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Title THE LOCALIZATION OF THE UNITED STATES SUGAR BEET SEED INDUSTRY WITH EMPHASIS ON THE WILLAMETTE VALLEY

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This investigation has analyzed and described the impact of place on one of man's activities -- the production of sugar beet seed. It is apparent that in this activity man's relationship to the earth is especially close and dependent upon a number of factors. These are localizing factors. Sugar beets grown for seed are sensitive to a number of environmental elements, particularly to the physical element of temperature. Relative compatibility with certain established farming systems and the establishment of seed producing organizations in places favorable for sugar beet seed production are other localizing factors. Since the market for sugar beet seed is tightly controlled by contracting, and since the seed producing agencies have been established in certain favorable areas, and since quantity needs are rather static, it is probable that sugar beet seed production will continue to be localized in the present production areas. Furthermore, no great increase in quantity of production can be expected.

The long, relatively mild winters with temperatures favorable to development of the reproductive phase of growth in the sugar beet have made the Willamette Valley of Oregon one of the two chief sugar beet seed producing areas of the United States. Because it is the place offering the best opportunity for total or complete reproduction in all varieties, the Willamette Valley is the foremost producer of seed of bolting resistant varieties of sugar beets. For the same reason, it is the most prominent place for producing seed breeders' elite and stock seed for increase. It is probable that these aspects of the United States sugar beet seed industry will remain localized to the Willamette Valley.

The Willamette Valley has ample land on which sugar beets for seed could be raised should demand for seed ever warrant expansion. Sugar beets for seed compete favorably with other crops grown on the Valley's best soils; the present situation indicates that the same kind of competition could be carried to any suitable part of the Valley. With the only slight expansion now taking place, localization within the Willamette Valley will likely remain within a radius of 30 to 40 miles of Salem, and principally on a north-south axis on the more suitable alluvial soils.

THE LOCALIZATION OF THE UNITED STATES SUGAR BEET SEED INDUSTRY WITH EMPHASIS ON THE WILLAMETTE VALLEY

by

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RESEARCH METHODS

This investigation is based upon library and field research and some personal background. A major portion of the primary data was accumulated through interviews with personnel of the West Coast Beet Seed Company and farmers actively engaged in sugar beet seed production. A typewritten questionnaire containing about 55 items was used in the interviews with growers. Questions were asked concerning the nature of the farm and the grower's experiences, practices, and attitudes concerning the sugar beet seed crop. In selecting interviewees, it seemed desirable to talk with representatives of different parts of the Valley where sugar beets are grown for seed. This selection resulted in discussions with growers on different soils and topography, with different distances from Salem, and with locations in areas concentrating on different cropping patterns.

The Oregon State University Library was of value primarily as a source of data concerning the effects of temperature and light on development of the reproductive phase of growth in the species *Beta vulgaris*, particularly varieties of sugar beet.

Having resided for a number of years in one of the Willamette Valley's notable areas of sugar beet seed production, the writer has been in a position to observe closely some aspects of production of the crop. The writer's participation in a sugar beet seed harvest one summer intensified his observation of that aspect of production.

THE LOCALIZATION OF THE UNITED STATES SUGAR BEET SEED INDUSTRY WITH EMPHASIS ON THE WILLAMETTE VALLEY

INTRODUCTION

Insignificant might be a word which would come to mind to describe the sugar beet seed industry when statistics of sugar beet seed production in the United States are first viewed. Beet seed harvested from 4,078 acres yielded 6,227 tons in 1960. These statistics lose their insignificance when it is recognized that locked within the relatively small quantity produced on the relatively small acreage was the spark of life-energy that produced approximately 17,966,000 tons of sugar beets on 1,087,800 acres in 1961 (20). It thus becomes feasible to contend that the United States sugar beet seed industry is as important in the production of beet sugar as is the United States beet sugar industry. Even if the sugar beet seed industry were insignificant economically, it would make an engaging study for the geographer.

The sugar beet seed industry is eligible for investigation from a geographical point of view because production is found at particular places. Professional geographers would generally agree that geography is "the study of place on the earth's surface." More specifically, the geographer investigates place seeking to discover how it is modified by human organization and use. When the geographer properly studies sugar beet seed production he seeks to find what factors, physical and human, cause that production to be found at particular places. A major aim of this investigation is to discover why, of all the places in the United States, a considerable part of the country's sugar beet seed production is located in the Willamette Valley of Oregon.

What is place? A recent college edition of Webster's New World Dictionary defines place as "a particular area or locality; region." According to this definition, the Willamette Valley is a place. Moreover, this definition allows that a section one mile square within the Willamette Valley, or an even smaller area, can be considered places. All three measures of place are employed in this investigation; and the second objective of this systematic inquiry is to consider why the sugar beet seed industry of the Willamette Valley is localized to certain smaller places within the Valley.

A part of the task in the geographer's study of place or of a particular phenomenon localized at a place is the development of an analytical description of the place or the phenomenon as it appears at a place and is managed by man because of the peculiarities of that place. It is to this task that the final portion of this study is devoted.

FACTORS LOCALIZING SUGAR BEET SEED PRODUCTION WITHIN THE UNITED STATES

Although this investigation is concerned primarily with the sugar beet seed industry of the Willamette Valley, a study of factors localizing the industry within the United States is first essential. Research into factors localizing the sugar beet seed industry within the United States reveals that localization has resulted primarily from climatic influences. Temperature appears to be the most notable; however, length of day and moisture considerations have some bearing. Influences of lesser significance have to do with availability of land, farming systems, soils, diseases, and establishment of contracting agencies. The yield from research into the above influences forms the subject matter of the first portion of this thesis.

Temperature

The foremost localizer of the sugar beet seed industry within the United States is temperature. The ramifications of this climatic element on localization are plural.

Temperature first decides whether the life cycle principally used for production of seed of sugar beets in the United States can be used at a place. Although the sugar beet plant (Beta vulgaris) is considered a biennial, requiring two years to produce seed, it can be grown as an annual in some places by planting seed in late summer or early autumn. The plant undergoes a change from the vegetative to the reproductive phase of growth during the winter and develops its crop of seed in the following summer (16). This system of seed production is called the winter-annual method.

The winter-annual method has a localizing effect since characteristic winter temperatures at the place where it is practiced must allow the plant to survive. Probably most of the areas of the United States with continental type climates, characterized by occasional abrupt changes from mild or moderately cool weather to below freezing weather and long periods of below freezing weather (especially where there is not adequate snow cover), are eliminated from sugar beet seed production by the winter-annual method. It should be mentioned, however, that a method used for seed production in the first quarter of this century is technically possible in some of these places; however its use is not economically practicable for volume production because of greater labor and biennial time requirements. This method involved sowing the seed in the spring and letting the plant grow vegetatively the first season. In preparation for winter, the roots were dug and buried in field trenches or silos; these were planted the next spring in order to make seed the following ~~winter~~ summer (By W.F.T.) (16).

The winter-annual method, in short, localizes the sugar beet seed industry of the United States to those places which have sufficiently mild winter temperatures to permit survival of the plant after a fall sowing. The Willamette Valley in Oregon is one such place.

The second way, and apparently an even more important way, that temperature exerts a localizing influence on the United States sugar beet seed industry is through its effect on inducing reproductive development in the sugar beet plant. The effect of temperature in bringing about the reproductive phase of development is known as thermal induction. When reproductive development has proceeded to the stage that a seedstalk appears, the plant is said to have bolted, whether or not flowering later occurs (19, p. 51).

There seems to be a rather well identified or established range of temperatures for various varieties of sugar beets in which thermal induction will take place. Relatively cool temperatures induce the reproductive phase of growth in the vegetative sugar beet plant (19, p. 50). Within this relatively cool range of temperatures, the warmer temperatures supply smaller amounts of thermal induction and are suitable for induction in only easy-bolting varieties. (Easy-bolting varieties require the least extensive thermal induction in order to make them begin reproductive development. Other varieties are classed as having ordinary or intermediate bolting tendencies if they require intermediate or moderate amounts of thermal induction.

Still other nonbolting or bolting resistant varieties require extensive thermal induction in order to initiate reproductive development.) Certain temperatures, which supply the most extensive thermal induction, are adequate for induction in all varieties, but are required for nonbolting varieties (19, p. 64).

The "relatively cool" temperature range mentioned is shown in Figure 1. Generally temperatures slightly above and below 45° F are most effective for thermal induction (2, p. 435; 16). Temperatures above 60° F are cause for reversal, a neutralizing or subtracting of the inductive effect accumulated in a plant by favorable inductive temperatures. (Reversal will be discussed later in connection with a possible localizing effect.) Only vegetative growth is encouraged with temperatures above 70° F. Since induction is a growth phenomenon, temperatures near freezing have little inductive effect in that internal plant activity is slowed greatly at temperatures near freezing (16). Stout (19, p. 65) says: "It is evident that, although a large amount or high degree of thermal induction may be attained by storing sugar beets at a temperature near freezing, a long period of time is required because of the reduced rate of change that occurs at such temperatures." From this quotation it can be reasoned that although adequate induction might be attained by prolonged exposure to near freezing temperatures, the optimum range for induction occurs

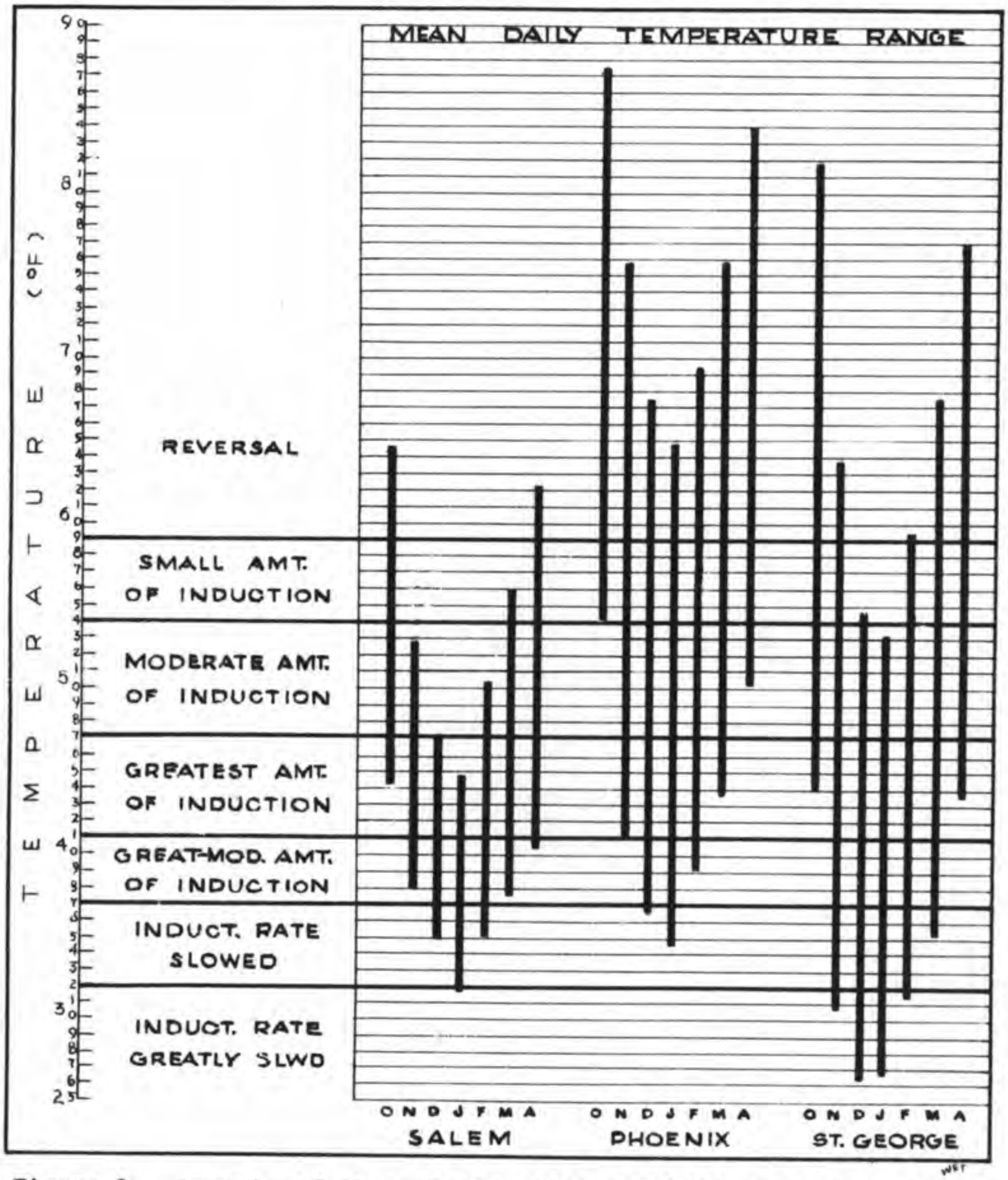


Figure 1. Amounts of thermal induction supplied by various temperatures and seed producing areas. The top point of each bar is the mean of the daily maximum temperatures for each month given, the bottom point the mean of the daily minima. The means show that the range of monthly and diurnal temperatures for Salem is much smaller during the induction period than for the other areas and that Salem's temperatures remain in the most favorable induction range longer. This is more clearly understood if it is recognized that of total bar length for each area, a much larger proportion of Salem's is in the range of greatest induction.

at warmer temperatures at which the rate of induction is more rapid.

With the most favorable temperatures, prolonged or long exposure is also an aid to induction. When a plant is exposed to favorable inductive temperatures for long periods, there is a greater potential or reserve for reproductive development accumulated than when the plant is exposed to the same temperatures for shorter periods (9, p. 106-8). A rather long period of exposure to inductive temperatures, 90 - 110 days, is necessary for most commercial varieties, with bolting resistant varieties probably requiring even a longer period.

What has all this to do with localization of the sugar beet seed industry in the United States? The answer is simply this: no place can produce sugar beets for seed unless it can supply the thermal induction requirement demanded by the variety to be grown there. This means not just occasionally reaching the induction temperatures favorable for the variety; it means maintaining those temperatures for a period sufficiently long for the variety to receive the amount of thermal induction required for the reproductive process to be fully completed.

The Willamette Valley of Oregon, the Salt River Valley of Arizona, and the Virgin River Valley of southern Utah are among the places in the United States which are able, at least for certain varieties, to meet the localizing requirements mentioned thus far. Indeed, these three places are easily the chief sugar beet seed producing areas of the United States. Among these places, however, there is a further localization of the sugar beet seed industry -- a localization by the thermal induction requirements of particular varieties.

Easy-bolting varieties, as mentioned, require only a relatively short period of cool temperature exposure to produce seedstalks. Nonbolting or bolting resistant varieties, however, require relatively long periods of exposure to cool temperatures for seedstalk development (19, p. 50). The longer exposure at relatively cool temperatures provides the more extensive thermal induction required by nonbolting varieties. As Figure 2 shows, the cooler temperatures within the favorable range provide adequate induction for all varieties, whereas the warmer temperatures provide adequate induction for only easy-bolting varieties. Comparison of temperature means and mean daily ranges in Figures 1 and 2 shows the impact of place on the ability to grow varieties of certain bolting resistances. The mean temperature range indicates that the Willamette Valley has temperatures more favorable for induction longer each day throughout the months when induction occurs. Figure 2 indicates that the Willamette Valley is able to produce all varieties, but is better suited

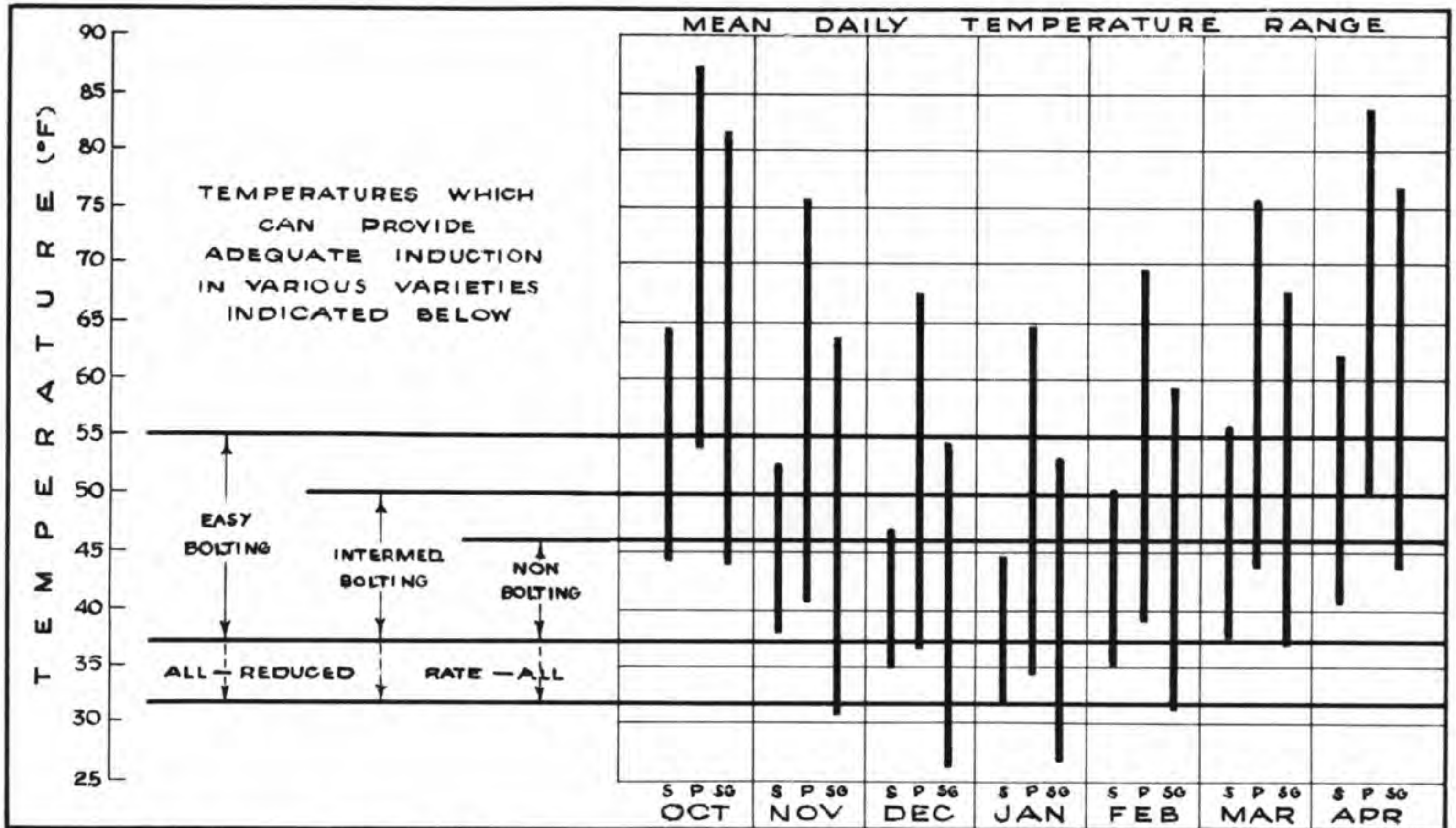


Figure 2. The general temperature ranges necessary to induce bolting in various varieties from easy-bolting to non bolting. The illustration also compares temperatures of the main sugar beet seed producing places month by month throughout the induction period. It is apparent that Salem's temperatures are more fa vorable for inducing bolting in nonbolting varieties. It may be noted that each bar, regardless of length, represents 24 hours.

than the other seed growing areas to produce nonbolting or bolting resistant varieties.

At this point it may be asked, "Why are there different degrees of bolting resistance? Why is there not one standard easy-bolting variety which can be used for seed production everywhere?" Stewart (16) answers, "The bolting resistance of a variety has definite bearing on regional adaptation for production of sugar and on the district in which seed can be grown by the winter-annual method." This is important. The place where seed will be sown for sugar production must not receive a variety which will bolt or form a seedstalk. Bolters in a sugar field contain less sugar, have lower quality, and are a nuisance in the mechanized harvest with the added trash of the objectionable seedstalks (4; 16).

Bolting is a minor problem in most sugar producing areas where the seed is planted in mid-spring. Easy-bolting varieties, the seed of which may be produced in warm winter climates like that around Phoenix in the Salt River Valley, may be planted in these areas for sugar, since by mid or late spring the temperatures of these areas will not supply adequate induction to produce bolting in even these easy-bolting varieties. But when seed is planted from September to November for sugar production, as in some mild winter climates such as the Imperial and San Joaquin Valleys of

California, it must be able to resist bolting and produce the sugary taproot -- not the seedstalk (16). Obviously these sugar producing areas require a bolting resistant seed which in turn must be produced at a place which is able to supply the thermal induction the variety requires to produce seed. The Willamette Valley is able to supply the requirements for the production of this bolting resistant or non-bolting seed (4). If easy-bolting seed produced at Phoenix were planted in late fall for sugar production in the Imperial Valley, the fields probably would produce mostly sugar beet seed.

Bolting resistant varieties of any notable degree of resistance cannot be produced in warm winter climates, such as at Phoenix, since the temperatures are not cool enough for sufficiently long periods to induce all the plants in a field to produce seed. (The warmth of the temperatures may be detrimental in another way as will be seen in the discussion of reversal.) Only the individual plants in the field with more tendency to bolt might go to seed; the more resistant will not. There will not be complete or total reproduction. This is undesirable since when the seed is harvested there is a kind of natural selection of seed of easier bolting tendency (2; 4, p. 435). Phoenix, then, and other warm winter climate places provide a thermal environment which works against seed growers' objectives in the production of bolting resistant seed.

Around St. George, Utah, in the Virgin River Valley, seed of a bolting resistance greater than that of Phoenix can be produced (4). This, and the fact that the Willamette Valley is able to produce a more bolting resistant seed than St. George and Phoenix may be seen in Figures 1 and 2 by study of the respective temperature ranges of each place.

Although the Willamette Valley could produce all varieties or all degrees of bolting resistance, it is particularly noted as a place which can produce the varieties of greatest bolting resistance. Nearly all of the bolting resistant varieties produced in the United States are grown in the Willamette Valley (4). One investigator (19, p. 66-7) of thermal induction in sugar beets tells again why this is so:

> From the standpoint of temperature, the most desirable seed-growing area, especially for the reproduction of non-bolting varieties, would be one in which moderately cool temperatures prevail continuously over a long period or one in which the transition from warm to low temperatures in the fall and from low to warm temperatures in the spring is long and gradual.

These ideals are more completely fulfilled in the Willamette Valley than in other seed growing areas. The "moderately cool" temperatures which prevail almost continuously over a long period in the winter in the Willamette Valley favor total or complete reproduction in bolting resistant varieties (4).

Total, complete, or 100 percent reproduction or formation of seed by every plant in a field is an important temperature-related localizing factor of the sugar beet seed industry in the United States. Not only is it important in the localization of nonbolting varieties, but it is perhaps more essential in localization to the place where plant breeders' stock or foundation seed of all varieties will be developed or grown for increase (4). In any field of sugar beets grown for seed anywhere it is desirable to have every plant form seed; but this is particularly true in the development of varieties grown in small plots for increase since there are many fewer plants within the plot than in a 20 acre field. It is desired that increases (the harvested seed) be as much like the parent material (the total of all plants grown in a field or plot) as possible in order to reproduce all the desired varietal characteristics of the parent material. "It is important that every plant produce seed in order to reproduce all these varietal characteristics"(4). When every plant in a plot produces seed, it is much more likely that the harvested seed will contain all the varietal characteristics of the parent plants in the plot than if only half the parent plants make seed. The half that does not seed could contain some desired varietal characteristic which requires an environment which will induce total reproduction. An example of this kind of condition on a larger scale was mentioned earlier in the discussion of why warm winter climates are not suitable for production of bolting resistant seed -- the temperature forces only the less desired easier bolting plants to seed.

To further clarify the special importance of total or 100 percent reproduction in small plots of stock seed grown for increase, a small plot might be compared with the tossing of a coin. If a coin is tossed only ten times, the result may be heads 30 percent, tails 70 percent. A much greater number of tosses (analogous to individuals in a sugar beet plot), perhaps 100, is much more likely to yield results true to the "parent" coin -- 50 percent heads and 50 percent tails.

Complete reproduction in stock or foundation seed grown for increase is most nearly effected in a place where the temperatures are relatively cool -- but not too cold -- for long periods, affording great amounts of thermal induction. The Willamette Valley also fulfils this localizing requirement better than any other seed growing place; no other provides such a long period of favorable induction temperatures. As a result, the Willamette Valley is the most important place for the production of stock seeds of all varieties (4).

A final aspect of the effect of temperature of reproduction in sugar beets should be mentioned since it may well have some influence on one of the localizing factors mentioned earlier. First, reversal, a term occurring on Figure 1, needs to be explained briefly. Reversal of induction is a neutralizing of the inductive effect previously accumulated in a plant (19, p. 50-1). It has been explained that the thermal requirements of different varieties have a localizing effect. It also was noted that Phoenix and places with warm winter climates cannot produce bolting resistant varieties because the temperatures are not cool enough for sufficient periods of time to induce bolting. In addition to not supplying adequate induction, or if it is supplied, the higher temperatures characteristic of these places reverse the inductive effect. "The rapid rate at which reversal occurs at warm temperatures suggests an explanation for the failure of nonbolting varieties to reproduce satisfactorily in some of the warmer seed-growing areas." (19, p. 67) Reversal results in incomplete reproductive development; seedstalks several feet high may turn vegetative (9, p. 121-2).

Even during the cooler periods of these relatively warm winter climates, temperatures at mid-day "may so counteract the effect of favorable cool night temperatures that little thermal induction results." Short "spells" or periods of too warm weather, which are harmful to reproductive development, can occur at any time from late fall through winter and early spring (19, p. 67).

Although reversal is an interesting and no doubt important consideration, it does not alter the localizing factor of thermal induction requirements demanded by different varieties -- that is, only easy-bolting varieties can be produced in warm winter climate places such as the Salt River Valley of Arizona. That any variety can satisfactorily produce seed in such places may seem surprising. The next section of this study may provide a partial explanation.

Length of Day

The sugar beet is a long-day plant, flowering when the periods of light are longer than the periods of darkness. The flowering schedule alone does not appear to be a localizing factor since all places in the United States have longer periods of light than darkness after about March 20 and shorter periods of light than darkness before that date.

Photoperiod, or length of light duration during the day, does seem to have an effect in inducing the reproductive phase of growth. For example, a long photoperiod appears to have somewhat the same effect on reproductive development in beets as does cool temperature (5, p. 78).

Of any two parallels of latitude in the United States, after about March 20 the northernmost daily receives a longer period of light and a shorter period of darkness than the other, and both receive over 12 hours of light. As the period of time after March 20 to June 20 becomes greater, the difference in the lengths of the periods of light and darkness also becomes greater. (Table 1) For example, on April 9, at latitude 45° N (Salem, Oregon) there is a day length of 13.2 hours. It is not until about 11 days later than latitude 33° N (Phoenix) has a day length of 13.2 hours.

Noting that the longer photoperiods seem the more favorable for induction, it can be recognized that after March 20 the more northerly places, such as the Willamette Valley, have photoperiods slightly more favorable for induction. Contrariwise, in considering a much larger portion of the induction period, the low-sun six months, the more southerly latitudes have longer photoperiods than the more northerly latitudes. For instance, for much of the middle of December Salem (45° N) has a day length of about eight hours and 48 minutes, whereas Phoenix (33° N) has a day length of ten hours. For the month of December alone, latitude 33° N receives 13 percent more day length than latitude 45° N. (Table 2 shows total day lengths for months of the induction period.) Although the difference in daylight received is greatest in mid-December, the more southerly latitude has greater day length during the entire low-sun period. For the entire low-sun season, latitude 33° N receives a total day length of 2274.0 hours, whereas latitude 45° N receives 1848.6 hours. The difference is 425.4 hours. It is remarkable to note that this difference is equal to over a month (35.4 days) of days with a light period

Table 1. Length of day (hours, sunrise to sunset) of the main sugar beet seed producing places of the United States during the period of induction of the reproductive phase in the beet.

Date Mon. Day		Phoenix, Ariz. 33°N	St. George, Utah 37°N	Salem, Ore. 45°N
Sept.	21	12.2	12.2	12.2
	25	12.0	12.0	12.0
	30	11.9	11.8	11.8
Oct.	5	11.7	11.6	11.5
	10	11.5	11.5	11.2
	15	11.4	11.3	11.0
	20	11.2	11.1	10.7
	25	11.1	10.9	10.5
	30	10.9	10.7	10.3
Nov.	5	10.7	10.5	10.0
	10	10.6	10.3	9.8
	15	10.5	10.2	9.6
	20	10.3	10.0	9.4
	25	10.2	9.9	9.2
	30	10.1	9.8	9.0
Dec.	5	10.1	9.7	8.9
	10	10.0	9.7	8.8
	15	10.0	9.6	8.8
	20	10.0	9.6	8.8
	25	10.0	9.6	8.8
	30	10.0	9.6	8.8
Jan.	5	10.0	9.7	8.9
	10	10.1	9.8	9.0
	15	10.2	9.9	9.2
	20	10.3	10.0	9.3
	25	10.4	10.2	9.5
	30	10.6	10.3	9.7
Feb.	5	10.7	10.5	10.0
	10	10.9	10.7	10.2
	15	11.0	10.8	10.4
	20	11.2	11.0	10.7
	25	11.3	11.2	11.0
Mar.	1	11.5	11.4	11.2
	5	11.6	11.5	11.4
	10	11.8	11.7	11.6
	15	11.9	11.9	11.9
	20	12.1	12.1	12.2
	25	12.3	12.3	12.4
	30	12.5	12.5	12.7
Apr.	5	12.7	12.8	13.0
	10	12.8	13.0	13.2
	15	13.0	13.1	13.5
	20	13.2	13.3	13.7
	25	13.3	13.5	14.0
	30	13.5	13.7	14.2

Source: United States Weather Bureau <u>Sunshine Tables</u> by C. F. Marvin. Reprint 1944, U.S. Government Printing Office.

Table 2. Total day length in hours of the months of the period of induction of the reproductive phase in sugar beets in the principal sugar beet seed producing places.

Month	Phoenix, Ariz. $33^{\circ}N$	St. George, Utah $37^{\circ}N$	Salem, Ore. $45^{\circ}N$
October	351.9	348.1	339.2
November	313.8	305.6	286.8
December	310.6	299.2	274.1
January	317.7	308.4	286.2
February	308.4	303.5	291.9
March	371.6	371.4	370.3
April	390.3	394.8	405.2
TOTAL	2664.3	2331.0	2253.8

The totals show that the more northerly latitudes have fewer hours of daylight. Since light appears to have an inductive effect, the more northerly latitudes provide for less photoperiodic induction than the more southerly latitudes.

of 12 hours each. Chroboczek (5, p. 77) says, "The fact that lengthening of the photoperiod has a similar effect to lowering of the temperature would indicate that both these factors bring about similar changes within the plants in relation to seeding in beets." The quotation leads the writer to suggest that the lengthened photoperiod of latitude 33° N provides greater, perhaps much greater, amounts of photo-induction than that provided by the photoperiod of latitude 45°N during the low-sun period, although neither latitude has a long daily photoperiod during this time. This writer would further suggest the hypothesis that the considerably greater amount of day length of Phoenix during the low-sun period, with the added induction it may supply, is a localizing factor in the sense that it allows part of the sugar beet seed industry to be localized at Phoenix, rather than being a localizing factor that actually draws the industry to Phoenix as temperature draws a part of the industry to the Willamette Valley. If it were not for the added induction seemingly supplied by photoperiod, the Phoenix area might not be able to satisfactorily produce sugar beets for seed. While discussing localization to the Phoenix area, it seems worthy of mention that higher light intensities seem beneficial to seed stalk development (5, p. 79). Any effect intensity of illumination may have, favors more southerly United States sugar beet seed producing places since the sun's rays strike the earth's surface in a more vertical manner at these places. It is notable also that the Phoenix area experiences characteristically sunny winters as contrasted particularly with the Willamette Valley's cloudy winters.

In considering the localizing factors or requirements of temperature and day length, it seems that a number of places in the United States could meet them, although it is apparent that some places can meet them better than others. The winter-annual method can be used to produce sugar beet seed in at least parts of the United States South. Central Tennessee produced a small amount during World War II. (17). Temperatures and daylength have allowed successful production in the Pecos and Rio Grande River Valleys of southwest Texas. "The winter-annual method with some modification is used in Denmark, and with good snow coverage the sugar beet will overwinter in southern Sweden" (17). These places are at about the same latitude as southern Alaska (55° N). The writer is not supposing that sugar beets could be produced for seed in southern Alaska, although the climate is similar to that of southern Sweden. It certainly seems likely, however, that the Cowlitz-Puget lowland of western Washington, with a climate much like that of the Willamette Valley, could produce seed. The West Coast Beet Seed Company of Salem, Oregon, has produced a small acreage near Madras, in central Oregon, in recent years. In this modified continental climate the crop froze out in one of the four years it was grown there; the presence or absence of snow cover and the abruptness with which cold temperatures begin in the fall seem to be the crucial factors concerning survival (6).

Other Factors

Although none is so critical as the tremendously important factor of temperature, a number of other localizing influences on the sugar beet seed industry in the United States are now reviewed briefly. They are: type of farming, availability of suitable land, moisture conditions, and diseases. When officials of what is now the West Coast Beet Seed Company were considering the Willamette Valley as a potential area for sugar beet seed production, they took into account most of these factors (4).

For example, sugar beet seed production is compatible with farming systems that include some intensive row crops and comparatively small fields. Sugar beet seed production is moderately intensive row-crop farming; in the Willamette Valley production occurs on comparatively small fields of five to 40 acres. Thousand-acre wheat ranches with an extensive kind of culture would not seem suited for a small acreage of intensive sugar beet seed production. On the contrary, a place in which the predominant kind of farming is highly intensive, with the crops earning a higher income per acre than sugar beets for seed, is not a suitable place for sugar beet seed production. A place such as the Willamette Valley, however, in which per-acre profits from sugar beets for seed compete favorably with other crops appears to be a desirable place from the standpoint of the localizing factor of type of farming.

The availability of suitable land is another factor to be considered. A deep, decidedly fertile soil is highly desirable (10, p. 5-6), in addition to level or slightly undulating topography. If different varieties are grown, there needs to be enough land to secure proper isolation of one variety from another. (The reasons for this will be discussed later.)

The precipitation pattern is a land-related localizing factor to be considered. The climate of a sugar beet seed producing place needs to be dry at harvest time in order that the seed may be properly cured and threshed. It is desirable that dry weather prevail for several weeks before harvest (4). Although it may be desirable to produce sugar beet seed in an area with a dry summer, the dry period necessitates the irrigation of the crop. The place where the crop is grown must have an availability of irrigation water and the means to irrigate.

Still another localizing factor is that it is desirable that no sugar beets grown for seed be produced in the same area as sugar beets for sugar (4). By avoiding beet sugar fields the opportunity of disease spread to and among beet seed fields is lessened.

Disease itself may be a localizing factor. "Curly top, a virus disease, is a major hazard to seed production in the Southwest if susceptible varieties are grown" (16). Pendleton and others (10, p. 20) report that varieties susceptible to curly top can be grown in western Oregon with little or no harm from the disease because the climate of that place is not favorable to the insect carrier of the virus of curly top. The Willamette Valley is able to provide for all of the localizing factors mentioned thus far. Of course, other places now producing sugar beet seed are able to meet whatever localizing requirements, besides the crucial one of temperature, that are demanded by the varieties they produce. After examining all the localizing factors mentioned, it is reasonable to wonder if there are places other than those noted that could meet all the requirements for at least certain varieties. There are several more places which produce small amounts of sugar beet seed; these will be discussed shortly. The question remains, however, if there are other United States areas which could produce seed, why are they not doing it? The answer lies in the reality that the present producing areas are able to meet the demand satisfactorily and have the established organization necessary to do so.

Sugar beet seed is produced by contract between a grower and a sugar company (16), or more commonly, between a grower and an agent of a sugar company -- a sugar beet seed company. The sugar companies know the kind of seed and how much of it they want produced. They contract with sugar beet seed companies to fill their specific needs, the quantity of which changes little from year to year. It follows that there is no need for expansion of the industry to new areas which might be marginal for seed production, or in some way not so desirable as present seed growing areas. Seed contracting agencies are presently established in areas where they evidently attain satisfactory, and probably the best, results for their purposes. Since their facilities for processing seed and their working relationships with some farmers are established, it would be inconvenient and expensive to move. The manager of the West Coast Beet Seed Company of Salem, Oregon, expressed the idea to the writer in referring to the seed producing agency of the Phoenix area with words to this effect: "They started ten years ahead of us. They continued because they were set up and were getting good quality and production." (4)

While discussing contracting and seed producing agencies, it seems fitting at this point to consider in slightly more detail the seed producing agencies, particularly the agency which operates in the Willamette Valley. Obtaining most of its seed in the Salt River Valley of Arizona, the Western Seed Production Corporation of Phoenix produces mostly commercial seed for the Middle West sugar producing areas of the following companies: Amalgamated Sugar Company, American Crystal Sugar Company, Great Western Sugar Company, and Holly Sugar Corporation. This beet seed agency accounts for about 50 percent of the United States sugar beet seed production (4). At St. George, Utah, the Utah-Idaho Sugar Company has established its own seed agency and obtains almost all its seed in the Virgin River Valley. This agency and area account for about ten percent of the country's output.

Of more importance to this study is the West Coast Beet Seed Company of Salem, Oregon, which became established in the Willamette Valley. In the fall of 1936 at Talent, near Medford in southern Oregon, an experimental planting was made with seed of such low bolting tendency that it would not satisfactorily reproduce in other seed growing areas by the winter-annual method. The crop the following summer did reproduce satisfactorily. By the fall of 1939, 500 acres were planted in Oregon (18). A West Coast Beet Seed Committee representing three sugar companies had an involvement in the 1936 trial. In 1940 this committee became the West Coast Beet Seed Company and established the center of its operations at Salem, Oregon (4). During the fall of that year 1,742 acres were planted in Oregon (18).

Today the West Coast Beet Seed Company is an independent corporation whose board of directors is composed of representatives of the eight major sugar refining companies -- Spreckles Sugar Company, Utah-Idaho Sugar Company, Union Sugar Company, Holly Sugar Corporation, Great Western Sugar Company, Amalgamated Sugar Company, American Crystal Sugar Company, and Farmers and Manufacturers Beet Sugar Association. West Coast provides all or a part of the seed requirements for these companies (4).

The member companies of the West Coast Beet Seed Company present that agency with orders for certain poundages of particular varieties of sugar beet seed, specifying what planting stock is to be used. After receiving the orders, West Coast acts independently in determining how many acres are required to produce the seed, in deciding the farmers with which to place acreages, and in placing acreages in order to provide proper isolation of the various varieties grown (4).

The West Coast Beet Seed Company produces large amounts of commercial seed, much of it of bolting resistant varieties. The agency is also responsible for the increase of sugar beet seed breeders' stock (new varieties of seed developed by plant breeders); this activity is carried on mainly in the Willamette Valley because of the more complete reproduction possible there. Increases are made of seed developed by plant breeders of the United States Department of Agriculture and various sugar companies (4).

Easily the greatest portion of West Coast's acreage (approximately 75 percent) is in the Willamette Valley, centering around Salem. A relatively small acreage is produced near Medford in the Rogue River Valley of southern Oregon. In addition, West Coast cooperates with the Farrar Loomis Seed Company of Hemet, California. The latter company contracts for some commercial sugar beet seed with farmers in the Hemet, Victorville, and Tehachapi areas of southern California (4). West Coast produces about 40 percent of total United States sugar beet seed production.

With the highly contractual basis upon which sugar beet seed is grown in the United States there is really no competition among the seed producing agencies. All seem to have somewhat specialized tasks which they perform for the sugar companies which they exist to serve.

Now that factors localizing the sugar beet seed industry within the United States and to the Willamette Valley have been discussed, it seems systematic to next consider factors localizing the sugar beet seed industry within the Willamette Valley.

FACTORS LOCALIZING THE SUGAR BEET SEED INDUSTRY WITHIN THE WILLAMETTE VALLEY

Salem, Oregon, at 45° N latitude is in the heart of the Willamette Valley. The Valley extends about 50 miles north of Salem to the juncture of the Willamette River with the west-flowing Columbia River. To the south of Salem, the Valley reaches over 60 miles to its head a few miles south of Eugene, Oregon. The width of the Valley is generally over 30 miles north of Salem and about 20 miles south of that city.

Joining the Willamette River as it meanders northward are a number of tributaries, of which the Santiam River is the most notable. The floodplains of the Willamette and its tributaries are coated with recent alluvial sediments. These stream bottoms are, in broad view, rather level with slight to notable undulations. The Willamette and its tributaries have carved themselves into a mass of older alluvial sediments known as the old valley filling soils which form the main valley floor. The main valley floor is level to gently rolling and interrupted occasionally, particularly in the central and northern parts of the Valley, by hills formed of resistant rock and protruding several hundred feet above their surroundings.

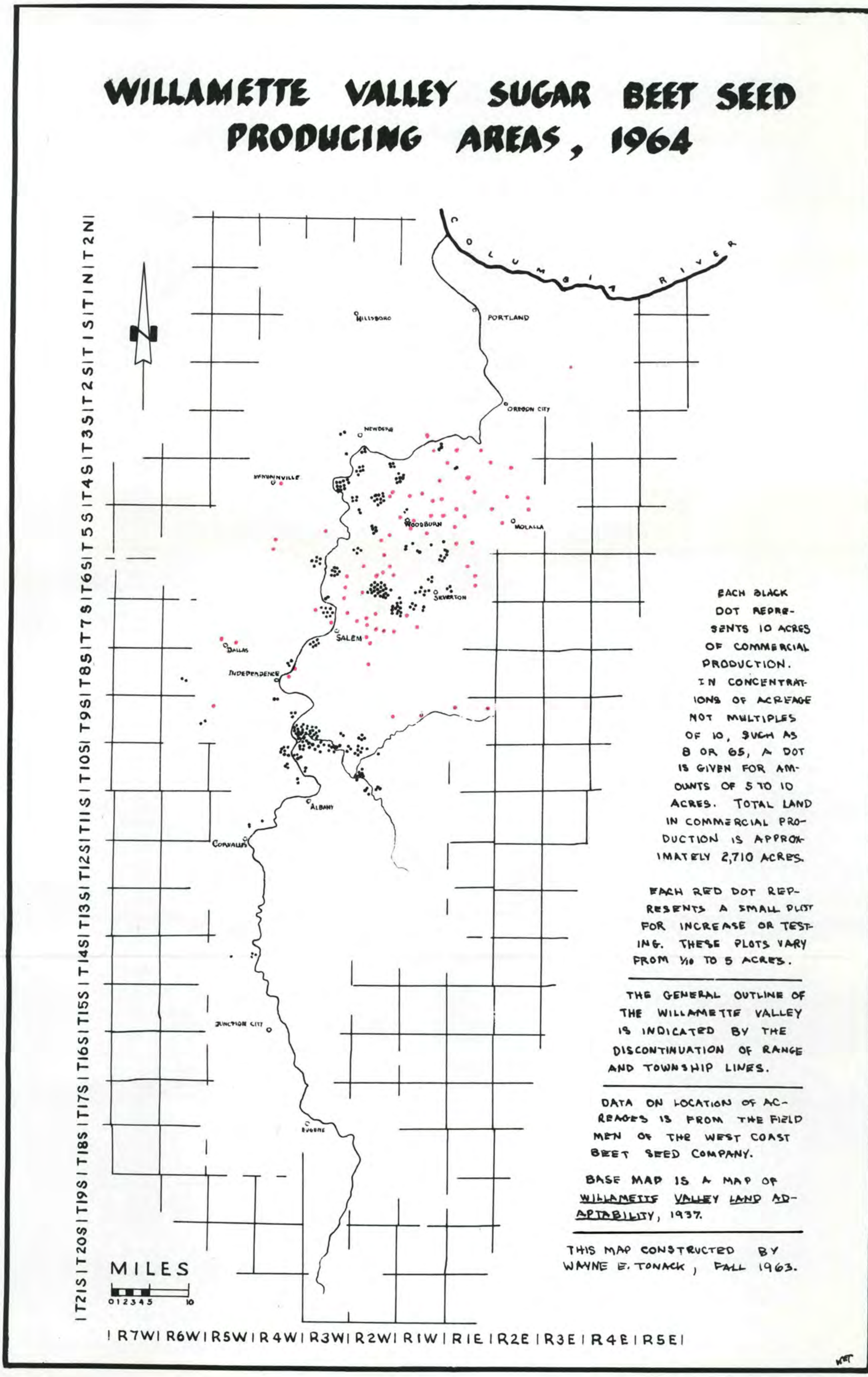
The Valley receives a mean annual precipitation of about 40 inches, mostly associated with cyclonic disturbances which pass over the area from late September to early June. Figure 1 shows that winter temperatures are relatively mild and subject to comparatively small daily ranges. Summer temperatures are much warmer and exhibit much larger daily ranges. In contrast to the almost continually cloudy skies of winter, the fair but hazy skies of summer produce almost no precipitation.

It is within this setting, and more specifically parts of this setting, that sugar beets are produced for seed. Several distribution patterns strikingly assert themselves as one examines the map of the Willamette Valley sugar beet seed producing areas. (Figure 3) These patterns are the result of the following localizing factors within the Willamette Valley: the need for isolation; the need for suitable soils; and proximity to Salem.

The Need For Isolation

The concentrations of acreage that clearly show on the map, especially north of Salem, may sometimes be seen plainly by driving through the Valley in an automobile. In the 1963-64 production year, it was possible for a person driving from Salem east to Silverton to see vividly a local concentration of acreage in the Central Howell-Pratum district several miles east of Salem. All the fields visible were on a strip-planted hybrid basis. (This kind of field will be

FIGURE 3


WILLAMETTE VALLEY SUGAR BEET SEED PRODUCING AREAS, 1964
COLUMBIA RIVER
PORTLAND
HILLSBORO
OREGON CITY
NEWBERG
MCMINNVILLE
WOODBURN
MOLALLA
SILVERTON
SALEM
DALLAS
INDEPENDENCE
ALBANY
CORVALLIS
JUNCTION CITY
EUGENE
N
EACH BLACK DOT REPRESENTS 10 ACRES OF COMMERCIAL PRODUCTION. IN CONCENTRATIONS OF ACREAGE NOT MULTIPLES OF 10, SUCH AS 8 OR 65, A DOT IS GIVEN FOR AMOUNTS OF 5 TO 10 ACRES. TOTAL LAND IN COMMERCIAL PRODUCTION IS APPROXIMATELY 2,710 ACRES.
EACH RED DOT REPRESENTS A SMALL PLOT FOR INCREASE OR TESTING. THESE PLOTS VARY FROM 1/10 TO 5 ACRES.
THE GENERAL OUTLINE OF THE WILLAMETTE VALLEY IS INDICATED BY THE DISCONTINUATION OF RANGE AND TOWNSHIP LINES.
DATA ON LOCATION OF ACREAGES IS FROM THE FIELD MEN OF THE WEST COAST BEET SEED COMPANY.
BASE MAP IS A MAP OF WILLAMETTE VALLEY LAND ADAPTABILITY, 1937.
THIS MAP CONSTRUCTED BY WAYNE E. TONACK, FALL 1963.
MILES
0 1 2 3 4 5 10
T2N | T1N | T1S | T2S | T3S | T4S | T5S | T6S | T7S | T8S | T9S | T10S | T11S | T12S | T13S | T14S | T15S | T16S | T17S | T18S | T19S | T20S | T21S
R7W | R6W | R5W | R4W | R3W | R2W | R1W | R1E | R2E | R3E | R4E | R5E
WET

discussed later.) After a few miles of driving on the main road and one county road, four different fields could be seen. A more thorough search of the area would have revealed more. After passing through expanses of the Willamette Valley which have no sugar beet seed production it is rather striking, especially in the winter, to come upon concentrations of the then bright green row crop. These concentrations, with the unusual pattern of distribution they create on the map, exist because of a need to isolate different varieties of sugar beets in order that cross-pollination does not occur.

Persons involved in sugar beet seed production do not want fields of one variety to contaminate fields of other varieties. Contamination by cross-pollination between different varieties results in a loss of varietal purity. If, for example, a field of a bolting resistant variety received pollen from a field of a less bolting resistant variety, the more bolting resistant field's seed would be of less bolting resistance than the plants on which the seed was produced. It will be remembered that the desired result is to have the seed be as faithful a reproduction of the parent plants as possible. Concentrations of different varieties must be spatially far enough removed from each other that cross-pollination will not occur (4).

The problem of securing proper isolation is complicated by the nature of beet pollen transport. The pollen of beets is dustlike;

it is so fine that it can be wind-blown great distances. Beets are among the plants that "...are noteworthy for the great distances that their pollen can be blown and effect cross-fertilization. Fields of different varieties of one type of beet (as garden beet or sugar beet) should be at least one-half mile apart -- preferably two miles." (1)

It is not difficult to recognize that the localizing effect of the need for isolation is influenced by considerations concerning winds. The influence of wind is seen by the following account. One of the farmers interviewed during this investigation told of a neighbor's field in which the pollinating plants were frozen out. Responsible persons decided that the pollinators of the farmer interviewed would pollinate the neighbor's male-sterile rows since the field of the farmer interviewed was upwind during the pollinating season (7). Prevailing winds also may alter the localizing requirements of isolation. With a prevailingly northwest wind in the Willamette Valley during the pollinating period, some varieties are purposely planted northwest of other varieties (4).

Any obstruction to pollen movement can alter the isolation requirements. A hill may reduce a one to two mile isolation requirement to a quarter mile. Trees can provide an especially effective screen to pollen movement (4). In Figure 3 in the area near the confluence of the Santiam River with the Willamette River (T. 9 S., R. 4 W.), a notable concentration of acreage appears. Near the west end of this concentration some different varieties are found. From the standpoint of isolation, the varieties seem too close together; no grouping of varieties can be differentiated. A part of the explanation for this proximity of varieties is that in this rather broad area of floodplain there is a tremendous screen of vegetation. A lush lower growth of vines, bushes, and small trees combines with tall cottonwood trees, among others, to provide a formidable barrier to pollen (6).

It should be mentioned in discussing concentrations that some produce only hybrid seed. In these concentrations it is possible to have several male-sterile varieties grown with a single pollinating variety. The male-sterile varieties are said to have a common pollinator(4;6). Concentrations with pollinators which have similar genetic background can be grown closer together with less harmful effects if pollen of one should reach the male-sterile variety meant to be pollinated by the other (6). The concentrations near the confluence of the Santiam and Willamette Rivers discussed above had pollinators of similar genetic background; this also is part of the reason the concentrations could be grown close together. Thus, similarity of genetic background also has an influence on the localizing factor of isolation. From the preceding paragraphs it is evident that there are several other "sub-localizing" factors which have an influence on the spatial requirements of the localizing factor of isolation.

Isolation seems to be even more important in localizing the small plots grown for the increase of breeders' stocks. Here again is a quotation from the manager of the West Coast Beet Seed Company:

> The primary concern in the production or increase of breeders' stocks is to keep the seed as free of contamination as possible. In the selection of ground for increase of these stocks, we endeavor to give other seed plots as wide a berth as possible so that contamination by wind-blown pollen will not occur.

This aids in the effort "... to insure that the seed to be harvested is the same as that which was planted." Figure 3 illustrates these words, showing the small plots widely scattered and generally located away from the center of the Valley where commercial seed is produced.

The effects of obstructions to wind also apply, of course, to small plots. In the center of T. 6 S., R. 2 W. two small plots may be noted rather close together. The plots in this case are separated by many fir trees. Also, some closely spaced small plots may have common pollinators, even though they be of different male-sterile varieties (6).

A final note about the localizing effect of the need for isolation is worthwhile. It has been shown that the need for isolation results in the concentration of acreages in certain localities. Conversely, the need for isolation is the factor that seems to keep sugar beets from being raised in the spaces or areas between many concentrations, even though these in-between areas may be perfectly suited for sugar beet seed production with farmers who would like to raise the crop. An Albany area grower (7) explained the situation neatly to the writer. The grower told of a farmer he knew who was located between two concentrations of different varieties. The farmer was unable to raise sugar beets because he was too close to each concentration, being between them (Figure 4). If he raised either variety, the pollen would contaminate the other variety. This space between remained barren of sugar beet seed production. Another example of the way the need for isolation can create areas in which sugar beets cannot be produced was reported by another farmer. He said that within about one mile of his sugar beet field a field of garden beets for seed was planted. Since garden beets and sugar beets are of the same species (Beta vulgaris) there was a danger of cross-pollination. Officials of the sugar beet company were concerned to the extent that they felt that if the situation were to be repeated they would not want to raise sugar beets there again. The garden beet seed farmer could have driven the sugar beet seed farmer out of business, creating a

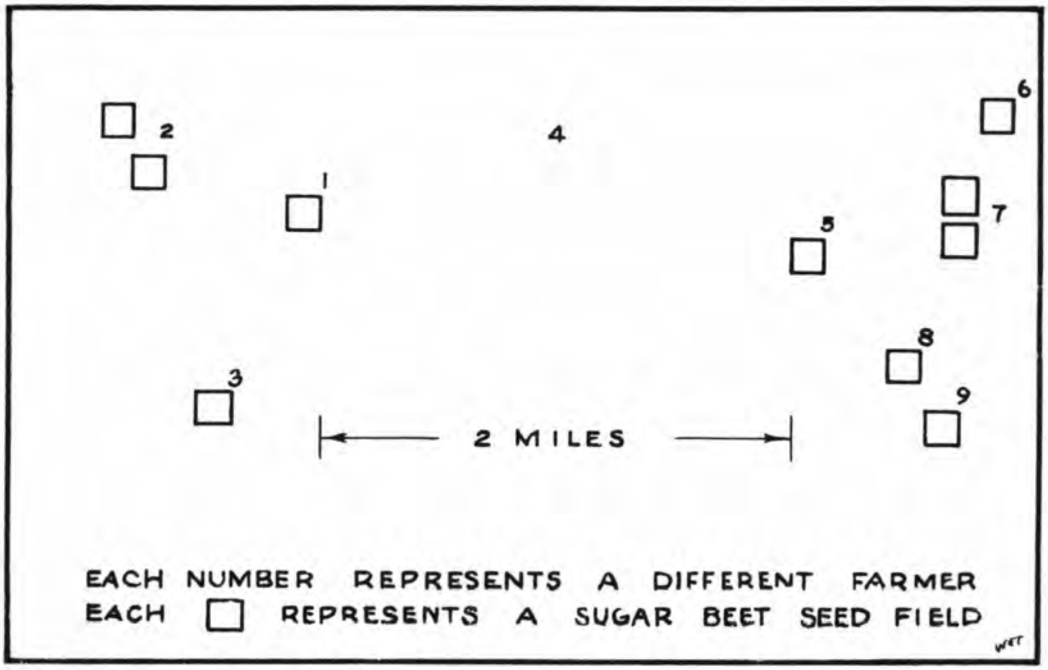


Figure 4. The localizing effect of isolation. Shown are two concentrations, each raising a different variety. As long as growers 1 and 5 raise sugar beets at their locations, 4 cannot, provided the variety concentrations remain the same. If either 1 or 5 quits, there is a possibility 4 could raise the variety he is nearest to. As it stands in the diagram, 4 would be too close to one variety if he would raise the other.

blank area for sugar beet seed production.

Now that the pattern of groupings and concentrations which appears in Figure 3 has been considered, it remains to consider why the concentrations and small plots appear where they do in the Valley.

The Need For Suitable Soils

Another look at the map of distribution shows that concentrations of acreage follow the Willamette and Santiam Rivers and are spread out in the area encompassing Salem, Silverton, and Newberg. Many small plots appear in the area from Salem northeastward across the old valley floor. Soil appears to be one of the chief factors localizing sugar beet seed production to these places.

The best soils for sugar beet seed production are high in fertility, friable, deep, and well-drained (10). The Willamette Valley soils which most completely display these qualities are those of the Chehalis, Newberg, and Willamette series. According to a Willamette Valley land adaptability classification (15), Chehalis and Newberg soils are classed as "land type 1", suited for production of intensive crops: mint, hops, vegetables, and the like. This type land is considered the best agricultural land in the Valley. "Type 2"land includes the Willamette series soils; it is less well adapted for production of intensive crops, but is adapted to general farming.

The Newberg series is a first bottom soil; it was deposited by swift water and has coarser subsoils than Chehalis, which is the second bottom soil formed in backwater. The Chehalis has a smoother topography than the Newberg series, although both are undulating to some extent. Both are well-drained, generally not leached, and neutral in reaction (11; 12; 13). Of the two, Chehalis generally is considered to be a better agricultural soil. Chehalis and Newberg soils are found most extensively on the Willamette and Santiam River floodplains, being recent alluvial soils.

Correlating the soil demands of sugar beets with the characteristics of Chehalis and Newberg soils, it is evident why concentrations of acreage follow the Willamette and Santiam Rivers.

In explaining the distribution of sugar beet seed acreage on the old valley floor in the area east of Salem, west of Silverton, and around Woodburn (Figure 3), soils again seem important. Much of this area is of Willamette series soils. These friable, fertile, well-drained soils with broadly or slightly rolling topography constitute land suitable for sugar beet seed production. Although some better drained Amity series soil is used, probably 80 percent of commercial production on the old valley floor is on soils of Willamette series (6). In summary, soils partly account for the broad patterns of distribution within the Willamette Valley. The localizing factors discussed thus far explain the concentrations of acreage that appear in Figure 3 and why the acreages and small plots are located where they are in the Willamette Valley. But it has not been explained why acreages occur only within an area about 25 to 30 miles north and south of Salem. Why is the great stretch of Willamette River bottom between Albany and Eugene not being used?

Proximity to Salem

The offices, warehouse, and cleaning facilities of the West Coast Beet Seed Company are at Salem. Growers must deliver their crop to that city. With a crop of high value for its bulk, such as sugar beet seed is, nearness to market is not a major localizing factor. When an Albany area farmer was asked if longer distance to market would make a difference in his choosing to raise the crop, he indicated that it would not since a six-ton truckload of sugar beet seed worth $1,800 can be hauled much farther than Albany to Salem with little reduction in profit. The factor of proximity to Salem has a different influence than cost of transportation to market.

Distance away from the Salem plant affects activities of the beet seed company itself to some extent. West Coast employs three men in the Valley who rather closely supervise the raising of the crop. With all the acreage shown on the map -- acreage that must be supervised -- it would be inconvenient, perhaps difficult, to have it spread farther away from Salem than is necessary. The small plots on the map, many involving very small acreages -- even fractions of acres -- normally require as much or more supervision than commercial fields (4). It seems only natural that the closest suitable land that can safely (isolation-wise) produce sugar beet seed is the land that is desired.

Other Factors

Within the areas that are physically suitable for sugar beet seed production there are other factors which further localize the industry. Size of farm is one such factor.

The effects of size of farm show especially well in considering small plots for increase and testing. Small farms of about ten to 30 acres are usually found for small plot seed increase and variety testing. The owners of these farms grow the crop only as a "sideline"; many are also engaged in other occupations. The owner of the plot is paid cash rent of $45 for a one-tenth acre plot provided the owner irrigates, and $35 if the beet seed company irrigates. It is essential that these small plots be irrigable. This may require irrigation with a garden sprinkler from a house well. Most of the

Figure 5. A varietal test plot characteristic of small plots for increase and testing. The garden-spot situation of some of these plots is shown here. The white stakes are about one foot high.

work is done by hand (6). For example, corn knives are used to harvest the seedstalks. Small hand threshers separate the seed from roughage. The small plot aspect of the Willamette Valley sugar beet seed industry is usually localized, because of its minute scale, to small farms or acreages (6).

The larger fields of commercial seed production seem to be localized on larger farms of the Valley. The average size farm on which these fields occur appears to be about 250 acres, based upon what the writer has discovered. In interviewing farmers the writer found more farms larger than 250 acres; the largest was 350, and the smallest was 150 acres.

For commercial seed production, it seems that larger diversified farms are more likely to have the equipment needed to raise sugar beets for seed, such as a vegetable crop cultivator, a self-propelled combine equipped with an attachment capable of picking up swathed rows, and adequate irrigation equipment.

No doubt a more important consideration is that the larger farms have adequate land on which to diversify and fit the sugar beet seed crop into rotations. Since sugar beets cannot be raised on the same land more than once every five years (volunteer beets would affect the following crops), a farm with plantings of 20 acres of sugar beets each year must have 100 acres on which to rotate sugar beets. Even a ten acre contract each year would require 50 acres of rotation land. Larger farms can afford also to summer fallow a field of land each summer if desired. (Summer fallowing land for sugar beet seed production is a common practice.) A smaller farm may need to keep all its acres in production every summer.

A farmer who has adequate land on which to raise sugar beets every year, who chooses to continue raising sugar beets, and who has a good production record, becomes an experienced grower and gains a preference over newer growers in the matter of obtaining contracts. The sugar beet seed company prefers to have experienced growers (4). An experienced grower who wants to raise sugar beets tends to keep the crop localized to his immediate area. This in a sense is a localizing factor within the parts of the Valley physically suitable and relatively close to Salem.

Localization of the sugar beet seed industry occurs on specific farms. Some larger farms include soils of more than one series. The crop would likely be localized on the better soil areas. Availability of irrigation can localize production of the crop on parts of a farm. An example is a farm near St. Paul which is divided into two separate parts (not adjacent; see Figure 6). Although both parts are Willamette River bottom land, one part cannot raise sugar beets because facilities for irrigation have not been developed (3).

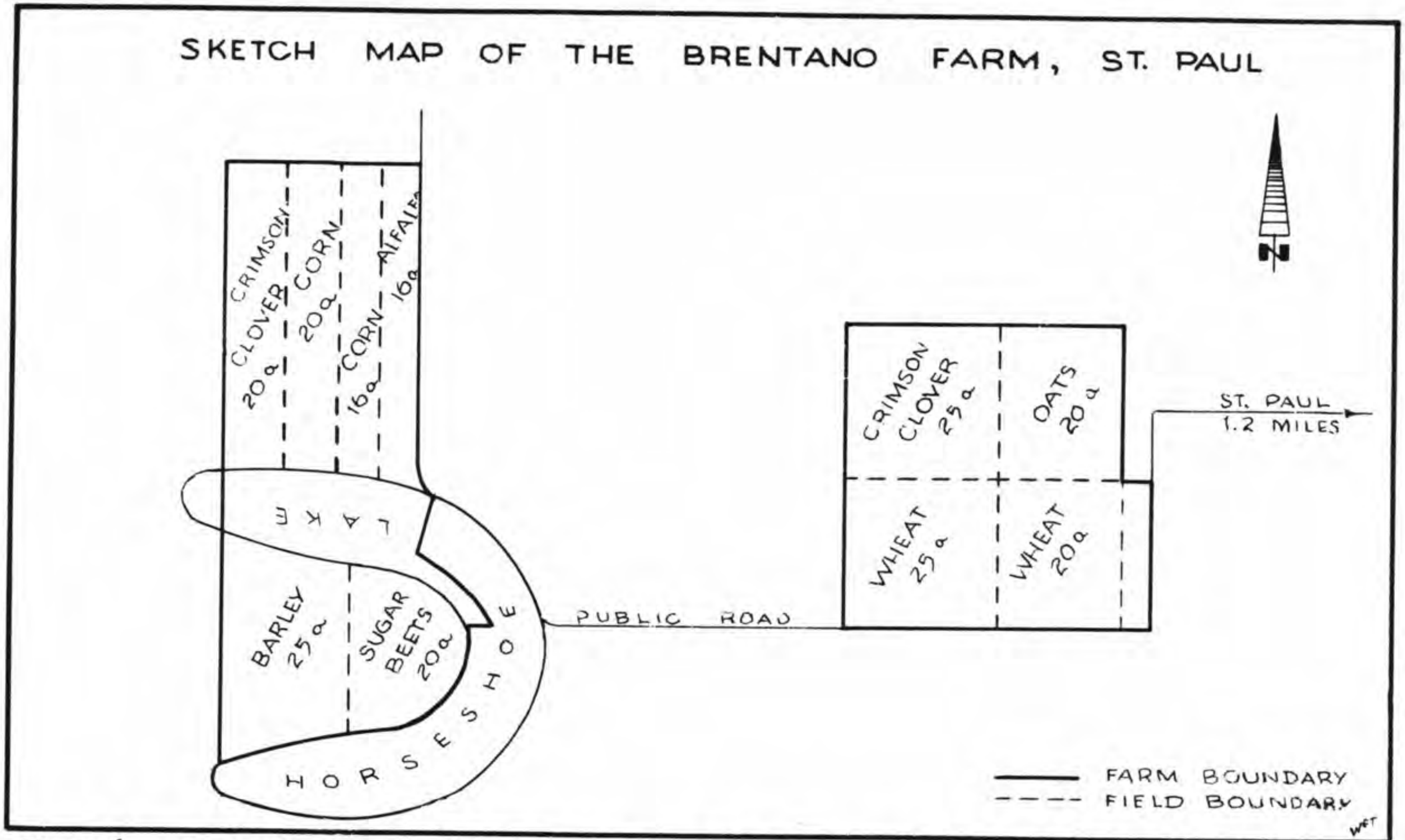


Figure 6. Localization on a particular farm. Since the eastern part of the farm is not irrigated, sugar beets are localized to the western part by irrigation. From year to year localization on the western part is determined by crop rotations.

When asked, "Why were your present sugar beet fields selected for the crop?" most farmers answered that the need to rotate creates a need to find a different field each year for five years. The field chosen could be any field which can be irrigated, has suitable soils, and is not producing a crop which competes to advantage with sugar beets for seed respecting profits. Sugar beets for seed earn considerably higher returns per acre than wheat, oats, barley, field corn, sweet corn, crimson clover, alfalfa, or hops, for examples in the Willamette Valley. If net return per acre for sugar beets is divided over a two year period, that crop earns notably less per year than pole beans, strawberries, or carrots for instance. If sugar beets are planted immediately after another crop is harvested, so that they occupy land for only one year, they offer returns that are among the better in the Valley. To illustrate the localizing influence of competitive profitability on a particular farm, the writer recalls having talked with a farmer who said that strawberries and pole beans earn greater profits for him than sugar beets for seed. Obviously, if a decision has to be made as to whether sugar beets or one of the other crops will be grown on a particular field, with profits the main consideration, the sugar beets will be localized elsewhere.

THE SUGAR BEET SEED CROP IN THE WILLAMETTE VALLEY

It is enlightening to consider more closely the crop in the Willamette Valley; to examine how it is adapted to the environment; and to recognize how it fits with farming systems and attitudes of some farmers of the area.

The Crop As It Is Grown In The Valley

Preparation of land for the sugar beet seed crop usually begins over a year before the crop is harvested. On about 75 percent of the land that is used for sugar beet seed production summer fallowing is practiced (4). This involves clean cultivation; the land is plowed in late spring or early summer and worked occasionally with various tillage tools, such as discs or spring-tooth implements (3). The aims of summer fallowing are to attain a measure of weed control and bring the soil into desirable tilth (4).

Willamette Valley sugar beet seed farmers work some variations on the summer fallowing theme. Some farmers irrigate to get weeds to germinate; then they till the land, killing the sprouted weeds. A farmer east of Salem told the writer he first harvests a clover hay crop from the land and manages to begin summer fallowing by plowing about July 1.

Nearly 25 percent of sugar beet seed land in the Valley is not summer fallowed or is fallowed for only a short time. This is possible when a crop being raised on the land is harvested early enough to allow soil preparation and the planting of the sugar beet seed at the proper time. An Independence area farmer (8) said that half the time he raises strawberries on land to be sown to sugar beets later in the summer. The strawberry crop, as the clover hay crop mentioned, is harvested early enough that considerable time remains for summer fallowing. An Albany area farmer (7) employs a system in which little or no summer fallowing may be done. Usually raising peppermint before the sugar beets, the farmer harvests the mint at about the same time the sugar beets are to be planted. The writer has seen an instance in which mint harvesting machinery was being followed on the same field by plows preparing the land for a sugar beet seed crop. Shortly after plowing, the land is "worked down" and leveled. The mint crop lends itself more to this kind of timing since with harvest the land is left clean: there is little roughage of any kind left on the field. The land also is slightly moist from summer irrigation. If the crop raised before sugar beets is harvested early enough, then, it is possible to raise two crops in two years, one of them being sugar beets. With all-summer fallowing before planting sugar beets, the crop demands the land for two years.

The Willamette Valley sugar beet crop is usually planted in August, early August being the most desirable time (4). Before planting, approximately 80 pounds of nitrogen in addition to four pounds of boron may be applied per acre and worked into the soil (3; 7). The rank growing sugar beets are heavy users of nitrogen; even the most fertile soils of the Valley require nitrogen applications (4; 10). Most of these soils also are deficient in boron. Applications of boron lessen the possibility of winter killing (10, p. 12). Some phosphoric acid and potash may be needed. Some farmers report the early fall application of up to 80 pounds of phosphate per acre (3; 8).

Before planting, the land is irrigated to insure sufficient moisture for seed germination. After the surface dries, the land is worked lightly to develop a favorable seedbed. Then the seed is planted (4).

A special four-row drill resembling a grain drill is used to plant fungicide treated seed. Unlike a grain drill, the sugar beet drill is equipped with "shoes" and packer wheels and spaces rows 24 inches apart (4; 7). Commonly the seed is planted at three-fourths to one inch in depth, depending on soil moisture conditions. Six to ten pounds of seed are planted per acre, depending on whether the seed is multigerm or monogerm. The desired spacing in the row is eight to 16 plants per foot; this helps to keep weeds controlled in the row and to restrict the size of individual sugar beet roots. (The plants with larger roots -- one and one-half inches or more near the crown -- are more liable to be killed by freezing than smaller plants.) (4)

Hybrid seed production brings about some interesting patterns of planting. With a method of "strip planting," a number of rows of pollinator variety are planted; a blank space is left; and a greater number of rows of male-sterile variety are planted. These strips are continued in order across a field. The common pattern is what the seed men call a 4-16-4 ratio. This means that four rows of a pollinator variety are planted, followed by a two-row space left blank, followed by 16 rows of a male-sterile variety, followed by a two blank row space, followed by four rows of the pollinator variety again. With this method 66.6 per cent of the field is male-sterile, 16.6 percent is pollinator, and 16.6 percent is blank space. The blank space is for the purpose of keeping the pollinator and the male-sterile from mingling together. The pollinator seed usually is not harvested. Even with two rows left blank, the two varieties may lodge or droop together when they mature.

Another method of producing hybrid seed is to plant the pollinator and the male-sterile seed as a mixture containing five to seven percent pollinator (4).

From the planting date in August to the beginning of dependable precipitation there commonly are dry periods. Hence irrigation, after planting (especially soon after), may be essential for fall growth (4).

As soon as the seedlings emerge, the field is cultivated. For this purpose a cultivator with precisely set sweeps (a part of the cultivator drawn through the soil) is used to break up the soil very close to the beet rows. Since the plants are very small at this stage, as much as 23 inches of the 24 inch row-to-row space may be disturbed in this cultivation. One farmer said he begins this cultivation as soon as the beet row becomes visible. This operation kills the weeds that are just beginning to sprout. In addition (7), this early cultivation avoids injury to the beet plant, since then they are small both above and below the surface of the soil. This very precise cultivating, however, remains a tedious task. One or two additional fall cultivations are normally required.

Too many weeds have adverse effects on sugar beet plants. Usually an effort is made to keep the crop as weed free as possible during the fall (4). Cultivation alone may not always be adequate. Fall hand hoeing may be employed as an aid in weed control. One farmer reported that the use of a tractor-mounted rototiller in a weedy field obtained favorable results (14). In early fall of 1963, the writer noticed a field in which mainly pigweeds were making a last effort to produce a crop of seeds and were thrusting seed arms as high or higher than the sugar beet plants. The field was beginning to look unsightly. The farmer brought in a tractor-mounted rotary mower and shredded both pigweeds and sugar beets to within a few inches of the ground. Within several weeks the sugar beets had grown new foliage, and the field appeared well-tended.

During fall and winter about six pounds of herbicide may be applied per acre to kill grasses if officials believe the grass problem is sufficiently threatening to warrant chemical control. Another spray may be applied during the winter to kill some broadleaf weeds. The beet plant, being somewhat dormant at the time of application, is not unduly damaged (6).

The sugar beet plants appear to nearly cease in external growth during winter (Figure 7). A relatively cold winter freezes the foliage to an extent that it may fall off, leaving a short, green growth at the center of the crown. During the winter, however, the plant is not inactive; thermal induction is taking place extensively.

Vegetative growth occurs with the onset of spring, and bolting begins shortly thereafter in early April. Once the seedstalks rise above the vegetative foliage, they heighten very rapidly. This time of resumption of external activity is a time of additional fertilizer

Figure 7. The typical appearance of sugar beet seed fields during the winter. The undulating topography characteristic of Willamette and Santiam River floodplain fields is illustrated by this field near the confluence of the Willamette and Santiam Rivers.

application (4). During the last days of March or the first of April generally 50 to 80 pounds of nitrogen are applied per acre. Additional nitrogen is added later in the spring. One farmer (7) reported the application of 80 pounds of nitrogen in late April, with 25 pounds more added in early June if he feels the crop needs it. The latter is applied through the first irrigation of the season; by that time the seedstalks are too tall for the tractor-drawn fertilizer spreader to be used. Another farmer hires an airplane application of 66 pounds of nitrogen in late spring (3).

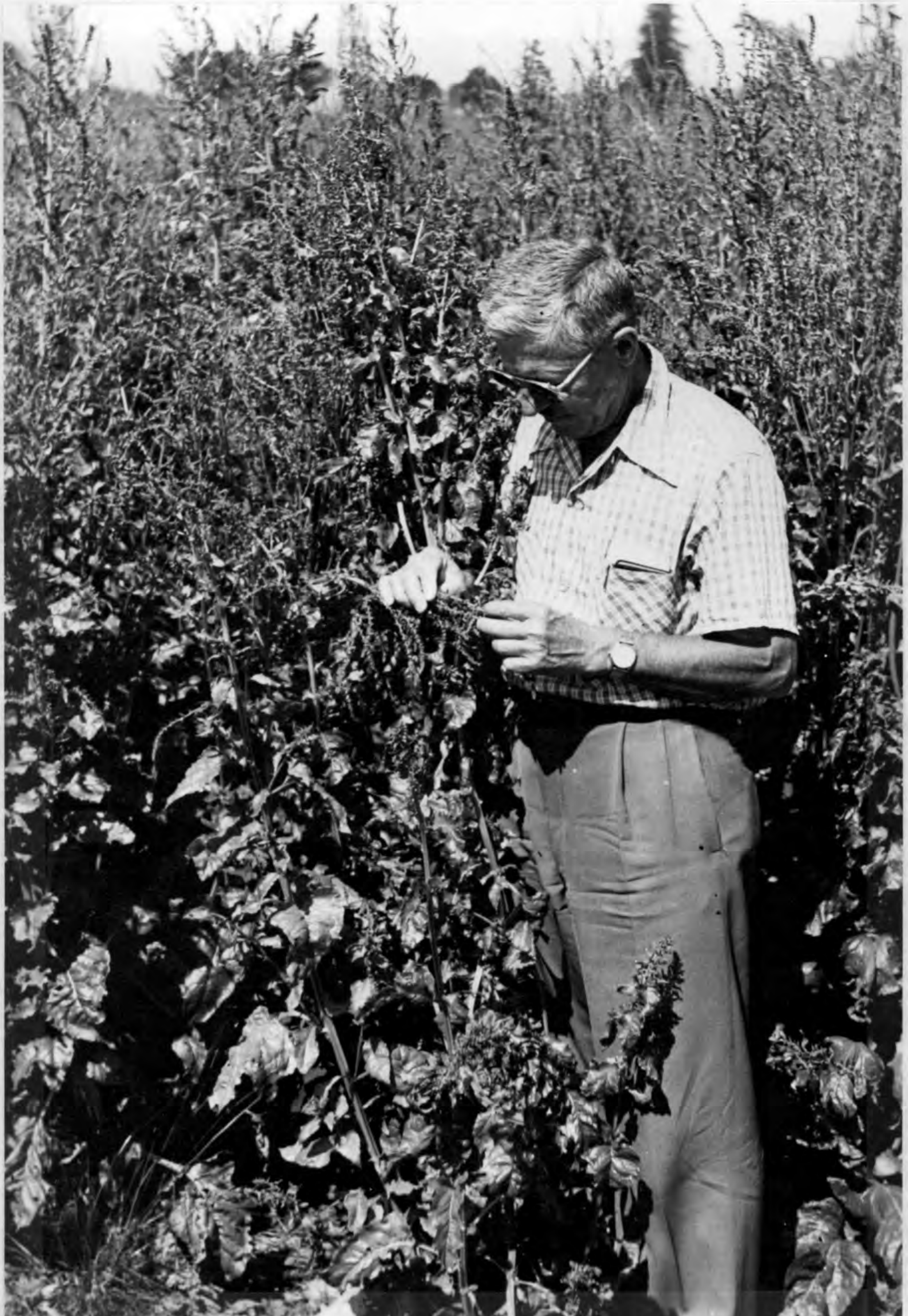
Because of the rapidity with which seedstalks elongate, field operations involving tractors must be completed relatively early in the spring. This rule pertains to the two or three cultivations. The height of the seedstalks after the middle of May eliminates the possibility of later cultivations. Additional hand weeding and hoeing, however, may be necessary in the spring and early summer. The first blooms appear in late May. The seedstalks attain heights of from seven to nine feet by early summer (4).

Depending upon the weather, the sugar beet fields are sprinkler irrigated every ten to 14 days from early June through the latter part of July. Three inches appears to be about the average amount of water applied at a setting. The writer, however, found some variances. The topography of the recent alluvial soils of the Willamette

Valley essentially demands sprinkler irrigation. This method becomes something of a problem when the sugar beets grow taller than the height of a man. The first irrigation requires little extra effort. With increasing height and later lodging, the sugar beet stalks create an entanglement almost impossible for men to carry pipe through. Techniques have been developed to lessen the severity of the problem. One farmer explained his technique; he "lays off trails like city blocks" in which to lay the pipe and walk. A trail is made through the field at every main (pipe) line outlet: this allows a passage route for the pipe and its movers. Perpendicular to these trails, at regular intervals throughout the field, another set of trails is constructed to permit moving the pipe across the field. Trails are made by manually parting the sugar beet growth. This process, once completed, is adequate for the season (3).

A farmer east of Salem removes this irrigation problem to some extent when he raises strip-planted hybrids. As the crop becomes rank, a huge sprinkler capable of irrigating about three-fourths of an acre per setting and mounted on wheels is pulled down the pollinator rows. From positions in these rows the sprinkler shoots water over the male-sterile rows from which the seed is to be harvested (14).

Figure 8. The rank growth of sugar beet plants grown for seed. The seed stalks attain heights of seven to nine feet by early summer. The stalks later lodge to heights of five to seven feet.



The sugar beet crop in the Willamette Valley is in full bloom in the middle of June. Later, when the maturing seed creates added weight, the stalks lodge and assume drooped heights of five to seven feet. Maturity is attained in early August, that stage being determined by cutting into individual seedballs at different places on different plants. If most seeds are in a moderate to hard dough stage, a field is ready for cutting. By this time some of the first seedballs to mature begin to shatter. Although most of the seed and stalks have a high moisture content and a green hue when cut, the stalk furnishes sufficient nourishment to ripen the seed (4).

The tangled, seed-laden stalks are cut and laid into large, loose rows by a self-propelled swather. For seed sugar beets, in addition to an eight foot horizontal sickle, the swather must be equipped with a vertical sickle approximately three feet in length. It would be almost impossible for the swather to move through the tangled mass of stalks without a vertical sickle to keep the side of the machine which moves through the uncut part of the field free from entanglement.

Varying somewhat with weather conditions, the swathed sugar beets lie on the ground for ten to 14 days. When the seed and roughage have dried sufficiently, a self-propelled threshing machine with large straw rack capacity is employed to separate the seed from the

Figure 9. A self-propelled combine threshing sugar beets north of Albany. A large tooth-studded belt with a width slightly greater than that of the swathed row continuously elevates the sugar beet roughage and seed into the slowly moving combine. The cloud of dust created by the combine indicates the degree of dryness required for the threshing of sugar beets. Sacked seed can be seen in the right middle-ground. (Courtesy of D. L. Cook)

roughage. The machine is equipped with a pick-up belt attachment at the header, so that as it creeps along, the swathed row is gently elevated and fed into the threshing parts (Figure 9). As the threshed roughage is discharged back to the ground behind the machine, the sugar beet seed is routed into either burlap sacks or into a large bin for later sacking.

The seed is delivered immediately to the West Coast Beet Seed Company's plant at Salem for cleaning and storage. The grower is paid immediately after his seed has met purity and germination requirements. West Coast stores seed for only a short time before shipping it on to the sugar companies (4).

Growers are paid 15 to 18 cents a pound for their cleaned seed. Farmers with whom this writer conversed get yields that range from 2,000 to 3,000 pounds per acre. Although an obvious exception, one farmer east of Salem is reported to have obtained 5,000 pounds per acre in a year in which yields were generally good. In the case of some hybrid seed fields, it will be recalled that 16.6 percent of a field may be unharvested pollinator, and 16.6 percent blank spaces. The grower is paid for the total acreage of his field as if it were all male-sterile. To state it differently, the grower is paid for the acreage of these two portions of his field on the basis of the yield per acre and price received on the male-sterile rows (4).

Figure 10. The West Coast Beet Seed Company plant at Salem, including offices, seed cleaning facilities, and warehouse. The method used to transport seed from the fields to the plant is shown by the several flatbed trucks loaded with seed contained in large burlap sacks.

Two farmers queried about production costs both agreed that three major costs were labor, fertilizers, and water pumping. One man, however, considered labor to be the largest cost item, whereas the other thought fertilizer was the largest.

Farmers seem to agree rather closely on labor requirements for sugar beet seed production in the Willamette Valley. With a field of about 20 acres, two men are required to plant, one man to cultivate, two men to irrigate, and two to five men to combine. Planting may take two days; total cultivation time may amount to two weeks; irrigation is twice daily for much of two months; and threshing may take over a week. These generalities depend, of course, on how many acres a grower has. There is some difference of opinion on hoeing or weeding labor. One man thought it does not pay to hoe; another thought a crew of five to 25 could be used if the occasion demanded it.

Equipment needed to raise sugar beets for seed in the Willamette Valley includes heavy tillage implements, a drill (planter), a vegetable crop cultivator, a fertilizer spreader, irrigation equipment (pump and pipe), a swather, a combine, and a medium weight flatbed truck. Most farmers use drills provided by the beet seed company; the same is true for the swather, but with the latter machine the company provides an operator also. If any airplane work is needed, it too must be hired.

Insects and diseases seem to be no real problem in raising the crop in the Willamette Valley. The Lygus bug, which eats on the green seed, has a detrimental effect on the seed's later germination. Airplane applications of DDT are effective against this insect (10, p. 22).

Although they are not serious disease problems, damping-off and Ramularia leaf spot can occur in the Willamette Valley. Damping-off is a fungus that causes newly emergent seedlings to develop blackened stems and to wilt to death. Ramularia leaf spot can lead to a loss of leaves of a plant.

Probably the most serious nuisance mentioned by farmers has to do with harvest aftermath; the ground is left with a smattering of beet seed. These seeds lead to volunteer sugar beets. From a distance the writer casually noticed a bright green field in November, 1963, which he assumed was a beet seed field. It was -- before its harvest three months earlier. Upon talking with the owner of the field, the writer learned what the situation was: great amounts of volunteer seed had sprouted.

Unusual weather is an infrequent problem. Two farmers mentioned having once had their crops frozen out in a cold winter. On another occasion hail struck a field and shattered seed to the ground

(7). Periods of wet weather during harvest are a slight problem.

Attitudes of Valley Farmers Toward The Crop

How does the sugar beet crop fit into some Willamette Valley Farming systems? The following specific cases attempt to answer the question.

About four miles northwest of Albany, Mr. M. J. Hansen farms 300 acres along the Willamette floodplain. His diversified operation concentrates upon peppermint, with 210 acres of that crop. Other enterprises include 20 acres of squash for seed, 20 acres of cucumbers for seed, ten acres of dill, and 20 acres of sugar beets for seed. Mr. Hansen has ten years of experience in raising sugar beets for seed. This experience is an influence in his continued raising of the crop, but the factor which every farmer is compelled to consider -- profits -- is perhaps a more important consideration. He says this crop is his most profitable, and that his land raises it well. Furthermore he states, "I like to raise cultivated crops." In short, sugar beets for seed fit in well with his present system of farming, and he likes to grow them.

About 20 miles north of Mr. Hansen, north of Independence, and on the west side of the river, is another large diversified farm -- the Sunset Farms, operated by Glen Hardman. The agricultural pursuits on this farm of over 300 acres include snap beans, table beets, sweet corn, strawberries, blackberries, cherries, in addition to sugar beets for seed. Mr. Hardman is a 14-year veteran in sugar beet seed raising.

Although Mr. Hardman considers snap beans and strawberries more profitable than sugar beets, the price he receives is one of the main reasons he chooses to produce sugar beet seed. The crop also fits well into his system of farming. Several examples show the truth of this statement. He follows his sugar beet crop with at least two years of corn in order to spray-control volunteer beets. Since corn is a blade-leaf plant, selective sprays can be used to kill the broadleafed sugar beets. In 1963, he planted sugar beets in a young orchard. He likes to follow strawberries with sugar beets; by so doing he is able to get two crops in two years from the same land. Mr. Hardman likes to raise sugar beets for seed because of the dependability of the crop. He says that with sugar beets there is less risk than with other row crops.

Ernest and Gerald Roth, a father and son team, farm 260 acres east of Salem in the Central Howell area. Their unit lies mainly on older alluvial soils of Willamette series. They raise wheat, oats, barley, sweet corn, alfalfa, clover, filberts, and sugar beets for seed. They planted 26 acres of the latter crop in 1963. Mr. Ernest

Roth says he likes the kind of profits that can be earned with sugar beets as well as the opportunity they give for furthering diversification and lessening dependence on certain other crops. He likes to raise sugar beets, a crop which fits in well with the Roth's present system of farming.

Another father - son unit, Charles and Harold Brentano, is located on a 268 acre farm about one mile west of St. Paul. Over 200 acres of this farm is Willamette River bottom land. Charles Brentano has been raising sugar beets for seed since 1943, shortly after the industry was established in the Willamette Valley. In addition to their 20 acres of sugar beets in 1963, the Brentanos raised red and crimson clovers for seed, field corn, wheat, barley, and oats. They feel essentially the same as the other farmers about raising sugar beets for seed. They believe that this crop is the most profitable of the several they raise; that it fits well with their system of farming; and they like to raise sugar beets for seed. No doubt 20 years of experience with the crop also must influence their decision to continue to raise it.

An interview with another grower revealed that he did not "especially" like to raise sugar beets, but that he thinks the crop fits in well with his system of farming and earns a good income.

The opinions expressed indicate that sugar beets for seed are compatible with other enterprises on Willamette Valley diversified farms of moderate to large size.

SUMMARY AND CONCLUSIONS

This investigation has analyzed and described the impact of place on one of man's activities -- the production of sugar beet seed. It is apparent that in this activity man's relationship to the earth is especially close and dependent upon a number of factors. These are localizing factors. Sugar beets grown for seed are sensitive to a number of environmental elements, particularly to the physical element of temperature. Relative compatibility with certain established farming systems and the establishment of seed producing organizations in places favorable for sugar beet seed production are other localizing factors. Since the market for sugar beet seed is tightly controlled by contracting, and since the seed producing agencies have been established in certain favorable areas, and since quantity needs are rather static, it is probable that sugar beet seed production will continue to be localized in the present production areas. Furthermore, not great increase in quantity of production can be expected.

The long, relatively mild winters with temperatures favorable to development of the reproductive phase of growth in the sugar beet have made the Willamette Valley of Oregon one of the two chief sugar beet seed producing areas of the United States. Because it is the place offering the best opportunity for total or complete reproduction in all varieties, the Willamette Valley is the foremost producer of seed of bolting resistant varieties of sugar beets. For the same reason, it is the most prominent place for producing seed breeders' elite and stock seed for increase. It is probable that these aspects of the United States sugar beet seed industry will remain localized to the Willamette Valley.

The Willamette Valley has ample land on which sugar beets for seed could be raised should demand for seed ever warrant expansion. Sugar beets for seed compete favorably with other crops grown on the Valley's best soils; the present situation indicates that the same kind of competition could be carried to any suitable part of the Valley. With the only slight expansion now taking place, localization within the Willamette Valley will likely remain within a radius of 30 to 40 miles of Salem, and principally on a north-south axis on the more suitable alluvial soils.

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