERSITY
DEPARTMENT OF AGRICULTURAL ECONOMICS
GRASS SEED SURVEY

County ______________ Production Year ______________ Farm Number ______________

Table 1. Description

Operator ______________ Age ________ Address ______________

Farm location: Township _____ Range _____ Section ____ Acres Owned ______ Rented ________

Organization ________________________________
(father-son, corp., leasing, etc.)

Table 2. Land Use and Investment

	Owned			Rented		
Grass Seed	Acres	Value	Total Value	Acres	Rent	Total Acres
Grain						
Other Crops						
Pasture						
Timber						
Farmland and Roads						
Other						
Total Value						

Table 3. Buildings and Improvements

Item	Orig. Cost	Accum. Deprec.	Deprec. this year	Present Value	Repair Cost	Notes
Bldgs. dir. rel. to seed crops						
Bldgs. indir. rel. to seed						
Other bldgs.						
Improvements						
Totals						

Notes on buildings used for grass seed (if not fully explained above)

Table 4. Machinery and Equipment Inventory

Item	No.	Date Acquired	New Value	Deprec. Method	Salvage Value	Useful Life	Accum. Deprec.	Deprec. this year	Sales	Repairs	End. Inv.	% of total use for grass seed
Totals												

* Include tractors and equipment for land preparation, spraying, fertilizing, harvesting, hauling, seed cleaning, etc.

Table 5. Livestock Inventory

	Beg. Inv. Jan. 1			Purchased			No.	No.	No.	No.	Sold			End. Inv. Dec. 31		
Description	No.	Price	Value	No.	Price	Value	Born	Raised	Died	Eaten	No.	Price	Value	No.	Price	Value
Cows																
Bulls																
Heifers																
Calves																
Ewes																
Rams																
Yearlings																
Lambs																
Hogs																
Other																
Total Value																

Enumerator: Beginning no. plus no. purchased plus no. born must equal no. died plus no. eaten plus no. sold plus ending inventory.

List own livestock grazed on grass seed fields, by type, no. head, and time.

Table 6. Labor Availability (Twenty-Five 10 hour days = 1 man-month of full-time labor)

Labor Source	Cash Wage Paid	Specify Availability per month (full-time, 1/2, etc.)	Check Months Available											
			J	F	M	A	M	J	J	A	S	O	N	D
Family														
Operator														
Wife														
Children Age														
Hired														

Table 7. Labor Use

Note for each individual how his labor is generally utilized (i.e., Joe: 9 mos. full-time seed, 3 mos. 1/2 time livestock, otherwise idle).

Table 8. Income

Source and Description	Quality	Price	Value
Farm Sources			
Grass Seeds			
(Pasture)			
Other Seeds			
Small Grains			
Other Crops			
Livestock			
Custom Work			
Other			
Off-Farm Sources			
Job-Operator			
-Wife			
Other			
Totals			

1. Did you sell a portion of your 1968 crop in 1969? No ____ Yes ____ If yes, how much? __________ pounds ________ value.
2. Are you holding a portion of your 1969 crop for sale in 1970? No ____ Yes ____ If yes, how much? _______ pounds. Current price per pound _____.

Table 9. General Farm Expenses (From IRS 1040F)

Item	Annual Cost
Labor hired	
Repairs, maintenance	(see Tables 3 & 4)
Interest	
Rent of Land	(see Table 2)
Feed	
Seed	
Fertilizers, lime	
Machine hire	
Supplies	
Breeding fees	
Vet., medicine	
Gasoline, fuel, oil	
Storage	
Taxes	
Utilities	
Freight, hauling	
Conservation	
Seed Certification and Testing	
Insurance	
Dues	
Legal and Accounting	
Licenses	
Travel	
Other	
Total Expenses	

Table 10. Cropping History

Field No.	Acres	Crop or use	Years Present Use	Yield Present	Yield Usual	Prev. Use.	Time required to establish peren. crop	Years remaining life of stand
Grass Seed								
Other, but grass previously								

Buyer	Crop 1 ____	2 ____	3 ____	4 ____	5 ____
1. Local Warehouse	__	__	__	__	__
2. Marketing Pool	__	__	__	__	__
3. Farmer Co-op	__	__	__	__	__
4. Other ________	__	__	__	__	__
Price Mechanism					
5. Pre-season Contract	__	__	__	__	__
6. Prevailing market	__	__	__	__	__
Price Fluctuations					
7. Range	__	__	__	__	__

Table 11. Cost of establishing or producing seed crop __________ Field No. __________ Acres __________

Date	*Operation or Implement	Size	Times Over	Power			Crew Size	Hired Labor		Unpaid Family			Custom Work Rate	Materials		
										Oper.	Other					
				Type	Hrs.	Rate		Hrs.	Rate	Hrs.	Hrs.	Rate		Item	Amt.	Rate
Totals																

* Enumerator: include all cultural operations, such as land preparation, planting, chemical application, hauling fertilizer, etc.

Table 12. Questions

A. Note changes made during past ten years which have affected the scope and/or objectives of the farm operation, in the following categories; land, crop, cultural practices, labor, other, (e.g., level of fertilizer use).

B. Goals and objectives of farm operator

Note anticipated changes in items listed above, as well as others.

OPINION: How would a burning ban affect your farming operation?

COMMENTS:

APPENDIX B

LOCATION OF SAMPLE FARMS


Portland
Salem
Springfield
Eugene

APPENDIX C

MACHINE COSTS PER HOUR

APPENDIX C

Machine Costs[1] per Hour

Tractor HP	Rate
20- 29	1.25
30- 39	1.50
40- 49	1.75
50- 59	2.00
60- 69	2.25
70- 79	2.50
80- 89	2.75
90- 99	3.00
100-114	3.25
115-125	3.50
126-150	4.00

Plow Size	Rate
3-16"	.85
4-16"	1.00
5-16"	1.20

Size	Rate
1 1/2 T	1.25
2 T	1.50

Sprayer Type	Rate
20-30' pull type	1.50
Swamp Buggy	10.00

	Working Width					
Machine	8'	10'	12'	14'	16'	18'
Chisel Plow	-	1.75	2.25	2.50	-	2.75
Disk	1.50	1.85	2.25	2.50	-	-
Roller	-	-	.25	-	-	-
Harrow	-	-	.65	.75	.85	-
Drill	-	1.75	2.25	-	2.50	-
Fertilizer Spreader	-	.25	.35	-	-	-
Windrower	-	4.00	4.75	-	-	-
Combine	-	8.00	10.00	11.00	12.00	-

[1]Imputed charges listed in this table represent 60 percent as fixed costs and 40 percent as operating charges exclusive of labor.

[2]Source: Reed, 1970, and Stevens and Fehr, 1964.