ALTERNATIVE USES FOR RYEGRASS LANDS

by

Lynn D. Johnson

A RESEARCH PAPER

submitted to

THE DEPARTMENT OF GEOGRAPHY

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

May 1980

Directed by
Dr. Richard Highsmith

TABLE OF CONTENTS

LIST OF FIGURES

ALTERNATIVE USES FOR RYEGRASS LANDS

Abstract: Agricultural field burning in Oregon's Willamette Valley has been an accepted farming practice for sanitizing fields and removing stubble and residues left on fields after harvest since the early 1940's. Unfortunately, the smoke and debris created by the burning in combination with other pollutants have been causing health and environmental problems in many parts of the Willamette Valley. Due to the probable increase of these problems and the increasing demand by citizens to stop the burning, a search for alternative uses for grass seed and for open field burning lands has become an important issue and is the focus of this paper.

INTRODUCTION

Each summer, Oregon's Willamette Valley experiences a noticeable amount of air pollution. The physiographic and meterological conditions of the area are such that most of the pollutants are blown south through the valley and are contained in the Eugene-Springfield metropolitan area by the surrounding foothills. Air inversion forces occasionally hold the pollution in this area for days at a time. Resulting health and environmental problems have initiated citizen complaint and environmental legislation aimed at restricting the sources of the pollution.

Air pollution is caused by, industry in the area, automobile emissions, slash burning in the surrounding foothills and from agricultural field burning. Of these sources, agricultural field burning is the most noticeable and the most controversial because it is concentrated into only three months: July, August and September.

Field burning is used as a management tool to rid cereal, small grain and grass seed field of pests and diseases, while at the same time burning up large quantities of stubble and residues left on the fields after harvest. Many of the other crops currently being burned are capable of being managed by some other means, or the soils are capable of producing an alternative product. Ryegrass on the other hand, must be burned in order to produce a profitable crop, and since Willamette Valley ryegrass seed sales amount to nearly 13 million dollars each year, ryegrass is a very important component of the valley's economy.

Ryegrass is grown on a variety of soils, but is concentrated in large part on the wetland of "Whiteland" soils of the valley - those soils which, due to poor drainage characteristics, have water standing on the surface during the wet winter months and dry up during the summer months. The most dominant of these soils, and also the most limited in terms of alternative agricultural uses, are the Dayton soils. Ryegrass is one of the few crops that can be profitably produced on these soils without extensive land reclamation.

PURPOSE

The valley pollution problem warrants exploring alternatives to agricultural field burning. If field burning were partially or completely banned in the Willamette Valley, many farmers would be able to produce some alternative crop on their fields or use the land for other purposes. Farmers with Dayton soils however, are much more limited in their choice, necessitating an in-depth look into the locations,

limitations, uses and future trends for the Dayton soils as well as alternatives to field burning as a management practice on ryegrass fields.

METHODOLOGY

This research paper contains three sections. The first section deals specifically with the Dayton soils, their uses and their limitations. The second section describes the characteristics of the ryegrass industry, the field burning situation and associated air pollution problems, and possible alternatives to open field burning. The third and final section deals with the current land use situation in the Valley; the impact of the burning limitations and future outlook for ryegrass production on Dayton soils.

Most of the background information on the burning problem and the ryegrass industry was obtained through a literature survey. The majority of available information was produced by Oregon State University faculty and graduate students and was commonly presented in the form of an economic analysis of the ryegrass industry and the burning situation. Most of this information was verified through discussions with Oregon State University faculty with special interests in this area.

All of the current information on ryegrass production and the information specifically for Linn, Benton and Lane counties were obtained through the use of soil surveys and through interviews with County Agricultural Extension Agents and soil scientists.

There are several apparent limitations in this research. Soil mapping in Oregon is incomplete and of the three counties surveyed, only

Benton County has a published soil survey. Difficult access to the maps and varying map scales made reproduction infeasible. Determining a trend for the use and management of the Dayton soils was problematic in that insufficient data are available at this time because limitations on field burning have only been in effect for about five years and most ryegrass farmers put their fields into rotation every few years. There really hasn't been sufficient time to see a clear pattern. Therefore, the final section is based in large part on the author's synthesis of available information.

BACKGROUND

Oregon's Willamette Valley encompasses more than one million acres and extends from Portland in the north, to the Eugene-Springfield area, some 105 miles to the south. The uplands of the east face of the Coast Range and the west face of the Cascades complete the Valley's boundaries to the west and east.

The Willamette River runs the length of the Willamette Valley, the Calapooia, North and Middle Santiam Rivers, the Clackamas and the Mollala Rivers all have their headwaters in the foothills of the Cascades and empty into the Willamette. The Long Tom, Mary's River, Luckamute, Yamhill and Tualatin Rivers have their headwaters in the Coast Range and empty into the Willamette from the west. The fertile, well-drained stream cut terraces on either side of these and other minor rivers are capable of supporting a wide variety of crops, and, in combination with the mild humid climate and long growing season, makes agriculture the Valley's primary land use. There are about

839,000 acres of cropland in the Valley, 175,300 acres of woodland pasture, and 166,400 acres in other agricultural uses.[1] The primary crops grown are small grains, grass seed, pasture and hay.

The valley floor-terraces, immediately above the stream-cut terraces, produce almost all of the nation's ryegrass seed, 90 to 95 percent of the bentgrass and fine fescue, 40 to 50 percent of the orchardgrass, and 10 to 25 percent of the Kentucky bluegrass and tall fescue seeds.[2] These crops are grown on a variety of soil types; however, most of the ryegrass is grown on the Dayton soils which cover over 120,000 acres of the Willamette Valley.

DAYTON SOILS

The Dayton soil series are characterized by the Soil Conservation Service as being deep and poorly drained with a clayey subsoil. The drainage problems are caused by a very slowly permeable to impermeable claypan, 12 or more inches thick, some 16 to 24 inches below the soil surface. This restrictive layer can result in a ground water table at or near the surface of the soil creating a perched water table for up to 120 days during the months of November to April. The wet soils often create tillage problems, hamper post-September harvesting, and because Dayton soils tend to have much higher concentrations of iron and manganese than other soil series, produce manganese toxicity in some plants. These physical soil properties, plus the mild Valley temperatures, make the Willamette Valley an ideal area for the production of certain grasses, particularly the ryegrasses because they are tolerant to saturated soil conditions for extended periods.

Before the grass seed industry became a major enterprise in the Willamette Valley, the Dayton soils were used extensively for grass pastures for livestock, spring sown oats, alsike clover and vetch. Surface drainage for these crops was provided by plowing furrows through the fields to the natural outlets. Without drainage, the production of grass seeds on Dayton soils is currently one of the most profitable and feasible uses of this land. The grasses survive the flooded conditions during the winter and produce a seed crop in the late spring and early summer months on the winter stored moisture. Hay, pasture and some spring grain crops are also grown on the Dayton soils.

With drainage, a wider range of crops can be grown. Corn, and winter and spring small grains are the most common. However, even with drainage, Dayton soils are still unsuitable for deep rooted crops and many perennials.

Geographical Distribution and Use

Dayton soils are scattered throughout the valley floor terraces of the Willamette Valley, with the largest concentrations located in Linn, Benton and Lane counties. (Refer to Figure 1) Linn County has the largest percentage of Dayton soils, approximately 63,200 acres, most located south of Highway 34 which runs east from Corvallis to Lebanon. This area has large concentrations of Dayton soils with only minimal mixing of other soil types, making large-scale farm operations; 1,000 to 1,200 acres on the average, quite common.

Based on analysis of the soil surveys, Benton County has approximately 13,200 acres of Dayton soils. Significant amounts of this

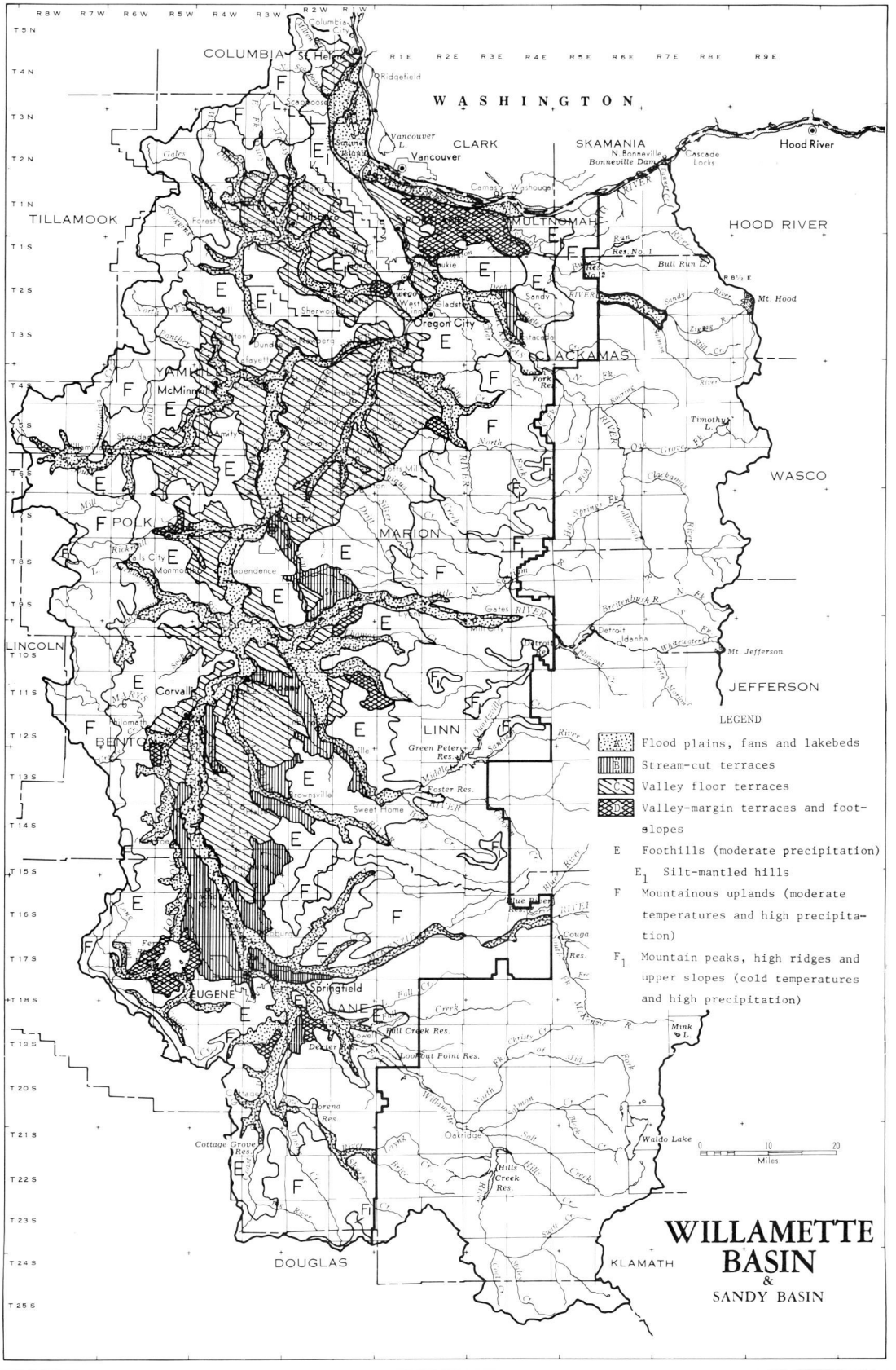

Figure 1. Willamette Basin depicting Valley-floor terraces. State Water Resources Board. 1969.

acreage occur in narrow bands following stream channels and are usually unsuited for cultivation. Benton County's largest concentration of Dayton soils is south of Corvallis, near the Corvallis airport. Large-scale farm operations seem to be in the majority there also.

There are about 4,286 acres of Dayton soils in Lane County, most of which is located west of Eugene, near Fern Ridge Reservoir. The remaining Dayton soils in the Valley are interspersed through Yamhill, Marion and Polk counties; however, acreages are less significant.

Almost all of the cultivable Dayton soils in Linn, Benton and Lane counties are currently producing ryegrass. There are, however, a few areas of the Dayton soils which are producing other crops or enterprises. In Linn County, a few farmers are irrigating their fields and have found that Dayton soils are capable of producing row crops, pasture, some perennial rye, bluegrasses and berries. Pacific Power and Light Company published a report called; "Improving Crop Production on Willamette Valley Wetland," which describes an irrigation study being conducted on the Glenn L. Jackson farm near Lebanon in Linn County. This study was directed at improving crop production through irrigation and fertilizer use on Dayton, Amity and Woodburn soils. As Figure 2 shows, with irrigation, crop yields on Dayton soils were comparable to those of the better soil types. However, irrigating Dayton soils becomes a problem when suitable drainage outlets are scarce.

There is one farmer in Linn County who is raising sunflowers as an experiment, and a few others who are experimenting with a crop called Meadowfoam. Yields are fairly low for these crops and both encounter production and processing problems, as explained in a later section.

		TONS PER ACRE
DAYTON:	Bush Beans	4.5
	Corn (grain)	3.3
	Corn (silage)	30.0
	Corn (sweet)	8.0
	Lotus-grass hay	7.4
AMITY:	Bush Beans	5.0
	Corn (grain)	3.8
	Corn (sweet)	8.5
WOODBURN:	Bush Beans	5.5
	Corn (silage)	34.0

Figure 2. Crop Yields.

Source: Pacific Power "Improving Crop Production on Willamette Valley Wetlands." Portland, Oregon. No date.

In Benton County, there are several small areas of Dayton soils being grazed, with three to five acres required to support a cow. These areas are usually too small to support field crops. Finley Wildlife Refuge in the southern part of the county has some acreages of Dayton soils producing a small amount of millet and milo to use as migratory bird seed. Growing millet and milo on a large scale, however, is infeasible because the plant will not mature due to the low night temperatures. Both crops also need irrigation to be productive.

An area of Dayton soils in northern Lane County and extending into southern Linn County is producing wheat using a technique called ridging. A machine traverses a field, piling the soil into lines of ridges. The ridges are built high enough so that the wheat can survive being flooded during the wet winter months. This technique has proven to be fairly successful although there are associated problems; for example, large

expenditures in labor, energy and machine costs in making the ridges. Ridges can not occur in all areas because there is a need to run water off the area. Tiling will help but there are few available outlets.

Due to their geographical distribution in the Willamette Valley, Dayton soils are also used for non-agricultural purposes. Parts of Corvallis, Albany and most of Monroe are built on Dayton Soils.

Engineering Properties of Dayton Soils

Dayton soils are structurally inferior for uses other than agricultural use. This soil contains montmorillonite clay which breaks down physically to form expansive soils which can cause structural damage. The tendency of these soils to expand is caused by the absorption of water by the clay. When structures are built on the clay soil, cracking and other structural pressures can occur when the soil expands after absorbing a little moisture, and then shrinks when it dries up. This is known as the shrink-swell potential of a soil, and in Dayton soils at the clay layer located some 16 to 24 inches from the surface, the potential is rated by the Soil Conservation Service as being high.

Because of the widespread distribution of Dayton soils in the Willamette Valley, the soils are used for purposes for which they are not particularly suited and which require special engineering adjustments. In the case of structures, Linn County soil scientists recommend using steel foundations for buildings, driveways reinforced with steel or wire mesh and gutters connected to an underground drainage system. Another approach is to erect basement walls directly on the soil without

the use of footings and to use heavy reinforcement in the foundation wall to protect the structure from cracking.[3] However, any type of additional reinforcement will be costly and in reality there is no fool proof method available. Other than the structural problems associated with using Dayton soils for urban uses, waste disposal seems to be the most limiting problem.

Septic Tank Absorption Fields

In the basic construction of a septic tank system a sewer line from the house leads to an underground septic tank in the yard. Overflow from the tank is dispersed into the soil through a system of underground drains or perforated pipes. Movement of effluent through the soil is determined mainly by the porosity of the soil, the size of soil particles, and by the kind of clay in the soil. Effluent moves faster through sandy and gravelly soils than through clayey soils. Soils high in clay content have limited pore space for holding effluent. Montmorillonite clay expands when wet and closes the pores entirely. Such soils are unsuitable for absorption fields because the effluent simply builds up and seeps to the surface.[4] With Dayton soils, septic systems usually work in the dry season and fail in the wet seasons. As a result, many jurisdictions prohibit the use of septic systems on Dayton soils.

Roads

The Soil Conservation Service rates Dayton soils as being "severe", that is, the soil presents serious problems which are hard to overcome, for local roads and streets because of their high shrink-swell potential and seasonal wetness. These soils are also rated as poor for road fill

because of high shrink-swell potential, and seasonal wetness. As a result the soil has low strength. Despite these limitations, roads are built on the Dayton soils in the valley. Road construction usually requires more rock base than other soils, as well as ditches and outlets. Due to the flat topography characteristic of Dayton soil locations, and the seasonal wetness, there are common occurrences of water overflowing road surfaces during the winter months. Figure 3 shows an example of the potential problem incurred with using a soil such as Dayton for locating roads.

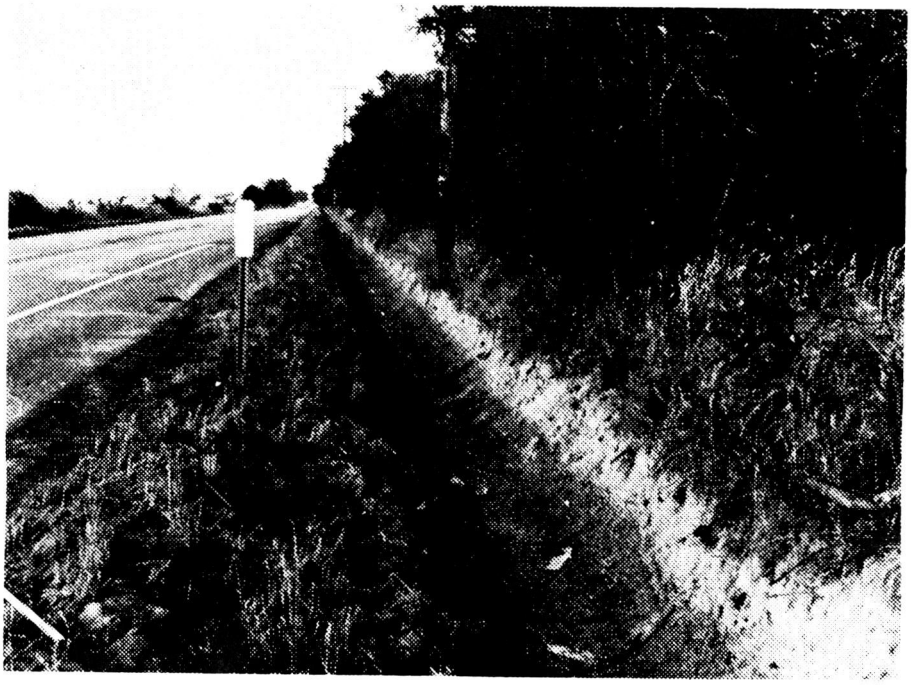

Figure 3. Restrictive layer in soil. The dark subsoil is a claypan that restricts water movement. Perched water tables are at or near the surface of this soil for several months of the year.

Recreation

Dayton soils are rated as unsuitable for recreational uses by the Soil Conservation Service because they tend to pond during the wet season, restricting their use. This is true for camp areas, picnic areas, playgrounds, paths and trails. Chintimini Park in northwest Corvallis is a case in point. During the summer this park functions well as a recreation area. However, during the winter, water tends to stand on the surface, prohibiting active use. One way to rectify this situation would be to bring in fill dirt and re-plant the area. Another method would be to put in tile drains. The problem with this is in finding a suitable drainage outlet. Both of these methods are expensive and when there are more suitable soils which are available in the area, using the Dayton soils seems unnecessary.

RYEGRASS

Settlement of the Willamette Valley Basin began in 1830. The earliest agricultural activities were the production of small grains and beef cattle. During later years, dairying and general farming became important. Ryegrass was intorudced to the area around 1935 for pasture and covercrop seed production. During the 1940's and 1950's, ryegrass, along with all the other grasses, experienced dramatic acreage increases. Today, out of about 232,000 acres of grass seed crops grown in the Willamette Valley, there are approximately 134,000 acres devoted to annual and perennial ryegrasses.[5] Thus, there is more acreage devoted to common or annual ryegrass than to all the other grasses combined. The Valley accounts for virtually all of the ryegrass grown in the United States.

Ryegrass as a crop, is fairly easy to manage. It is grown primarily on the poorly-drained Dayton soils in the Valley; it requires minimal fertilization and when burned it requires very little management.

Economics of Ryegrass Seed Production

In 1977, Benton, Linn, Polk, Marion and Yamhill counties in Western Oregon collectively produced 100 percent (248.8 million pounds) of the nation's ryegrass seed.[6] Not all of this was produced on the Dayton soils, but they were certainly the major locus.

Because ryegrasses are grown primarily on the poorly-drained Dayton soils, which are minimally productive compared to the well-drained soils, an economically profitable farm enterprise on Dayton soils would therefore require substantial acreages. The average farm on Dayton soils has a mean of 903.3 acres, which is almost twice the size of the mean (452.8 acres) for farms on all soils.[7]

Current (April 16, 1980) prices show ryegrass seed as being a profitable crop. Perennial ryegrass brings in about 42 cents per pound and annual ryegrass 9.25 cents per pound. With an average of 1,000 to 1,200 pounds per acre for perennial ryegrass, and 1,500 to 2,000 pounds per acre yield for annual ryegrass, this amounts to about $420 per acre for perennial ryegrass and $139 per acre for annual ryegrass. Prices, however, fluctuate daily. Because the Willamette Valley is the dominant producer of ryegrass seed in the country, future marketing potentials look very good.

Production costs for the ryegrasses are fairly low; however, returns per acre are often negative. Conklin and Dean in "Costs and Returns of Grass Seed Production in Oregon's Willamette Valley, 1959 to 1975", conducted a study on annual ryegrass for those 17 years, and found that the annual ryegrass, which amounts to about fifty percent of the total grass seed acreage, showed negative returns in over half of the years studied.[8] They found that on the average, profit margins were especially low for annual ryegrass, perennial ryegrass, tall fescue and highland bentgrass. Interestingly enough, annual ryegrass also had the highest yield of 1,263 pounds per acre during the 17 year period. Perennial ryegrass on the other hand, was the only seed type exhibiting a negative yield trend. This was thought to be due to a shift in perennial ryegrass varieties having lower average yields and greater yield variability. Production costs for perennial ryegrass are fairly low due to generally lower costs of nearly all operations.[9]

During the last 15 years, there has been a gradual decline in perennial ryegrass seed acreages in the valley. This was probably due to lower cropping flexibility, declining yields, small profit margins and greater risk in relation to annual ryegrass production.[10] However, in the last few years, market prices for the perennial ryegrasses have started to increase with a small shift in growers preference for that crop, particularly in Linn County.

Due to the uncertainties and costs involved in ryegrass production, it seems strange that ryegrass farmers are on the whole, unwilling to try to raise other crops which are adapted to the Dayton soils, such as fine fescue and bluegrass. These crops incur similar production costs

but also involve higher initial outlays. Several reasons for the apparent reluctance of farmers have to do with a lack of suitable alternatives and tradition. Ryegrass is a relatively easy crop to grow and few farmers are willing to change to intensive crop production.

Ryegrass is grown on the well-drained valley soils as well as on the Dayton soils but the better soils are better adapted to other, more profitable crops. A farmer on poorly-drained soils has no such wide selection of crops he can grow profitably.

FIELD BURNING

In the management of seed and cereal grain crops, field burning is a highly effective agricultural practice of removing post-harvest straw and residue; sanitizing fields; aiding seedbed preparation and in maintaining yields through sod-binding effects; stimulating plant growth; and improving fertilizer efficiency.

Residue Removal

Field burning began in the early 1940's as a quick and inexpensive method of removing the residue and aftermath volume of grass seed and cereal grain crops whose seed yields and vegetative growth had been steadily increasing with heavier applications of commercial fertilizers. Unless this aftermath was removed it could retard plant growth and provide a medium for disease transmission from one year to the next.[11]

The annual crops represent an estimated fifty-five percent of the Willamette Valley field burning acreage, and two-thirds of the tonnage burned.[12] Straw residue ranges from 1.5 tons per acre on bentgrass to

as much as 7 tons per acre on annual ryegrass. With an estimated average residue yield of 3.8 tons per acre, the volume of residue burned is around 700,000 tons annually.[13] As yet there is no economically feasible way to use the straw residue, and removal of straw by means other than field burning is very expensive.

Disease Control

During the 1940's, blind seed fungus (Gloetinia Temulenta) became widespread throughout the Willamette Valley perennial ryegrass fields. With up to ninety percent of these crops infested, the ryegrass industry was in danger of collapse. Burning was introduced to prevent further crop damage. Although there has been considerable research on disease control, researchers have failed to discover a chemical control for these diseases and pests that is both effective on a large scale and acceptable in terms of environmental regulations.

In addition, without burning, the seed tends to be of lower quality, thus necessitating an increase in fertilizer and herbicide use and costs. Fertilizers and herbicides are not as effective with a large quantity of organic material left on top of the soil. As a result, it costs more to achieve desired results.

Without burning the perennial crops, yields tend to decline. One way to deal with this would be to shorten the rotation period to every two or three years instead of every five or six years. This, of course, would tend to increase costs of operation.

Due to all these factors, it becomes obvious that a total or even partial ban on field burning would have considerable impact on valley grass seed growers.

Mechanical Alternatives

There are two machines being developed which have the potential of replacing the need for open field burning. The Mobile Field Sanitizer has been used for several years on a trial basis on valley ryegrass fields with minimal success. This machine burns on a very limited basis, containing the smoke and debris to the immediate vicinity of the machine. It is a very slow process, and the quantities of straw residues have been creating problems with operation. This machine is also very costly to use. There is a new machine being developed called the "Close Clipper Crew Cut" which removes post harvest residues efficiently enough to possibly replace burning. However, since it is still in the experimental stages development of the Close Clipper Crew Cut has a long way to go before it becomes fully operational. There are yet many unsolved problems such as; the high construction costs and the need for an effective means of controlling the dust created during operation. There is also the problem of what to do with the solid wastes collected by the machine. If these and other problems can be dealt with, the "Close Clipper Crew Cut" may provide at least a partial alternative to open field burning some time in the future.

There are various methods of mechanical post harvest residue removal including; bunching and hauling, baling and hauling, chopper blowing and hauling, stack forming and moving and cubing or some alternative means of densification and hauling. These methods are costly and inefficient, requiring expensive means of chemical pest and disease control. There is also the problem with what to do with the straw. As

yet, there is no market available for the straw and other grass field residues. Turning the residue back into the soil is possible only with annual ryegrass and requires a rotation crop every few years. Without a market for grass residues and without some method of field sanitation, seed yields can be expected to decrease, with an increase in diseases and pests.

POLLUTION PROBLEM

Air pollution in the Willamette Valley is aggravated by the physiographic and meteorological characteristics of the area. The Cascades and the Coast Range form effective barriers which retain air currents in the valley. The southern end of the valley grades into a series of foothills which form a semi-circle around the east, south, and west sides of the Eugene-Springfield area. This area receives the prevailing north-northwesterly air currents through the valley during the summer months when field burning occurs. During this time, winds are from the north-northwest approximately 90 percent of the time.

During the summer months, the physical nature of the area and the prevailing winds often result in temperature inversion layers characterized by stratified air currents with very little mixing of upper and lower levels. The field burning smoke rises only a few hundred feet, is retained at that elevation by the inversion, is pushed by the prevailing winds to the southern end of the valley, and is contained by the foothills and the Cascades to eventually settle upon the Eugene-Springfield area.[14]

Although smoke from field burning only contributes 17 percent of the air pollutant emission in Oregon, it is all concentrated into three months, July, August and September, with its presence felt especially in the Eugene-Springfield area. Apparently, the smoke causes a stinging in the eyes; impaired visibility, soiling and other damage to property; and possibly contributes to health problems. Field burning has been accused of contributing to lung cancer, particularly in males.[15] In 1969, over 4,000 complaints were registered against field burning. Field burning smoke has been known to cause driving problems on the highways, especially on Interstate 5 and has contributed to at least two deaths caused by car crashes when the burning got out of control and the smoke poured out onto the freeway.

The importance of field burning is understandable; it gives grass seed farmers a means of getting rid of pests and residues left on their fields after harvest. It is currently the only economic means of achieving this end. On the other hand, it apparent that field burning smoke is having a detrimental effect on people and property in the valley. This problem will not dissipate and will increase in magnitude along with the valley's population. What this comes down to is a matter of economic livelihood versus possible health and environmental damage. In view of this, it is critical to find an economical alternative to the ryegrass industry, or, to find an alternative to the method of open field burning.

ALTERNATIVES

Only a limited number of field crops will tolerate winter conditions on Dayton soils without land reclamation. These include grass

pasture for livestock, spring-sown oats, alsike clover and vetch. Highland bentgrass and bluegrass can be grown on Dayton soils but they require surface drainage as well as burning. Tall fescues and orchard grass can grow on these soils and can tolerate the lack of burning but encounter problems associated with straw removal. Sunflowers and soybeans have the potential of being produced on Dayton soils but neither crop is really adapted to this climate. Sunflowers also need irrigation and disease control measures. This crop is well suited to the wetlands but it has been plagued with such problems as requiring large applications of herbicides, the shattering of seeds and the need for a clean field. Together these make sunflower production incompatible with other crops. There is an experimental crop called Meadowfoam which when processed on a large scale, has the potential of replacing the need for whale oil. As was noted earlier, however, yields are fairly low and the crop is susceptible to fungii and requires large applications of fertilizer.

One of the biggest problems with any of these oil crops is a lack of processing plants in the Willamette Valley. White clover produced for seed does well on Dayton soils but the demand for this crop is limited. Growing forage for pasture is economically infeasible because farmers often cannot cover costs.

Forage Livestock Production

For the Willamette Valley the most likely choices for livestock production on Dayton soils are ewe-lambs, feeder lambs, cow-yearlings, beef-feeders and cow-calf operations. Currently many ryegrass farmers graze sheep on their fields after harvest. However, during the winter

months both sheep and cattle have problems with the wet, clayey soil conditions. A study has shown that

> "It is unlikely that sheep production on 'Whiteland' soils will provide as high a net farm income as that received from grass seed production under open field burning. Willingness to handle sheep and market price variability also must be considered. Where irrigation is needed an additional capital investment also would be required. A complete shift to sheep with no grass production would involve decapitalization of highly specialized grass machinery and new investments on buildings and specialized livestock equipment which might result in a net capital loss."[16]

Raising livestock also requires drainage to permit pasturing on "Whiteland" (Dayton and other similar soils) soils from November to April.

Drainage and Irrigation

Another alternative mentioned earlier, is to drain and irrigate the Dayton soils. This would improve the ability of the soil to support other crops. Drainage would help to overcome the handicap these soils have of excessive water during parts of the season and irrigation would improve the limited water-holding capacity of the surface soil during the growing season. When drained and irrigated, Dayton soils can produce bush beans, sweet corn and peppermint. Drainage can provide significant increases in yield, particularly when combined with irrigation and applications of commercial fertilizers. The major problem with draining the Dayton soils is in finding suitable drainage outlets. Dayton soils are concentrated on the stream-cut terraces which are nearly level. There are very few good locations for outlets. Surface drains are commonly constructed to remove surface water, but

generally are of limited effectiveness because of the very low slopes. Drainage is also affected by permeability, depth to the claypan or other layers that influence the rate of water movement, depth to seasonal water table, stability of ditchbanks, susceptibility to flooding or ponding, and salinity or alkalinity.[17]

Irrigation on Dayton soils is desirable because the period of least precipitation coincides with the growing season of most crops. This moisture shortage is aggravated in some soils, particularly Dayton soils, because of its extremely small water holding capacities. Dayton soils have available water capacity of only three to six inches above the clay subsoil.[18] Supplemental summer irrigation requirements for intensive crop production are estimated as requiring nearly 12 acre-inches of water per acre. For Dayton soils, this usually means ground water supplies. However, there is no serious shortage of water for irrigation in any of the watershed areas in the Middle Willamette River Basin that have easy access to the Willamette or Santiam Rivers.[19]

The Soil Conservation Service rates Dayton soils as being poor for irrigation. Irrigation suitability of a soil is affected by surface slope, susceptibility to stream overflow, water erosion, soil texture, content of stones, permeability of soil layers below the surface layer and fragipans or other layers that restrict the movement of water, amount of water held available to plants, and the need for drainage or depth to water table.

Because of the limitations Dayton soils have for irrigation and drainage, the requirements for equipment involved is more costly than with most soils. In draining an area of Dayton soils, tiles need to be

spaced fairly close together. It is estimated that the lowest cost possible with a plow drainage system, which would be required for most Dayton soils, would amount to $425 to $525 per acre if the tiles were spaced at 30 to 40 foot intervals. If a pumping system were required due to inadequate outlets, another $100 to $125 per acre can be expected. Annual costs for irrigation would range from $10 to $32 per acre if the same system were used.[20]

Irrigation costs for putting in a side roll sprinkler system would average about $285 per acre. Because the design and management of irrigation systems are different for Dayton soils than for other soils, costs are generally higher. It is necessary to apply the water slower and more frequently which does increase costs. Total costs of drainage and irrigation plus labor and machinery costs would amount to well over $1,000 per acre. Also included in the total cost is the interest on the average investment which is estimated at 20 years. On an average sized farm of 900 acres, drainage and irrigation costs alone, would amount to about $639,000 if the tiles were spaced at 30 foot intervals. Farmers would need a very high value cash crop to make the cost of putting in such a system pay for itself. There is also a problem with the relatively short life-spaon of the tiles, which is estimated at 20 years.

Some other Problems

Even with drainage and irrigation, farmers would have a difficult time making the crop pay for itself. For one thing, farmers gorwing the same crops on the better soils will be getting much higher yields

per acre. Another problem is market availability. In most cases, farmers sell their produce through a contractual agreement with marketing firms. It is very difficult to obtain contracts and in most cases, produce cannot be sold locally. This would increase total costs since crops would need to be trucked out of the immediate area.

Another alternative is simply to burn less frequently. This will produce less smoke, but will also produce a profitable crop only every other year or so. Combining this method with the "Close Clipper Crew Cut" may be an alternative although it will probably reduce seed quality and make the market less accessible.

OUTLOOK

In 1971, the Oregon Legislature passed a schedule for the reduction of field burning acreages and also called for an end to all field burning of cereal crops after January 1, 1975. In 1975 the date of abolition of burning was rescinded. A phasedown schedule was imposed to not more than 95,000 acres in 1975 and to 50,000 acres after 1977. Since that time, the Legislature raised the allowed acreages to 250,000 acres. The actual acreage to be burned, however, was to be based on weather conditions and the smoke management program of the State Department of Environmental Quality.[21] Along with the phasedown, burning fees were increased from three dollars per acre in 1975 to a maximum of eight dollars per acre in 1978. The fee was used as a disincentive to burning and to pay for research funds.

The limitations on burning have been in effect for about five years, and inevitably have had some effect on Willamette Valley grass and cereal crop growers.

However, the recent limitations on field burning acreages have had little impact on agricultural practices in the Willamette Valley. Some farmers have had to adopt alternative agricultural practices, such as using crop rotation and burning only the perennial crops every year, and scheduling the annual crops for burning every two to three years. In one study entitled "Oregon's Mid Willamette Valley Wetlands"[22], 10.6 percent of the several hundred farmers interviewed between 1977 and 1978 had made some land use changes. There were large net gains in acreages for legumes and small net gains for row crops, peppermint and strawberries. The largest net acreage loss was for grain. Smaller net losses occurred for grass seed and silage. "While the Willamette Valley grass seed industry constantly faces changing conditions, those which have occurred since 1970 have been especially pronounced. More costly field sanitation, residue removal and field cultural practices have begun to replace lower cost traditional open field burning which is no longer socially acceptable for environmental reasons."[25]

Fisher, in "An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley", reports on an economic study of the impacts of the burning ban on farmers by county. He suggests the following impacts:

> "Farms in Region 1, Clackamas and Multnomah countires, 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 farm size. In Washington and Yamhill counties where grass seed production serves primarily as complementary and/or supplementary enterprises, the trend toward production of proprietory 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."[26]

It has been estimated that high-cost annual ryegrass producers (10 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 ten dollars per acre above variable costs.

> "These data suggest that immediate internal adjustments involving cost reduction through increased resources used efficiently would become necessary following a burning ban for the high-cost producers of Bentgrass and ryegrasses. Adjustments include control of; (1) fertilizer and herbicide application, (2) machine costs, (3) hired labor through increased supervision and more judicious resource use."[27]

According to Fisher, in Linn, Benton and Lane counties, where poorly-drained soils are prevalent, the primary farming choice is to continue ryegrass production and adopt cost-reducing cultural practices and machine technology, as they become available, i.e., to stay competitive or leave the industry. Farm size expansion is an integral part of this adjustment process. Conversion of poorly-drained grass seed land for urban use is not expected to be rapid unless joint action for costly large-scale drainage effort is conducted.[28]

CONCLUSION

The Eugene-Springfield area is one of the fastest growing population centers in Oregon. There is no reason to believe this growth

trend will decrease, and in fact, projections indicate that it will continue to increase along with most other Willamette Valley cities. Along with the population increase there will inevitably be an increase in automobile use, pulp mill production and slash burning. When combined with the smoke from open field burning, the Eugene-Springfield area, along with the other areas receiving all these pollutants, will be, at times, very unpleasant environments in which to live. In view of this situation, it seems clear that the Oregon State Legislature will eventually have to adopt some strong anti-pollution measures limiting agricultural field burning until suitable alternatives are found. When this happens, several things are likely to occur:

(1) Those farms with fairly productive soils growing ryegrass, will change to some other crop;

(2) Small farms on Dayton soils will be consolidated into larger farms, and;

(3) Those farms near urban centers will shift from agricultural production to urban uses.

These three situations have been occurring on a small scale in Oregon already.

An important aspect of this paper has been the problems involved with non-agricultural use of Dayton soils. With the land use planning emphasis in Oregon on saving the most productive agricultural land for farm use, and the centralized location of the Dayton soils, conversion to non-agricultural uses seems inevitable for the Dayton soils. This potential shift to non-agricultural uses implies the need for in-depth practical information on ways to improve or reclaim the Dayton soils for urban and recreational uses.

There seems to be little that farmers can presently do to substitute for open field burning without incurring heavy expenses. Eventually there may be a suitable alternative, but in the meantime, farmers will probably continue to cut back their acreages and use a longer time span on their crop rotations before burning. The problem with finding a suitable alternative is that the alternative must be equal to, or more profitable than, the present crops or enterprises. This is, of course, necessary in order to amortize the additional production costs that will be associated with the changes or improvements.

FOOTNOTES

1 Setsuo Harry Tsutsui, "Oregon's Mid-Willamette Valley Wetlands: Agricultural Uses, Alternative Uses, Problems and Trends". Doctoral dissertation, Oregon State University, Corvallis, July 1979, p. 1.

2 Frank S. Conklin, and Douglas E. Fisher, Economic Characteristics of Farms Producing Grass Seed in Oregon's Willamette Valley. Circular of Information 643. Agricultural Experiment Station, Oregon State University, Corvallis, November 1973, pp. 3-4.

3 Fu Hua Chen. Foundations on Expansive Soils Developments in Geotechnical Engineering 12. Elsevier Scientific Publishing Company. New York. 1975, pp. 103, 104.

4 United States Department of Agriculture, Soil Conservation Service. "Waste disposal....Soil Surveys can help you". Washington, D.C. September 1974.

5 Frank S. Conklin, and Carlyle R. Bradshaw. Farmer Alternatives to Open Field Buring: An Economic Appraisal. Special Report 336, Agricultural Experiment Station, Oregon State University, Corvallis, October 1971.

6 Setsuo Harry Tsutsui, "Oregon's Mid-Willamette Valley Wetlands: Agricultural Uses, Alternative Uses, Problems and Trends". Doctoral dissertation, Oregon State University, Corvallis, July 1979, pp. 55, 56.

7 Ibid., p. 87.

8 Frank S. Conklin, and Jon Dean. Cost and Returns of Grass Seed Production in Oregon's Willamette Valley, 1959 to 1975. Special Report 464, Agricultural Experiment Station, Oregon State University. October 1976, p. 2.

9 Ibid., p. 18.

10 Frank S. Conklin and Carlyle R. Bradshaw. An Evaluation of Expected Private Losses from Selected Public Policies for Reducing Open Field Burning, Willamette Valley, Oregon. Circular of information 675. Agricultural Experiment Station, Oregon State University, Corvallis. March 1979, p. 30.

11 Douglas E. Fisher. "An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley, With Special Attention to Cultural Practice of Field Burning". Doctoral dissertation. Oregon State University, Corvallis. June 1972. p. 2.

12 W. H. Foote and H. J. Mack, Agricultural Field Burning in the Willamette Valley. Air Resources Center, Oregon State University. January 1969. p. 1.

13 Ibid., p. 1.

14 Douglas E. Fisher. "An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley, With Special Attention to Cultural Practice of Field Burning". Doctoral dissertation. Oregon State University, Corvallis. June 1972. p. 16.

15 W. E. Morton, D. F. Goldsmith and M. M. Martin, "Lung Cancer Mortality in Oregon". Oregon Comprehensive Cancer Program. Portland. November 1976. p. 2.

16 Frank S. Conklin, and Carlyle R. Bradshaw. Farmer Alternatives to Open Field Burning: An Economic Appraisal. Special Report 336, Agricultural Experiment Station, Oregon State University, Corvallis, October 1971, p. 6.

17 United States Department of Agriculture, Soil Conservation Service, in cooperation with Oregon Agricultural Experiment Station. Soil Survey of Benton County Area, Oregon. July 1975. p. 92.

18 Ibid., p. 23.

19 Oregon State Water Resources Board. ISDA Report on Water and Related Land Resources, Middle Willamette River Basin, Oregon. Portland. July 1962, p. 92.

20 Setsuo Harry Tsutsui, "Oregon's Mid-Willamette Valley Wetlands: Agricultural Uses, Alternative Uses, Problems and Trends". Doctoral dissertation, Oregon State University, Corvallis. July 1979, p. 98.

21 Ibid., pp. 57-62.

22 Ibid., abstract.

23 Oregon State Water Resources Board. Oregon's Long-Range Requirements for Water, Appendix 1-2, Willamette Drainage Basin. Portland 1969, p. 32.

24 Ibid., p. 32.

25 Frank S. Conklin and Jon Dean. Cost and Returns of Grass Seed Production in Oregon's Willamette Valley, 1959 to 1975. Special Report 464, Agricultural Experiment Station, Oregon State University, Corvallis. October 1976. p. 25.

26 Douglas E. Fisher, "An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley, with Special Attention to Cultural Practice of Field Burning". Doctoral dissertation. Oregon State University, Corvallis. June 1972, p. 146.

27 Ibid., p. 148.

28 Frank S. Conklin and Carlyle R. Bradshaw, An Evaluation of Expected Private Losses from Selected Public Policies for Reducing Open Field Burning, Willamette Valley, Oregon. Circular of Information 675. Agricultural Experiment Station, Oregon State University, Corvallis. March 1979, p. 55.

BIBLIOGRAPHY

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

Conklin, Frank S., and Dean, Jon., Cost And Returns of Grass Seed Production in Oregon's Willamette Valley, 1959 to 1975. Special Report 464, Agricultural Experiment Station, Oregon State University, Corvallis. October 1976.

Conklin, Frank S., and Bradshaw, Carlyle, R., Farmer Alternatives to Open Field Burning: An Economic Appraisal. Special Report 336, Agricultural Experiment Station, Oregon State University, Corvallis. October 1971.

Conklin, Frank S., and Bradshaw, Carlyle R., An Evaluation of Expected Private Losses from Selected Public Policies for Reducing Open Field Burning, Willamette Valley, Oregon. Circular of Information 675. Agricultural Experiment Station, Oregon State University, Corvallis. March 1979.

Chen, Fu Hua., Foundations On Exapnsive Soils. Developments in Geotechnical Engineering 12. Elsevier Scientific Publishing Company, New York, 1975.

Fisher, Douglas E. "An Economic Analysis of Farms Producing Grass Seed in the Willamette Valley, with Special Attention to Cultural Practice of Field Burning". Doctoral dissertation. Oregon State University, Corvallis, June 1972.

Floyd, Richard Thomas, Jr., "Drainage Studies on Dayton, Amity and Willamette Soils In the Willamette Valley, Oregon". Doctoral dissertation. Oregon State University, Corvallis. June 1958.

Foote, W. H., and Mack, H. J., Agricultural Field Burning in the Willamette Valley. Air Resources Center, Oregon State University. January 1969.

Hyer, Becker and Mumford: "The Economics of Grass Seed Production in the Willamette Valley, Oregon". Oregon Agricultural Experiment Station Bulletin 484. Oregon State University, Corvallis. September 1950.

Morton, W. E., Goldsmith, D. F., and Martin, M. M. "Lung Cancer Mortality in Oregon". Oregon Comprehensive Cancer Program. Portland. November, 1976.

Powers, W. L., and King, A. S., "Drainage Practices for Oregon". Station Bulletin 492, Oregon State University Agricultural Experiment Station. November 1950.

Tsutsui, Setsuo Harry, "Oregon's Mid-Willamette Valley Wetlands: Agricultural Uses, Alternative Uses, Problems and Trends". Doctoral dissertation, Oregon State University, Corvallis. July 1979.

Oregon State University, Agricultural Experiment Station. "Oregon State University Research on Field Burning", Circular of Information 657. Corvallis, December 1974.

_____, Agricultural Experiment Station, and Air Resources Center, Corvallis. "Research Related to Agricultural Field Burning. A Progress Report". February 1971.

_____, Agricultural Experiment Station. "The Management of Willamette Valley Soils. A Preliminary Report". Station Bulletin 185. November 1921.

Oregon State Water Resources Board, USDA Report on Water and Related Land Resources, Middle Willamette River Basin, Oregon. July 1962.

_____, Oregon's Long-Range Requirements for Water, Appendix 1-2, Willamette Drainage Basin. 1969.

United States Department of Agriculture, Soil Conservation Services, in cooperation with Oregon Agricultural Experiment Station. Soil Survey of Benton County Area, Oregon. July 1975.

United States Department of Agriculture, Soil Conservation Service, "Waste disposal....Soil surveys can help you". September 1974.